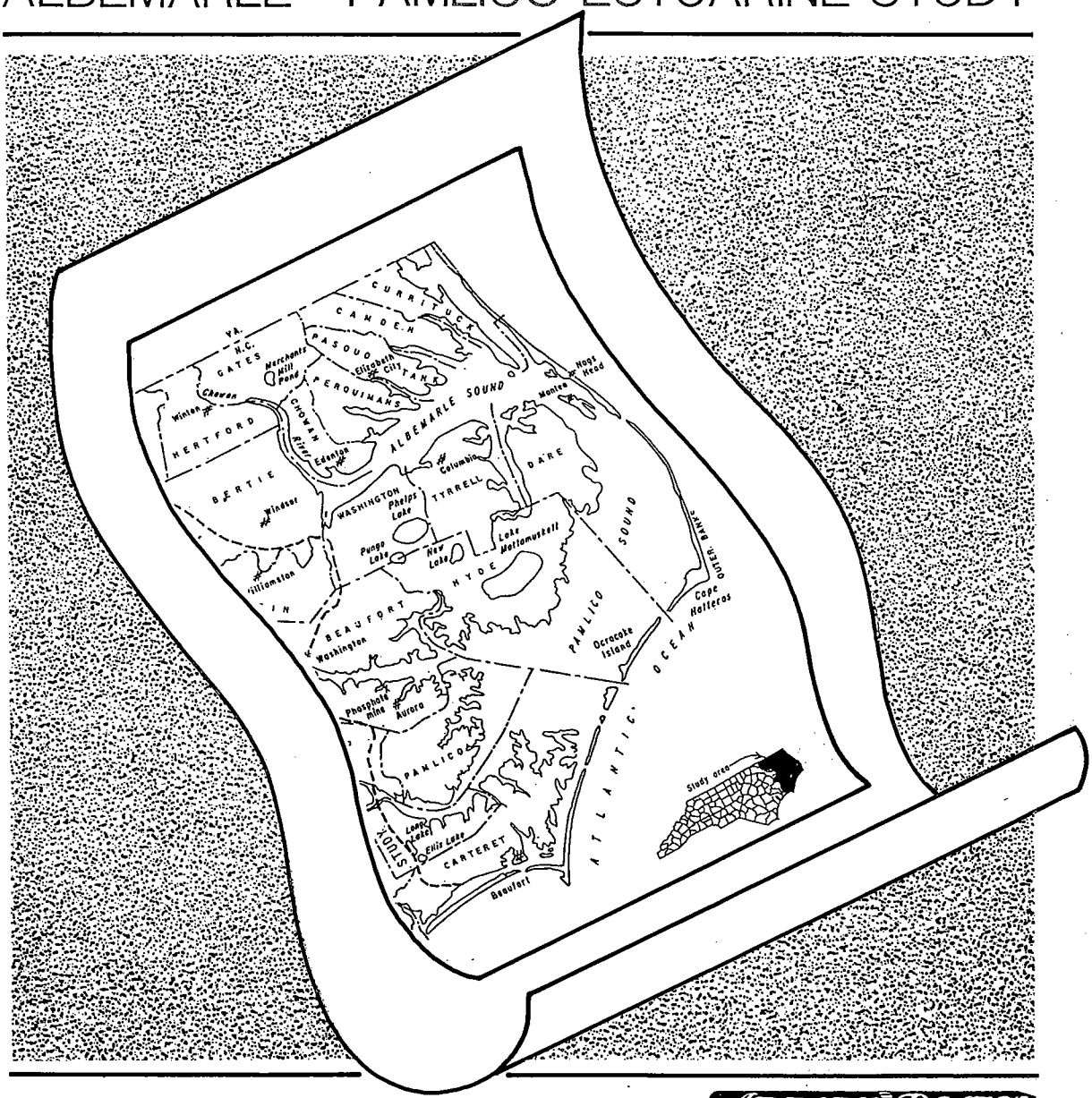
December 1990 Project No. 90-19

A Comprehensive Environmental Management Plan for the Currituck Sound Drainage Basin: Background Investigations

ALBEMARLE - PAMLICO ESTUARINE STUDY



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ALBEMARLE-PAMLICO

A Comprehensive Environmental Management Plan for the Currituck Sound Drainage Basin: Background Investigations
Final Report

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A/P Study Project No. 90-19
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I am indebted to John Abbott, Head Librarian, Natural Resources Library, North Carolina State University, for performing an online search for pertinent bibliographic references; and also to the United States Soil Conservation Service, City of Virginia Beach, City of Chesapeake, and North Carolina Center for Geographic Information and Analysis for preparing a map of the study area.

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ABSTRACT

The Currituck Sound drainage basin experienced rapid population growth and development during the past two decades. As a result of the changes that have occurred and are continuing to occur in the watershed, natural resource managers face new management issues.

The objectives of this study were to 1) prepare an up-to-date, computer-accessible bibliography on Currituck Sound and Back Bay, Virginia; 2) identify perceived management issues in the study area; and 3) analyze an array of responsive, prospective management alternatives. Government officials and researchers performing investigations in the study area were consulted for their views concerning management issues in the Currituck Sound drainage basin. Formal and informal interviews were conducted over a one year period from September 1989 through August 1990. In order to determine the general issue perception of the Currituck Sound Watershed Committee, the advisory panel for this project, each member was asked to complete a short questionnaire. Although no clear consensus exists on the nature and extent of problems in the Currituck Sound watershed, the interviews yielded two broad issue categories: 1) Currituck Sound is perceived to be a declining resource with respect to water quality and wildlife habitat; and 2) Responsibility for management of this ecosystem is split among multiple federal, state, and local jurisdictions.

Three categories of prospective alternatives for future management of the Currituck Sound drainage basin were considered:

1. Alternatives which require no new institutions
   -Maintenance of the status quo
   -Increased local government action

2. Alternatives which require formation of new, non-statutory institutions
   -Adoption of an administrative agreement
   -Creation of an interstate planning agency
3. Alternatives which require formation of new, statutory institutions
   -Adoption of an interstate compact
   -Formation of a federal-interstate compact.

Each prospective option was examined in terms of advantages and disadvantages. Also, alternatives were analyzed with respect to conformity with attributes of a successful natural resource mangement agency and ability to perform requisite duties. No attempt was made to select a preferred alternative for future management of the Currituck Sound drainage basin as this decision was outside the scope of the current project. It is intended, however, that this work will provide insight to government officials and resource managers charged with making such decisions for the Currituck Sound-Back Bay complex and the larger Albemarle-Pamlico Estuarine Study Area.

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A Comprehensive Environmental Management Plan for the Currituck Sound Drainage Basin: Background Investigations

INTRODUCTION

The Water Quality Act of 1987 (Public Law 100-4) created a National Estuarine Program with a fourfold purpose:

1. identification of nationally significant estuaries that are threatened by pollution, development, or overuse;
2. promotion of comprehensive planning for, and conservation and management of, nationally significant estuaries;
3. preparation of management plans; and
4. coordination of estuarine research (101 Stat. 61).

The law gave "priority consideration" to Albemarle Sound, North Carolina. A joint project of the United States Environmental Protection Agency (EPA) and the State of North Carolina, the Albemarle-Pamlico Estuarine Study (A/P Study) was the first program designated under the 1987 amendments to the Clean Water Act. Developing a comprehensive resource management plan for the Albemarle-Pamlico drainage basin emerged as a major goal of the A/P Study. Currituck Sound, a 97,000 acre freshwater estuary located in the northeast corner of North Carolina (Currituck Sound Task Committee, 1980), is a part of the Albemarle-Pamlico estuarine complex. In recent years, local interests have become concerned about the environmental condition of the Sound. For example, the "Preliminary Status and Trends Report of the Albemarle-Pamlico Estuarine Study" identified several serious environmental problems impacting North Carolina's estuaries. These include declining water quality, decreasing populations of submerged aquatic vegetation, and a declining fishery resource. Conversion of wetlands for development and agricultural purposes is another area of major concern (Copeland and Gray, 1989). Although Currituck Sound

shares the difficulties of the complete estuarine complex, it is also an individual entity with unique problems. Various natural resource issues have surfaced relative to the Sound: fish productivity, water circulation, salinity, water quality, aquatic plant growth, fish disease, and migratory waterfowl status (Currituck Sound Task Committee, 1980).

This project focused on gathering and analyzing background information necessary for development of a comprehensive management plan for the Currituck Sound drainage basin. In addition to the waters of Currituck Sound, the study area included 26,000 acres of open water in Back Bay, Virginia and the land draining into Currituck Sound, Back Bay, Northwest River, North Landing River, and other tributaries to Currituck Sound (Figures 1 and 2). Based on North Carolina Center for Geographic Information and Analysis calculations, the total watershed covers approximately 733 square miles. However, delineating exact watershed boundaries in the topographically flat lower coastal plains is extremely difficult. For this reason, the project focused on jurisdictions that fall wholly <u>or</u> partially within the drainage basin.

The project was divided into three tasks:

1. Preparation of an up-to-date, computer-accessible bibliography on Currituck Sound and Back Bay, Virginia.
2. Identification of perceived management issues in the study area.
3. Analysis of an array of prospective management alternatives and coordinative mechanisms for the Currituck Sound-Back Bay complex.

The success of this project depended on close coordination among federal, state, and local government agencies involved with the management of the study area. A Currituck Sound Watershed Advisory

Figure 1. General Location Map
Currituck Sound Drainage Basin

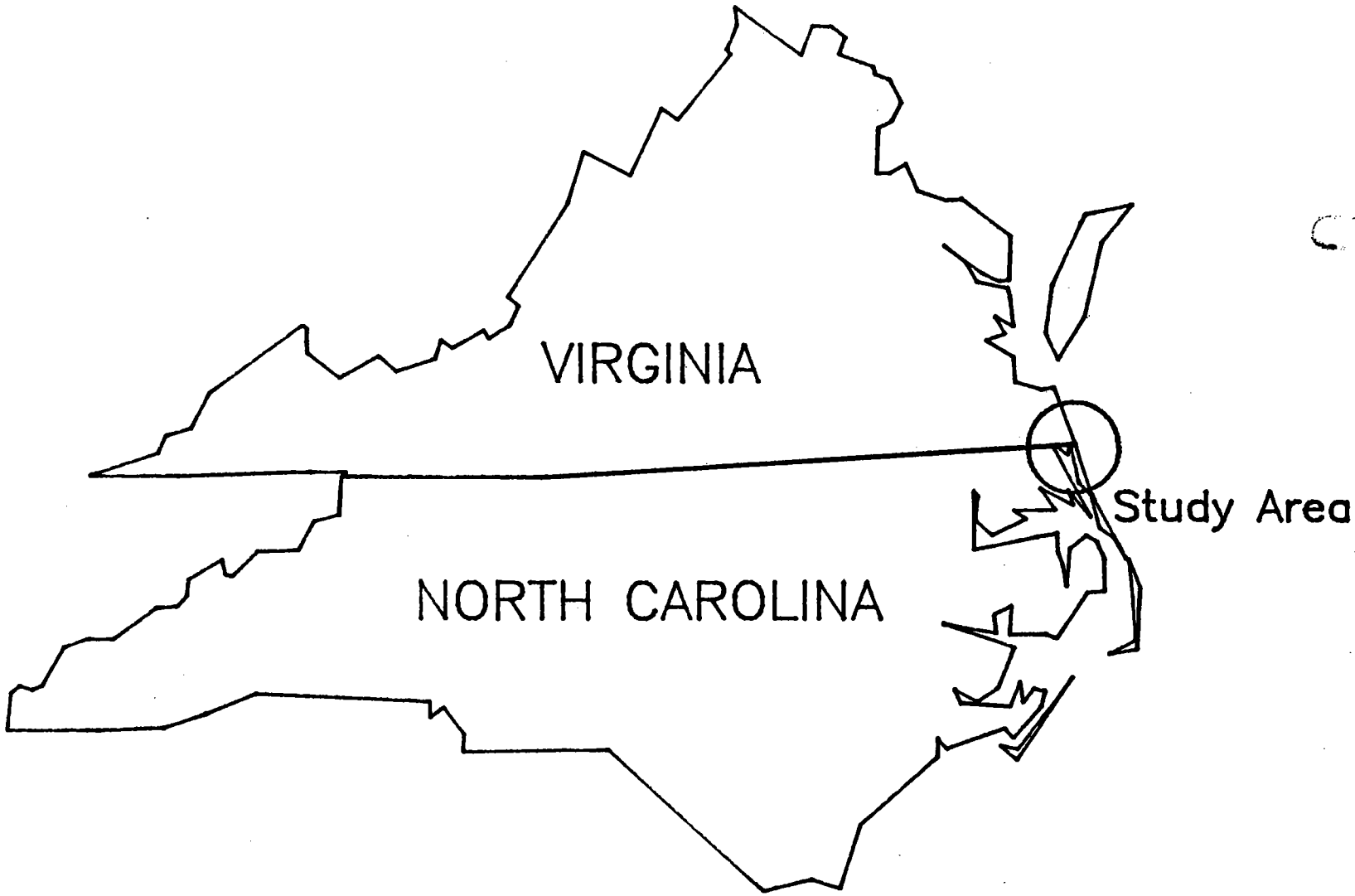
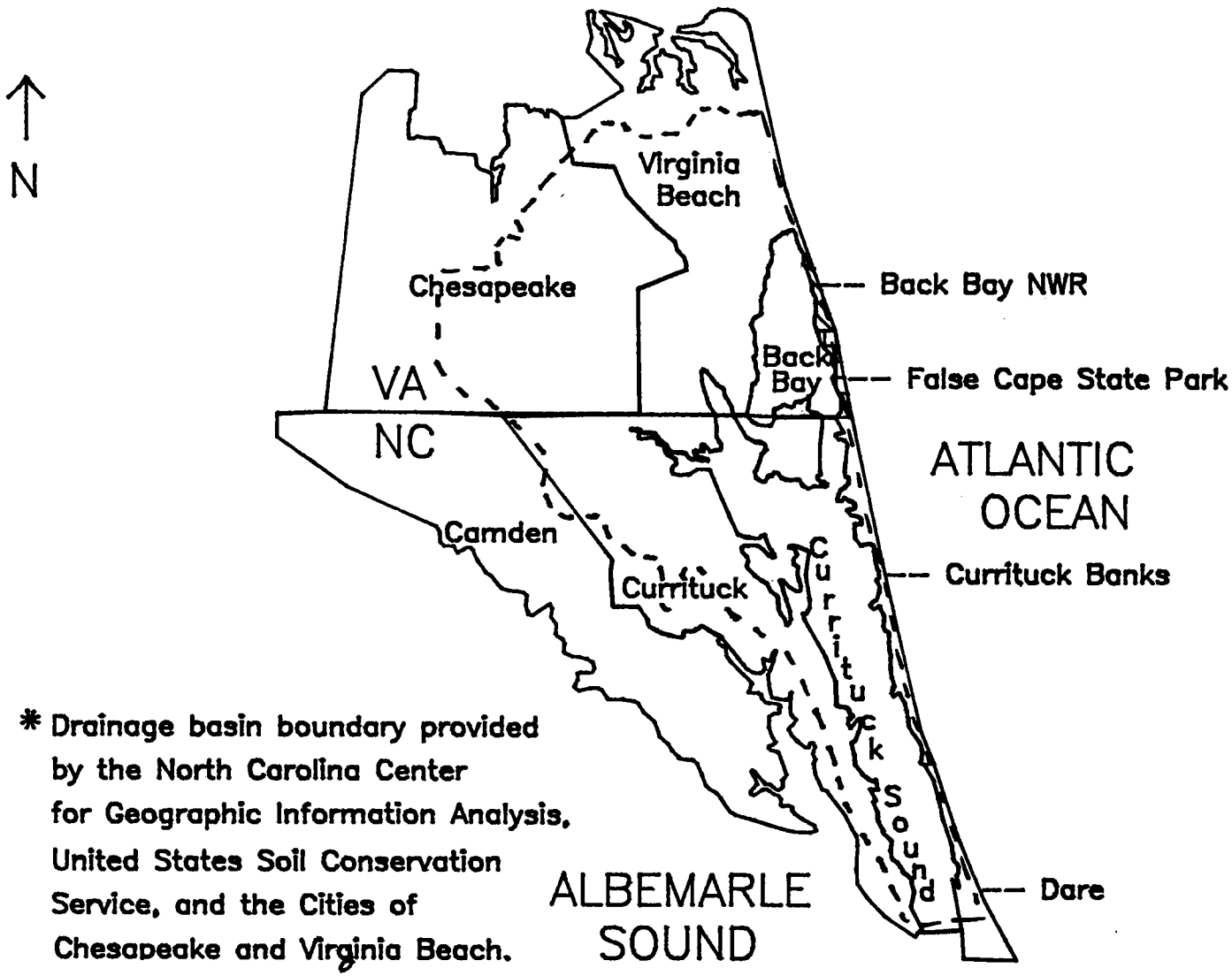


Figure 2. Jurisdictional Map
Currituck Sound Drainage Basin



* Drainage basin boundary provided by the North Carolina Center for Geographic Information Analysis, United States Soil Conservation Service, and the Cities of Chesapeake and Virginia Beach.

Committee was formed to guide the research and provide expert counsel. Members of the advisory committee included representatives of three federal resource management agencies, state officials from North Carolina and Virginia, a regional representative from southeastern Virginia, and a member of the Albemarle Citizens' Advisory Committee (Table 1).

Table 1. Project Advisory Committee

CURRITUCK SOUND WATERSHED
ADVISORY COMMITTEE

Yates Barber	Albemarle Citizens' Advisory Committee
Ray Burby	UNC Department of Regional Planning
John Carlock	Hampton Roads Planning District Commission
Bill Cole	U.S. Fish and Wildlife Service
B.J. Copeland	UNC Sea Grant College Program
Jim Cummings	N.C. Division of Soil and Water Conservation
David Griffin	N.C. Division of Coastal Management
Richard Hamilton	N.C. Wildlife Resources Commission
Bill Hogarth	N.C. Division of Marine Fisheries
Bob Holman	Albemarle-Pamlico Estuarine Study
Jim Lewis	Virginia Div. of Soil and Water Conservation
Mitchell Norman	Virginia Div. of Game and Inland Fisheries
Dianne Reid	N.C. Division of Environmental Management
Cecil Settle	U.S. Soil Conservation Service
Jim Turner	U.S. Geological Survey

TASK I: SYNTHESIS OF EXISTING INFORMATION

The objective of Task I was to prepare an up-to-date, computer-accessible bibliography on the Currituck Sound drainage basin. Prior to this project, the body of knowledge concerning Currituck Sound resided in various publications and data collections. Compiling the existing information was, therefore, the logical first step in moving toward a comprehensive environmental management plan for the study area.

The Currituck Sound drainage basin database was built in two phases. During the late 1970s, public concern mounted over the condition of the Sound. Arguments revolved, primarily, around whether Currituck Sound should be a freshwater or saltwater system (Currituck Sound Task Committee, 1980). The controversy lead to a research project funded by the Coastal Plains Regional Commission and implemented through the University of North Carolina Water Resources Research Institute. Under the direction of the project leader, David A. Adams, Elizabeth Garlo prepared a bibliography on Currituck Sound (Garlo, 1982). This early bibliography was completed in 1982. During Task I, the 1982 bibliography was reviewed and updated. Relevant references were extracted from the earlier work and included in the 1990 version of the Currituck Sound bibliography. The 1982 bibliography focused solely on the Sound and its resources rather than the complete watershed. Thus, the newer version is different in two major respects:

1. The 1990 Currituck Sound bibliography contains references for works published since 1982.
2. The 1990 Currituck Sound bibliography also includes work done in the Virginia portion of the drainage basin.

The researchers focused on references pertaining to demography,

fish/wildlife, land use, institutional infrastructure, regulatory programs, and water quality. References contained in the Currituck Sound bibliography are the products of an online search involving numerous databases such as Selected Water Resources Abstracts; review of the Albemarle-Pamlico Status and Trends Draft Report (Albemarle-Pamlico Estuarine Study, 1989); follow-up on leads from interviews; and, of course, library detective work.

All references were entered into a database using Papyrus Version 6.0, a bibliographic computer program. Papyrus was chosen because it is extremely user-friendly and relatively inexpensive. In addition, this computer program was developed for personal computers rather than mainframes and is, therefore, more accessible. Using Papyrus Version 6.0, one can easily perform searches of the Currituck Sound drainage basin database using author's last name, reference number, keywords, year of publication, or reference type. These features should promote future expansion and use of the bibliography by government officials, researchers, and citizens interested in the study area (See Appendix A for Papyrus Version 6.0 operating instructions).

The 1990 Currituck Sound bibliography is composed of 175 references (Appendix B). Copies of the bibliography are available on 3-1/2 inch diskette through the Albemarle Pamlico Estuarine Study and the Sea Grant College Program of the University of North Carolina.

TASK II: DESCRIPTION OF THE PRESENT SITUATION

The objective of Task II was to identify perception of management issues as they apply to the Currituck Sound drainage basin. Attention was focused on issues in the economic, environmental, legal, political, and social arenas.

METHODS

During Task II, government staff officials and researchers performing investigations in the study area were consulted for their views concerning management issues in the Currituck Sound drainage basin. The interviewees' responses were based on many things including personal experiences and observations, individual perceptions, and scientific data. These formal interviews were conducted over a four month period from December 1989 through mid-March 1990 (Table 2). Numerous informal interviews were conducted by telephone over the project period.

Table 2. Task II Formal Interviewees

Name	Agency
Yates Barber	Albemarle Citizens' Advisory Council
Clayton Bernick	City of Virginia Beach Planning Department
John Carlock	Hampton Roads Planning District Commission
Lee Dydiw	City of Chesapeake Department of Planning
Bill Hegge	United States Fish & Wildlife Service (Mackay Island National Wildlife Refuge)
Dwane Hinson	United States Soil Conservation Service
Harrell Johnson	North Carolina Division of Marine Fisheries
James Kornegay	North Carolina Wildlife Resources Commission
Elana Leithold	North Carolina State University Department of Marine, Earth, and Atmospheric Sciences
Mitchell Norman	Virginia Department of Game and Inland Fisheries
John Phillips	United States Fish & Wildlife Service (Back Bay National Wildlife Refuge)
Colin Powers	City of Virginia Beach Planning Department
Bill Richardson	Currituck County Government
Ron Southwick	Virginia Department of Game and Inland Fisheries
Bruce Williams	United States Army Corps of Engineers

Interview questions were tailored for the respective represented agencies or research programs. For example, biologists from the Virginia Division of Game and Inland Fisheries were asked to describe the status of the Back Bay fishery and characterize waterfowl population changes. In addition, they responded to questions on declining water quality and possible impacts of the opening of Virginia Beach Streams Canal No. 2. All interviewees answered more generic questions such as "What is the most pressing management issue in the Currituck Sound drainage basin" and "What cooperative actions might North Carolina and Virginia undertake to better manage this bi-state resource"?

In order to determine the general issue perception of the Currituck Sound Watershed Committee, the advisory panel for this project, each member was asked to complete a short survey (Appendix C). A necessary first step toward consensus, this questionnaire was intended to prompt discussion of management issues and suggestions for future action. In addition, the survey provided committee members with an idea of the types of questions included in the Task II interviews.

PERCEIVED MANAGEMENT ISSUES

"An issue originates with the idea in someone's mind that some real-world situation is unsatisfactory" (Solesbury, 1976). During the course of Task II, natural resource managers and scientists were asked to define management issues for Currituck Sound. There are no correct or incorrect opinions.

> "Witnesses to an event are likely to give differing accounts of what happened. Sometimes the accounts differ so much that it is inconceivable that all the witnesses perceived the same event" (Jones, 1984).

Such is the case with the Currituck Sound drainage basin and changes occurring therein.

Although no clear consensus exists on the nature and extent of problems in the Currituck Sound watershed, the Task II interviews yielded two broad issue categories:

1. Currituck Sound is perceived to be a declining resource with respect to water quality, the fishery, and waterfowl wintering grounds.
2. Responsibility for management of this ecosystem is split among multiple federal, state, and local jurisdictions.

Task II interviewees also discerned the potential for future problems stemming from the continued growth and development forecasted for the region, especially in regards to the limited water supply. Controversy surrounding the City of Virginia Beach's plans to pipe drinking water from Lake Gaston to the city has already eroded the relationship between the State of North Carolina and Commonwealth of Virginia. Resource managers recognized the need for immediate unified action in order to halt the decline of this shared estuarine system and address the water supply issue.

Issue 1: Declining Resource Values

Physiographically estuarine, the Currituck Sound-Back Bay system is characterized by wind-influenced tide levels, relatively low salinities, and a fresh- to brackish-water biota. Water depth rarely exceeds 6 feet in the Currituck Sound-Back Bay complex. Freshwater fish species such as largemouth bass, bluegill, black crappie, bullheads, carp, channel catfish, chain pickerel, pumpkin seed, striped bass, white catfish, white perch, and yellow perch occupy the study area (Mann, 1984). Marine species such as spot, croaker, mullet, and blue crabs are found in the southernmost waters of

Currituck Sound. The Currituck Sound-Back Bay complex also provides habitat for wintering waterfowl, assorted mammals, songbirds, and aquatic plants. Aquatic vegetation common to the study area includes sago pondweed, bushy pondweed, wild celery, redhead grass, leafy pondweed, and Eurasian watermilfoil (Gale, 1983). Denizens of the ecosystem include two federally-listed endangered species: the bald eagle and the peregrine falcon. (Mann, 1984).

The preceding observations on the fishery, wildlife habitat, and flora of the study area are based on work completed in the early 1980s. The current perception is that conditions in the Currituck Sound-Back Bay complex have deteriorated over the past 10 years.

Land in the Currituck Sound watershed is devoted to many different uses including agricultural and timber production, urban development, and preservation. A sprawling city, farms, hamlets, forests, marshes, and sand dunes jointly occupy the study area. The City of Virginia Beach, located in the northernmost portion of the drainage basin, threatens to expand urban development southward. Rapid population growth and development are challenging the Currituck Sound drainage basin's current rural character. Thus, the study area is in a period of change. The natural system is being surrounded by people and manmade environments. What are the perceived implications of these changes for the Currituck Sound-Back Bay ecosystem?

Water Quality

"Water quality is a relative concept and cannot be defined in an absolute fashion. The intended use of the water determines the characteristics that are either necessary or desired" (Neilson, 1982). At the present time, no one has examined Currituck Sound and its tributaries in terms of defining the highest uses for the Sound and

conditions necessary to optimize those uses. In the absence of such standards, it is difficult to assess the status of water quality in the study area. Moreover, there are currently few water quality data for the Sound system, especially the portion located in North Carolina. Several Task II interviewees and members of the Currituck Sound Watershed Advisory Committee pointed to the lack of scientific evidence to document declining water quality in Currituck Sound. Regardless, almost everyone agreed that water quality problems exist in the Sound and its tributaries. Eight of nine respondents to the Task II survey (Appendix C) ranked water quality problems as the "issue of greatest concern in terms of detrimental effects on the Currituck Sound drainage basin". What evidence is there to support this perception?

In a 1986-87 study conducted in Back Bay, Virginia, suspended solids and total Kjeldahl nitrogen (TKN) surpassed or violated Environmental Protection Agency (EPA) reference levels (Southwick and Norman, 1987). The researchers attributed the high levels of suspended solids to strong winter winds which induced wave action and, thereby, kept the sediment in suspension. Phytoplankton activity and decomposition of organic matter were blamed for the high TKN. Regardless, the <u>overall</u> nutrient levels including nitrates, nitrites, ammonia, and phosphorus were not "excessively high" (Southwick and Norman, 1987).

A later study found very poor water clarity and high turbidity values in Back Bay. According to a report published by the Virginia Department of Game and Inland Fisheries (Southwick, 1989), the turbidity appears to be "correlated with the continuing decline in aquatic vegetation". Beginning in 1980, submerged aquatic vegetation

(SAV) suffered severe, rapid population declines in Back Bay. Without stabilizing vegetation, the Bay is subject to wind-induced churning of the bottom sediments: This results in high turbidity. Over the past 3 years, the SAV situation has worsened in Back Bay and Currituck Sound. "There has been some regrowth [of SAV] this summer and fall, but the Sound in general has been the most barren I have ever seen it in my 50 years acquaintance with it" (Yates Barber, personal communication). Chesapeake Bay and the Albemarle-Pamlico Estuary have suffered similar declines in SAV. Declining water quality has been implicated as a contributing factor to the SAV problem. SAV habitat is vulnerable to indirect damage "resulting from excessive turbidity, eutrophication, or changing patterns of salinity" (Ferguson et al., 1990).

In July 1987, the United States Geological Survey conducted a study to determine the cause of the decline in Back Bay SAV. Light attenuation, Secchi depth, chlorophyll-a, and suspended sediment concentrations were measured at selected stations ranging from the North Carolina-Virginia state border to the extreme northern end of Back Bay. USGS researchers found poor water clarity and high suspended sediment loads. Between 37 and 80 percent of the suspended material was organic carbon indicating "the presence of large numbers of algae" (Carter and Rybicki, 1990). Chlorophyll-a concentrations ranged from 43 micrograms per liter to 71 micrograms per liter. Presenting the data at the Back Bay Ecological Symposium (November 1990), Carter noted that the July 1987 chlorophyll-a and total suspended sediment concentrations increased moving northward through the Bay.

In the North Carolina portion of the drainage basin, the North

Carolina Division of Environmental Management operates one water quality monitoring station. Located at Point Harbor, the station is monitored monthly for chlorophyll-a, dissolved oxygen, coliform bacteria, pH, turbidity, and certain metal concentrations. In 1989, chlorophyll-a concentrations violated the North Carolina standard on one occasion. Although it was not an overwhelming violation of the 40 microgram per liter standard, the 42 microgram per liter reading was indicative of high nutrient levels in the water. As a result, the mouth of Currituck Sound may be classified as "support threatened" for its class "C" water uses which include propagation of aquatic life and secondary recreation (John Dorney, personal communication). Still, Currituck Sound is perceived as having relatively good water quality, especially in comparison to other sounds and estuaries in North Carolina.

Ideas abound concerning the causes and symptoms of the perceived Currituck Sound water quality problems. Task II interviews focused attention on three issues affecting water quality in the Currituck Sound drainage basin: agricultural runoff, development, and salinity changes. Also, significant logging activity in the forested areas of the watershed may impact water quality.

In the Back Bay-North Landing River watershed, there are approximately 350 farm units with an average size of 100 acres (Mann, 1984). For the Currituck Sound drainage basin as a whole, the exact number of farms is unknown. However, the total number of farms does not give a good assessment of the density of farming. Many of the North Carolina operations cover several thousand acres (Dwane Hinson, personal communication). According to the Soil Conservation Service's 1982 Natural Resources Inventory, there are 94,600 acres of cropland

in Currituck and Camden counties. This constitutes almost one-third of the two counties' combined acreage. All of this land, however, does not drain into Currituck Sound. There are no recent estimates for the amount of North Carolina cropland draining into the study area.

The primary crops grown in the area include corn, soybeans, wheat, and livestock, especially swine. There is also significant acreage of broccoli, cabbage, and Irish potatoes. High-value crops such as broccoli and cabbage require large inputs of fertilizer and pesticides. Corn also needs a sizeable quantity of nitrogen fertilizer-- up to 200 pounds per acre. These facts alone seem to point to significant agricultural nutrient input into Currituck Sound and Back Bay. Discharges from animal waste lagoons add to the nutrient load entering the system from croplands:

> ". . . owners have been cited by the courts for allowing waste discharges from their lagoons into adjacent creeks, and other instances have been noted of possible seepages or siphoning off of lagoon liquid from brim-full ponds" (Mann, 1984).

Generally, however, instances of seepages and/or siphoning from animal waste lagoons are isolated incidences and Mann concluded that these anaerobic storage lagoons are "the best method by which to handle swine waste" (Mann, 1984).

In most of the region, agricultural runoff is filtered through swamps before entering the Sound (Dwane Hinson, personal communication). This natural filtering mechanism removes a portion of the nutrient load from the runoff and, thereby, reduces the amount of agricultural nutrients entering the Sound system. The effectiveness of swamps at removing these nutrients, however, is unknown.

No one can deny that cropland management impacts water quality in

the Currituck Sound drainage basin. One might question the extent of agricultural runoff's contribution to perceived water quality problems. Urban runoff and atmospheric deposition are also possible sources of nutrient input to the Currituck Sound-Back Bay complex. "Overall, farm acreage has declined while the water quality situation has worsened" (Ron Southwick, personal communication). This observation on reduced farm acreage is based on scrutiny of Agricultural Stabilization and Conservation Service (ASCS) aerial photographs dating from the 1930s to the present.

Much of the farmland no longer in production has been developed and is now part of the Virginia Beach urban complex. The Currituck Sound watershed lies within the Norfolk-Virginia Beach Metropolitan Statistical Area. A region experiencing rapid growth (Table 3), the drainage basin has expanded in terms of urban area and population. Currituck County, a bedroom community for the mushrooming cities to the north, underwent a greater than 20 percent increase in permanent population between 1980-86 (Albemarle-Pamlico Estuarine Study, undated). Development, like agriculture, contributes to the perceived water quality issue.

Urbanization affects water quality "even under the best planning and design standards" (Mann, 1984). A plethora of problems accompany urban development. Runoff from sites cleared for construction carries soil into the water. Pollutants from oil residues and automobiles are washed off the roadways and into the waterways. Malfunctioning septic systems leak raw sewage into surrounding soil and groundwater. During intense storm events, untreated urban runoff is discharged into creeks and streams.

Table 3. Population Estimates for Primary Jurisdictions of the Currituck Sound Drainage Basin, 1960-1990

	Chesapeake[1]	City of Virginia Beach[2]*	Currituck County[4]
1960	66,400	85,218	6,601
1970	89,580	172,106	6,976
1980	114,486	262,199	11,089
1990**	151,000	390,000[3]	14,671

The original source for all estimates was U.S. Census Bureau figures

1 (Deborah Darr, personal communication)
2 (Mann, 1984)
3 (Deborah Darr, personal communication)
4 (Evan Anderson, personal communication)

* formerly, Princess Anne County
** projected

During the 1970s, the City of Virginia Beach experienced an enormous increase in population. The percent population change for the coastal city during the decade exceeded 50 percent (Mann, 1984). Tidewater Virginia grew more slowly in the 1980s, but the overall population continued to climb. Most of the urbanization occurred in the northern sector of Virginia Beach and to the northwest of the city. This helped preserve the water quality of Back Bay and the rural quality of the southern portion of the coastal city. Furthermore, the City of Virginia Beach has expressed the desire to continue efforts to protect the rural character of the Back Bay watershed. Adopted by the City Council, the Comprehensive Plan established a "green line" south of which development is limited. However, as developable land becomes more scarce north of the "green line", there will be increasing pressure to expand southward. This is of great concern to those involved in management of the Currituck

Sound watershed and its resources.

Another issue associated with development in the Virginia Beach area is the possible impact of the recently opened Virginia Beach Streams Canal No. 2. The new Canal No. 2 enlarges a segment of an older canal that was built during the 1960s. Built for flood control purposes, the canal drains an area of 37 square miles. According to an Army Corps of Engineers fact sheet, Canal No. 2 traverses Oceana West Industrial Park, the Lynnhaven Mall, and several residential areas. In addition, the 2.6 mile canal connects the Chesapeake Bay and Albemarle-Pamlico systems. Task II interviewees were concerned that pollution and saltwater will enter Currituck Sound and Back Bay via this newly functioning canal. Yates Barber, a member of the Albemarle Citizens' Advisory Committee and longtime resident of the area, expects adverse effects on fish and wildlife in Currituck Sound. "The old canal [built during the 1960s] has already impacted water quality in the Back Bay/Currituck Sound/North Landing River system through introduction of salinity and pollutants" (Yates Barber, personal communication). Comments in the Fish and Wildlife Coordination Act report on the Canal No. 2 project also point to possible negative impacts on water quality and native species.

The final perceived problem affecting water quality in the Sound is changes in salinity. Salinity is not actually a measure of water quality. The saltwater versus freshwater controversy has raged for many years in North Carolina. The argument climaxed in the early 1980s when citizens proposed introduction of seawater into Currituck Sound to restore water quality. This idea was based on the principle that positively-charged particles in saline water will bind with negatively-charged soil particles and precipitate out of solution.

This, in turn, results in improved water clarity and, thereby, allows sunlight to penetrate the water column. One desired outcome is increased plant production which is beneficial for fish and waterfowl (Norman, 1988).

Salinities in excess of ten percent sea strength, however, interfere with largemouth bass (Micropterus salmoides) reproduction (Currituck Sound Task Committee, 1980). For this reason, sports fishermen opposed introduction of saltwater into Currituck Sound, a nationally famous largemouth bass fishery. North Carolina never attempted to change this freshwater estuary's salt content due to the prohibitive cost and uncertainty about possible effects (Currituck Sound Task Committee, 1980). The City of Virginia Beach did pump seawater into Back Bay intermittently between 1965 and the mid-1980s. Between 1978 and 1987, the city pumped 800,000 gallons of seawater per hour during high tide and 300,000 gallons of seawater per hour at low tide into Back Bay (Ron Southwick, personal communication). During this period, water quality in the Bay did not improve. In fact, water clarity and vegetation reached "record lows" during the pumping period (Norman and Southwick, 1987). As a result, Virginia Beach discontinued pumping seawater into Back Bay in August 1987.

Presently, there is little debate over whether the Currituck Sound-Back Bay complex should be managed as a freshwater or saltwater estuary. The system currently has no direct connection to the ocean. From some time prior to 1585 until the early 1800s, however, there were tidal inlets through Currituck Banks. A 1985 study published by the North Carolina Division of Coastal Management pointed to a high potential for natural inlet opening through Currituck Banks in the near future (Lynch and Benton, 1985). If this occurred, the natural

values of the freshwater Currituck Sound-Back Bay system would be replaced by saltwater values. For example, the popular largemouth bass fishery would decline. Simultaneously, the Sound would begin to support an oyster fishery and provide spawning habitat for blue crabs (Adams and Overton, 1984). An event such as natural inlet opening might spur renewed controversy in the freshwater versus saltwater battle. For instance, sports fishermen might advocate inlet closure with support from local Currituck County residents who depend on annual tourist income for their livelihood. Commercial fishermen would probably oppose the idea of inlet closure. Essentially, this situation would be the reverse of the controversy in the early 1980s when many citizens favored artificial inlet opening in Currituck Banks.

The Task II survey (Appendix C) asked the following question: "Should there be a contingency plan for the management of Currituck Sound in the event of natural inlet opening"? Only 1 respondent/ interviewee felt that such a contingency plan is necessary. The other interviewees dismissed the salinity controversy.

Resource managers and researchers perceived declining water quality to be a significant management issue for the Currituck Sound drainage basin. Although the available data indicate that Currituck Sound possesses the highest level of water quality in the coastal area of northeastern North Carolina (Currituck Sound Task Committee, 1980; John Dorney, personal communication), there is still concern among resource professionals. Agricultural production and rapid urban development in the watershed are viewed as the primary causes of declining water quality in the Currituck Sound-Back Bay complex. During the course of Task II, interviewees representing the City of Virginia Beach and Chesapeake pointed to agricultural runoff as the

major source of pollutants to the Sound. In contrast, interviewees representing the Virginia Department of Game and Inland Fisheries, Currituck County government, and various North Carolina state government agencies cited urban development as the greatest threat, current and future, to water quality in the Currituck Sound watershed.

The Fishery and Waterfowl Habitat

Along with water quality, there is a general perception that the fishery and waterfowl habitat is declining. Below normal rainfall during the 1980s has resulted in reduced freshwater input into Currituck Sound. The salinity level has increased "beyond tolerable limits for most freshwater species" (Kornegay, 1989). However, there is no statistical difference between mean standing crop estimates for fish from a 1977 study and the North Carolina Wildlife Resources Commission's 1989 Currituck Sound fish population survey. Kornegay does point out that the small sample size of the 1989 study may preclude any "realistic statistical comparison" between the studies. The fact remains that many fishermen feel they just are not catching as many fish as they did in past years (Mike Corcoran, personal communication). Sportsmen in the Back Bay area would agree (Norman, 1988).

During the 1970s, Currituck Sound and Back Bay attracted sports fishermen from around the nation. In 1978, it was estimated that anglers traveled 625,000 miles to fish the waters of Back Bay (Norman, 1988). Currituck Sound was also a nationally famous largemouth bass fishery: "According to the Bass Angler Sportsmen Society (B.A.S.S.), during the 1975 B.A.S.S. national championship tournament on Currituck Sound, both numbers and pounds of largemouth bass caught ranked fourth in 49 tournaments held from March 1972 to February 1978 at 33

locations throughout the nation" (Currituck Sound Task Committee, 1980). Today, however, many fishermen are not experiencing as much success in catching the champion bass. Norman, a biologist with the Virginia Department of Game and Inland Fisheries, summarized the sport fishing situation as follows:

> "This gold mine of a freshwater fishery began a rapid decline in the early 1980's and has continued its decline up to the present day. As a result, there is virtually no freshwater fishery in Back Bay today" (Norman, 1988).

Norman and his coworker Ron Southwick believe that high salinity levels and loss of the formerly abundant submerged aquatic vegetation (SAV) caused a decline in the freshwater fishery and waterfowl habitat. SAV has been characterized as the building block on which estuarine life depends: Waterfowl, fish, and shellfish rely on SAV for food. In addition, the submerged plants serve as nurseries and hiding grounds (Blankenship, 1990). Citing reestablishment of SAV as a critical step in restoring the wildlife values of Back Bay and Currituck Sound, Norman and Southwick suggested that it may be necessary to think about introducing an exotic plant capable of tolerating the turbid waters (Mitchell Norman and Ron Southwick, personal communication). Resource managers in North Carolina take issue with the idea of exotic plant introduction. An irreversible action with unpredictable effects, exotic plant introduction should be thoroughly studied prior to implementation. Currently, there are no federal or state laws that would prevent introduction of a non-native plant unless the proposed plant is listed as a "noxious weed" in the Federal Noxious Weed Act of 1974 (Gene Cross, personal communication).

Rapid development in the Currituck Sound drainage basin has also had a negative impact on wildlife, especially waterfowl. Prior to the

1980s, Currituck Sound was one of the premier waterfowl wintering areas along the Atlantic flyway. During the last decade, however, there has been a significant decline in populations of ducks, geese, and swans utilizing Currituck Sound. Based on aerial, midwinter surveys, waterfowl populations in the Currituck Sound area have decreased at a "much greater rate than elsewhere in eastern North Carolina" (Dennis Luszcz, personal communication). During the 1980s, habitat loss and decreased breeding success resulted in a nationwide waterfowl population decline. Dennis Luszcz, Waterfowl Project Leader for the North Carolina Wildlife Resources Commission, attributes the heavy population decline in the Currituck Sound region to increased human disturbance, loss of submerged aquatic vegetation, and rising salinity levels. Also, wildlife management programs designed to improve habitat conditions in Maryland may have contributed to the waterfowl decline: the birds are simply stopping further north. For whatever reason, "there have been noticeable changes in a short period of time" (Dennis Luszcz, personal communication).

Issue 2: Lack of a Coordinated Management Approach

The State of North Carolina and Commonwealth of Virginia share responsibility for any decline in the waters or resource values of the Currituck Sound-Back Bay complex. The Currituck Sound watershed clearly lies within both states. Ecosystems do not recognize state borders. This leads us to the second broad issue category uncovered during the Task II interviews: lack of cooperation between/among the governing bodies responsible for the management of the Currituck Sound drainage basin.

Several agencies representing four different levels of government manage land and water in the study area (Table 4). No one agency,

Table 4. Resource Managing Agencies in the Currituck Sound Watershed

Government Level	Agency
Federal	Army Corps of Engineers (COE) Environmental Protection Agency (EPA) Fish & Wildlife Service (USFWS) *Back Bay National Wildlife Refuge *Currituck National Wildlife Refuge *Dismal Swamp National Wildlife Refuge *Mackey Island National Wildlife Refuge Soil Conservation Service (SCS)
State	
North Carolina	Division of Coastal Management (DCM) *Currituck Banks Estuarine Research Reserve Division of Environmental Management (DEM) Division of Land Resources (DLR) Division of Marine Fisheries (DMF) Division of Water Resources (DWR) Wildlife Resources Commission (WRC) *Northwest River Game Lands
Virginia	Council on the Environment (VCOE) Chesapeake Bay Local Assistance Department (CBLAD) Department of Game and Inland Fisheries (DGIF) *Pocahontas Waterfowl Management Area *Trojan Waterfowl Management Area Division of Soil and Water Conservation (DSWC) Division of State Parks (DSP) *False Cape State Park Marine Resources Commission (MRC) State Water Control Board (SWCB)
County	
North Carolina	Camden County Currituck County Dare County
City	
Virginia	Chesapeake Virginia Beach
Regional	
North Carolina	Albemarle Regional Development Commission (ARDC)
Virginia	Hampton Roads Planning District Commission (HRPDC) (HRPDC was formerly referred to as the Southeastern Virginia Planning District Commission)

however, possesses all the functions required for effective natural resource management. In addition, there is no comprehensive environmental management plan for the Currituck Sound watershed. Presently, the many managing agencies operate independently.

Federal, state, and local officials agree that North Carolina and Virginia must cooperate in order to best manage the Currituck Sound-Back Bay complex. The resource is perceived to be declining with respect to water quality, the fishery, and wildlife habitat. In addition, the region's limited drinking water supply poses a significant problem that has not been resolved to the mutual satisfaction of the two states. Thus, some action is warranted.

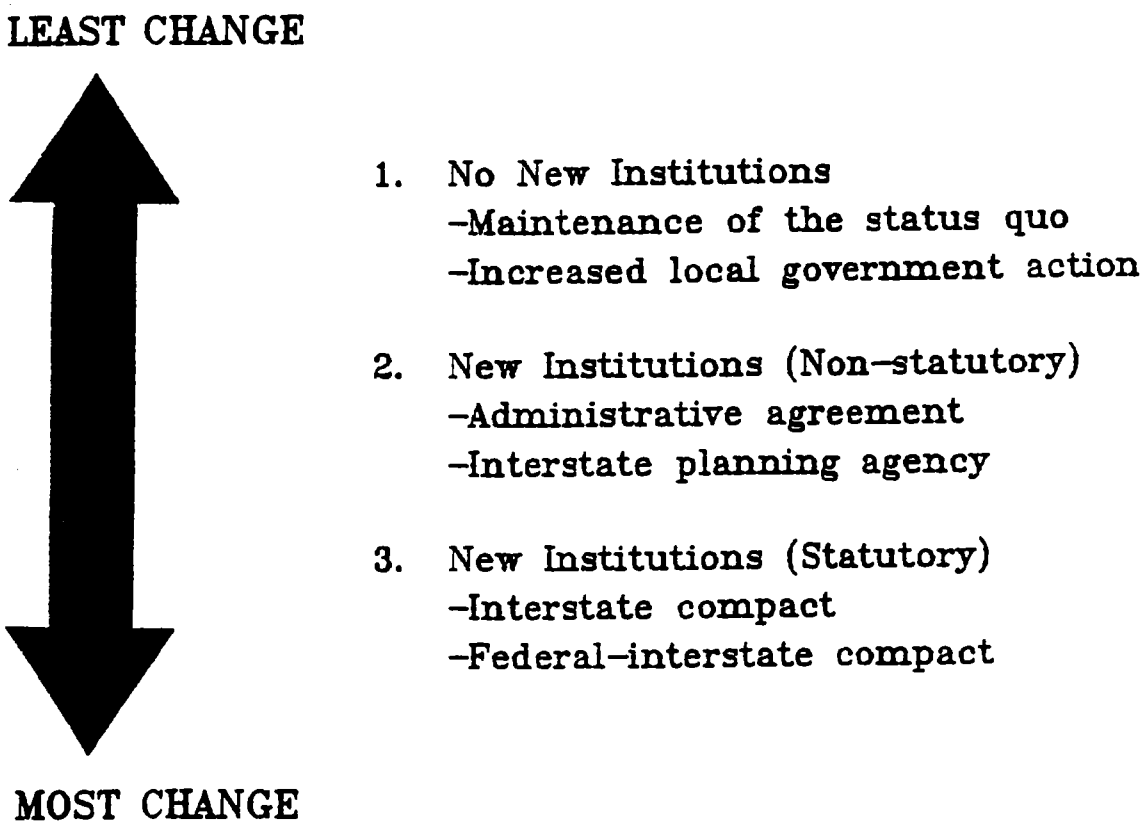
TASK III: ANALYSIS OF PROSPECTIVE MANAGEMENT ALTERNATIVES

The objective of Task III was to analyze an array of prospective management alternatives and coordinative mechanisms for the Currituck Sound-Back Bay complex. This section of the report will focus on three classes of management options in order of increasing departure from existing conditions (Figure 3):

- alternatives requiring no new institutions,
- alternatives requiring formation of new, non-statutory institutions, and
- alternatives requiring creation of new, statutory institutions.

In addition, this section will discuss a proposed change in Environmental Protection Agency (EPA) and United States Fish and Wildlife Service (USFWS) regional boundaries to more closely follow ecological systems. Ideas for an education program patterned after the successful Chesapeake Bay model will also be explored. Selecting a preferred alternative or action, however, is outside this project and will not be attempted.

Figure 3. Continuum of Management Alternatives.



CURRENT MANAGEMENT STRATEGIES

Presently, responsibility for managing the Currituck Sound drainage basin is split among many agencies and regions at the federal, state, local, and regional government levels. No single agency is accountable for management of the study area as a whole.

Federal Agencies

The United States Fish and Wildlife Service (USFWS) manages four national wildlife refuges in the Currituck Sound drainage basin, encompassing more than 125,000 acres. The primary emphasis of these refuges is to protect migratory waterfowl in accordance with the

Migratory Bird Treaty Act of 1918 (40 Stat. 755). North Carolina and Virginia fall into different Fish and Wildlife Service regions. Thus, refuge managers in the same watershed report to different regional headquarters. For example, Back Bay National Wildlife Refuge is within the northeastern region which is headquartered in Boston, while Currituck National Wildlife Refuge is in the Atlanta-based southern region. This separation may cause some inefficiency and hinder communication. USFWS also has responsibility under the Fish and Wildlife Coordination Act (16 U.S.C. 661-664, 1008 (1982)) to comment on impacts of proposed Federal actions on fish and wildlife resources such as habitat.

The Environmental Protection Agency (EPA), Army Corps of Engineers (COE), and Soil Conservation Service (SCS) do not manage distinct parcels of land in the Currituck Sound drainage basin, but the three agencies do participate in management of the resource. EPA attempts to control water pollution and works very closely with the states in this effort. As is the case with the Fish and Wildlife Service regions, North Carolina and Virginia are in two separate EPA regions. This arrangement may hinder cooperation on management of the study area. The Water Quality Act of 1987 (101 Stat. 7) named EPA as the lead agency for the National Estuarine Program. Preparing management plans for nationally significant estuaries that are threatened by pollution, development, or overuse is one purpose of the National Estuarine Program (101 Stat. 61). A joint project of the Environmental Protection Agency and the State of North Carolina, the Albemarle-Pamlico Estuarine Study (A/P Study) was the first program designated under the 1987 law. "To forge a partnership between science, government, and the public so that informed decisions can be

made about the future of the Albemarle-Pamlico Estuary" is the ultimate goal of the A/P Study (Albemarle-Pamlico Estuarine Study, undated). Although a large portion of the A/P Study Area lies within the Commonwealth of Virginia, that state is not a formal participant in the A/P Study.

COE is the nation's primary water resource development agency. In addition, the Corps administers laws such as Section 404 of the Clean Water Act (13 U.S.C. 1344) and the River and Harbor Act of 1899 (33 U.S.C. 401, 403, 407) to protect the nation's navigable waterways and wetlands. Under the Coastal Zone Management Act of 1972, moreover, the Corps provides technical assistance to coastal states including provision of data on sensitive coastal areas (U.S. Army Corps of Engineers, 1989). At the present time, there are few major Corps water resource development activities in the study area (Bruce Williams, personal communication). The Corps is, however, actively involved in carrying out a water quality monitoring plan for the Canal Number 2 Flood Control Project in Virginia Beach, Virginia. The plan includes storm event monitoring, sediment and water column sampling, and analysis of organic contaminants in the water column.

The North Carolina and Virginia portions of Currituck Sound watershed are in different EPA regions and COE districts. Essentially, this doubles federal involvement but fragments responsibility for managing the resource. Although regional offices do interact, the degree of information sharing is limited. The A/P Study has attempted to address this problem by including Virginia portions of the Albemarle-Pamlico drainage basin within the project's study area. This effort has increased dialogue between officials representing the various state, regional, and local interests in the

watershed.

Finally, the Soil Conservation Service plays a role in the Currituck Sound watershed. SCS provides various forms of technical assistance to landowners including soil mapping and farm planning. More specifically, SCS assists farmers in complying with the "sodbuster", "swampbuster", and Conservation Reserve Program provisions of the Food Security Act of 1985 (99 Stat. 1355). Soil Conservation Service also cooperates with other government agencies in conducting river basin studies, developing small watershed projects, and providing technical support for implementation of Best Management Practices at the farm level.

State Agencies

Prior to the Albemarle-Pamlico Estuarine Study, there was relatively little exchange between North Carolina and Virginia environmental programs. However, there is a precedent for cooperation in this arena. In 1974, the Governors of the two states signed a cooperative agreement which created the North Carolina-Virginia Water Resources Management Committee. The purpose of this committee was to develop joint positions on water resources issues and advise the Governors on recommended courses of action. Meeting on an "ad hoc" basis, the committee was simply a forum for "good faith discussions on water issues" (North Carolina-Virginia Water Resources Management Committee et al., 1982). Little planning and no regulatory or enforcement powers were given to the bi-state committee. Today, the organization is defunct because Governor Martin of North Carolina and Governors Baliles and Wilder of Virginia have not renewed the cooperative agreement formed by their predecessors.

Currently, the Hampton Roads Planning District Commission

(HRPDC), a regional agency, is attempting to bridge the gap between the two states by working closely with the A/P study. A large part of the new interaction centers around information exchange and public involvement. HRPDC represents 14 Virginia local governments including the cities of Chesapeake, Franklin, Hampton, Newport News, Norfolk, Poquoson, Portsmouth, Suffolk, Virginia Beach, and Williamsburg as well as Isle of Wight, James City, Southampton, and York counties (Carlock, 1989).

North Carolina

A single state agency claims primary responsibility for environmental management of the North Carolina portion of the Currituck Sound watershed: the Department of Environment, Health, and Natural Resources (DEHNR). Article 13 of the General Statutes of North Carolina charges DEHNR with stewardship of the state's estuarine resources. Several divisions within the Department of Environment, Health, and Natural Resources, therefore, have an interest in the study area. Among the most important are the Division of Coastal Management (DCM), the Division of Land Resources (DLR), the Division of Environmental Management (DEM), the Division of Soil and Water Conservation (DSWC), the Division of Marine Fisheries (DMF), and Wildlife Resources Commission (WRC).

In 1974, the North Carolina General Assembly passed the Coastal Area Management Act (CAMA) "to insure the orderly and balanced use and preservation of our coastal resources on behalf of the people of North Carolina and the nation" (G.S. 113A-102(b)(3)). The three primary elements of CAMA included land use planning, permitting of development in Areas of Environmental Concern (AECs), and preservation of natural

areas for research, study, and public use (Division of Coastal Management, 1986). CAMA established a 15 member Coastal Resources Commission (CRC) to set policies for the state's management program in the 20 coastal counties. Under the authority of the CRC, the Division of Coastal Management issues permits for major development in Areas of Environmental Concern such as estuarine waters and shorelines. Major development includes "any development which requires permission, licensing, approval, certification or authorization from any other state or federal agency; occupies a land or water area in excess of 20 acres; contemplates drilling for or excavating natural resources on land or under water; or contemplates on a single parcel, a structure or structures in excess of a ground area of 60,000 square feet" (G.S. 113A-118(a)(1)). Permits for minor development in AEC's are obtained from the appropriate local authority. Minor development is defined as "any development other than major development" (G.S. 113A-118(d)(2)). A general or blanket permit may be obtained for routine development projects (G.S. 113A-118.1) such as bulkheads or piers. Granting of general permits streamlines the permit process for simple projects (Todd Ball, personal communication).

Local governments must develop land use plans to guide development outside designated AEC's. As part of the planning process, local governments prepare a data base which contains population trends; an analysis of current land uses; zoning ordinances and other regulations; current land use problems; and projections of economic demands and future land use needs (Gottovi, 1985). The data base, in turn, allows the local government to assess its growth

potential. The plans focus on a ten year planning horizon. After approval by the Coastal Resources Commission, the land use plan is implemented at the local level.

The Division of Coastal Management is also responsible for administering North Carolina's Coastal Reserve Program (G.S. 113A-129.1). The state's estuarine reserves belong to the National Estuarine Research Reserve system. Established under the authority of the National Oceanic and Atmospheric Administration (16 U.S.C. 1461), estuarine reserves serve as sites for scientific study of estuarine processes. In addition, they function as outdoor classrooms to educate the citizens of the state. Currituck Banks Estuarine Research Reserve is located in the project study area.

Administered by the Division of Land Resources, the Sedimentation Pollution Control Act of 1973 (G.S. 113A-50 to 113A-66) addresses a critical point: sediment is the greatest water pollution problem in North Carolina. This act requires erosion and sedimentation control plans for activities other than agricultural and forestry practices disturbing more than one acre of land. Forestry activities, however, must be conducted in accordance with Forest Practice Guidelines Related to Water Quality (Best Management Practices) in order to be exempted from the erosion and sedimentation plan requirement (G.S. 113A-52(6)). The Sedimentation Pollution Control Act also includes mandatory standards regarding buffer strips, slope stabilization, and establishment of groundcover (G.S. 113A-57(1)).

Other pollutants are monitored by the Division of Environmental Management (DEM). This agency is responsible for evaluating water quality statewide, improving degraded waters, and maintaining existing uses in all waters (G.S. 143-214.1). The Environmental Management

Commission (EMC) defines uses for the state's surface waters according to specific procedures for assignment of water quality standards (15 NCAC 2B .0100). Based on North Carolina's water quality classification system, Currituck Sound is class "SC" waters and is best suited for "aquatic life propagation and maintenance . . . wildlife, secondary recreation, and any other usage except primary recreation or shellfishing for market purposes" (15 NCAC 2B .0212(b)(1)). Recently, DEM was petitioned to declare Currituck Sound "Outstanding Resource Waters" (ORW). In order to be classified as ORW, the Sound must meet the following conditions:

1. There are no significant impacts from pollution with the water quality rated as excellent based on physical, chemical, and biological information.

2. The characteristics which make the waters unique and special may not be protected by the assigned narrative and numerical water quality standards (15A NCAC 02B.0216(a)(2)).

The Division of Environmental Management will soon begin to collect information to determine if Currituck Sound meets the Outstanding Resource Waters requirements (Diane Reid, personal communication).

On a monthly basis, DEM monitors water quality in Currituck Sound for compliance with established standards. At the present time, however, there is only one DEM monitoring station in the study area. Located at Point Harbor, at the extreme lower end of Currituck Sound, the station is monitored for chlorophyll a, dissolved oxygen, coliform bacteria, pH, salinity, turbidity, and certain metal concentrations. Previously, there was a second monitoring station at Aydlett, but it is no longer functional.

Among its many duties, DEM issues permits for waste water treatment plants, trains plant operators, and serves as the lead

agency for nonpoint source pollution control. In addition, the Division of Environmental Management is the state's permitting agency for point source discharges, those discharges which can be traced back to a definite source such as a pipe or ditch. Currently, there are no permitted point source discharges into Currituck Sound (Diane Reid, personal communication). However, a developer recently applied for a permit to dump concentrated brine from a planned water desalination facility into the Sound. The Division of Environmental Management denied the NPDES Permit Application for discharge to Currituck Sound, and the developer submitted a notice of intent to dump the brine into the Atlantic Ocean rather than Currituck Sound.

The Division of Soil and Water Conservation provides assistance to local soil and water conservation district offices in administering the North Carolina Agricultural Cost-Share Program (15A NCAC 03F.0001-.0008). Intended to reduce the input of agricultural nonpoint source pollution into the state's waterways, the cost-share program helps landowners pay for installation of Best Management Practice (BMP) systems. DEM also cooperates with DSWC and the local soil and water conservation offices in this effort to control nonpoint source pollution. Participation in the cost-share program is voluntary. Several farmers in the Currituck Sound drainage basin take advantage of the program, but participation is not 100 percent (Dwane Hinson, personal communication).

The Division of Marine Fisheries (DMF) is "charged with the stewardship of the marine and estuarine resources of the State of North Carolina" (15A NCAC 03A.0002(a)). Physiographically, Currituck Sound is an estuarine system. With salinities rarely exceeding 3 ppt, however, Currituck Sound is virtually a freshwater system (Currituck

Sound Task Committee, 1980). Coastal fishing waters supporting a significant number of freshwater fish may be designated joint fishing waters by agreement of the Marine Fisheries Commission and the Wildlife Resources Commission (G.S. 113-132(e)). Currituck Sound has been classified as joint waters (15A NCAC 03F.0200(j)). Thus, DMF administers several programs for the Sound including commercial and recreational fisheries management and enforcement; applied research and monitoring; fisheries statistics; and education (15A NCAC 03A.0002(b)). Between May and August of each year, DMF conducts a juvenile sampling program for Upper and Lower Currituck.

"The North Carolina Wildlife Resources Commission has statutory responsibility for the conservation and management of wildlife and inland game fish in Currituck Sound" (Richard Hamilton, personal communication). Created by the Wildlife Resources Act (G.S. 143-237 to 143-254.2), WRC has the following duties:

> "to manage, restore, develop, cultivate, conserve, protect and regulate the wildlife resources of the State of North Carolina, and to administer the laws relating to game and other wildlife resources enacted by the General Assembly" (G.S. 143-239).

Providing a sound, comprehensive, continuing, and economical game, game fish, and wildlife program for the State of North Carolina is the objective of this agency. The Wildlife Resources Act granted WRC permission to enter into cooperative agreements pertaining to the management of wildlife resources with federal, State, and other agencies, or governmental subdivisions. In this case, "State" refers to North Carolina.

For a complete description of North Carolina legislation that affects development in the Currituck Sound drainage basin, one should consult Finch and Brower's "Management Programs and Options for the

Albemarle-Pamlico Estuarine Study". The document classifies the laws based on the environmental problems they address. A list of legislation with major impacts follows:

Agricultural Development Act	(G.S. 106-580 to 106-587)
Air and Water Resources Act	(G.S. 143-211 to 143-215.73)
Boating Safety Act	(G.S. 75A-1 to 75A-26)
Coastal Area Management Act	(G.S. 113A-100 to 113A-134.3)
Conservation and Historic Preservation Agreements Act	(G.S. 121-34 to 121-42)
County Service Districts Act	(G.S. 153A-300 to 153A-309)
Drinking Water Act	(G.S. 130-166.39 to 130-166.56)
Emergency Management Act	(G.S. 166A-1 to 166A-16)
Interstate Environmental Compact Act	(G.S. 113A-21 to 113A-23)
Environmental Policy Act	(G.S. 113A-1 to 113A-10)
Fisherman's Economic Development Program	(G.S. 113-315.15 to 113-315.19)
Forest Development Act	(G.S. 113A-176 to 113A-183)
Industrial and Pollution Control Facilities Financing Act	(G.S. 159C-1 to 159D-28)
Industrial and Pollution Control Facilities Financing Authority Act	(G.S. 159D-1 to 159D-27)
Metropolitan Sewerage District Act	(G.S. 162A-64 to 162A-80)
Metropolitan Water Districts Act	(G.S. 162A-31 to 162A-58)
Mining Act	(G.S. 74-46 to 74-65)
Municipal Service Districts Act	(G.S. 160A-535 to 160A-544)
Municipal Subdivision Control Act	(G.S. 160A-371 to 160A-376)
Municipal Zoning Act	(G.S. 160A-381 to 160A-392)
Natural and Scenic River System Act	(G.S. 113A-30 to 113A-43)
Nature and Historic Preserve Dedication Act	(G.S. 143.260.6 to 143.260.10A)
Oil Pollution and Hazardous Substances Control Act	(G.S. 143-215.75 to 143-215.98)
Pesticide Law of 1971	(G.S. 143-435 to 143-469)
Recreation Enabling Act	(G.S. 160A-350 to 160A-356)
Regional Sewage Disposal Planning Act	(G.S. 162A-26 to 162A-30)
Regional Water Supply Planning Act	(G.S. 162A-20 to 162A-25)
Sedimentation Pollution Control Act	(G.S. 113A-50 to 113A-66)
Small Watershed Projects Act	(G.S. 139.53 to 139.57)
Soil Additives Act	(G.S. 106-50.28 to 106-50.41)
Soil and Water Conservation Districts Act	(G.S. 139-1 to 139-57)
Solid Waste Management Act	(G.S. 130A-290 to 130A-309.28)
Special Assessments Act	(G.S. 160A-216 to 160A-238)
Stream Sanitation Act	(G.S. 143-211 to 143-215.73)
Structural Pest Control Act	(G.S. 106-65.22 to 106-65.39)

Toxic Substances Act	(G.S. 14-284.2)
Water Use Act	(G.S. 143-215.12 to 143-215.37)
Watershed Improvement Districts Act	(G.S. 139-16 to 139-38)
Well Construction Act	(G.S. 87-83 to 87-114)
Wildlife Resources Law	(G.S. 143-237 to 143-254.2)

(Finch and Brower, 1986).

One law stands out in light of the acknowledged need for cooperation between North Carolina and Virginia in managing the Currituck Sound drainage basin: The Interstate Environmental Compact Act of 1971 (G.S. 113A-21 to 113A-23). Recognizing the interest of the state in protecting the environment, the law states as its purpose "to promote intergovernmental cooperation for multi-state action relating to environmental protection through interstate agreements and to encourage cooperative and coordinated environmental protection by the signatories and the federal government" (Brower and Finch, 1986). This law has never been used, however, because Congress failed to grant consent to the multi-state Environmental Compact Commission (Council of State Governments, 1979). Tracing the legislative history of the national Interstate Environmental Compact Act yielded no conclusive reason for Congress' failure to grant consent. First introduced in the Senate, the compact bill (S. 9) was passed on June 22, 1973 (Congressional Information Service, 1973). Subsequently, the bill was referred to the House of Representatives. No further action was taken on the Interstate Environmental Compact Act because it "died" in the House Judiciary Committee.

Virginia

The Commonwealth of Virginia has no coastal management law comparable to North Carolina's Coastal Area Management Act (John Carlock, personal communication). The state does, however,

participate in the federal Coastal Zone Management Program. Composed of a core of eight regulatory programs, Virginia's Coastal Resources Management Program (VCRMP) "assures that critical land and water uses are subject to regulation by the Commonwealth" (Office of Ocean and Coastal Resource Management et al., 1986). The networked core programs include:

- -Fisheries Management,
- -Subaqueous Lands Management,
- -Wetlands Management,
- -Dunes Management,
- -Nonpoint Source Pollution Control,
- -Point Source Pollution Control,
- -Shoreline Sanitation, and
- -Air Pollution Control.

Each of these eight regulatory programs is administered by a state agency in conjunction with a citizen board or commission. Several Virginia state government agencies are involved with the Virginia Coastal Resources Management Program and, thereby, management of the Virginia portion of Currituck Sound-Back Bay drainage basin. These include the Virginia Council on the Environment, the Department of Game and Inland Fisheries, the Division of State Parks, the Virginia State Water Control Board, the Division of Soil and Water Conservation, the Chesapeake Bay Local Assistance Department, and the Marine Resources Commission.

The Virginia Council on the Environment acts as the lead agency for the Commonwealth's Coastal Resource Management Program. Council on the Environment is the locus for routine administrative functions of the network. In addition, this agency monitors state actions for consistency with the policies of the coastal program (Office of Ocean and Coastal Resource Management et al., 1986).

Analogous to the North Carolina Wildlife Resources Commission, the Virginia Department of Game and Inland Fisheries is responsible for

management of wildlife and inland game fish species in Virginia. Employees of this division conduct research on nutrients, water clarity, and fish populations in Back Bay as well as the Northwest and North Landing Rivers. This type of research lead to the shutdown of saltwater pumping into Back Bay by the City of Virginia Beach (Mitchell Norman and Ron Southwick, personal communication). The Department of Game and Inland Fisheries also operates two waterfowl management areas in the Currituck Sound drainage basin: The Pocahontas and the Trojan Waterfowl Management Areas.

The Virginia Division of State Parks manages False Cape State Park to preserve the natural beach system and provide outdoor recreation. Located on the ocean-side of Back Bay, the park lies between Back Bay National Wildlife Refuge and the Currituck Outer Banks. Many tourists visit this park each year although there is no public road access. Public access is limited to bicycle and pedestrian trails. Past arguments have revolved around road access and possible impacts of new roads on the environment, especially Back Bay National Wildlife Refuge.

The primary water resources agency in the Commonwealth of Virginia is the State Water Control Board (SWCB). This agency has responsibility for water quality regulation, water resources planning, and policy making in the water resources arena. SWCB administers the Point Source Water Pollution Control Program, a component of the state's Coastal Resource Management Program (Section 62.1-44.15, Code of Virginia). In fulfilling this duty, the Board issues permits for point source discharges. In addition, SWCB has developed a comprehensive water and related land resource plan for every major river basin in the state of Virginia (North Carolina-Virginia Water

Resources Management Committee et al., 1982).

In Virginia, nonpoint source pollution control rests with the Division of Soil and Water Conservation (DSWC). DSWC has regulatory authority over erosion and sedimentation from non-agricultural land disturbing activities. Pursuant to the 1973 Virginia Erosion and Sediment Control Law, DSWC establishes minimum standards and guidelines to control non-agricultural nonpoint source pollution. According to the 1973 law, all localities must adopt an erosion and sediment control program which is consistent with state guidelines (Office of Ocean and Coastal Resource Management et al., 1986). The Division of Soil and Water Conservation is also involved with control of runoff from agricultural lands. Administering a state cost-share program and providing technical assistance in nutrient management, DSWC encourages voluntary use of Best Management Practices (BMPs). Virginia, like North Carolina, does not require landowners to exercise BMPs.

The Chesapeake Bay Local Assistance Department (CBLAD) was formed pursuant to passage of the Chesapeake Bay Preservation Act (Section 10.1-2100, Chapter 21, Title 10.1, Code of Virginia). CBLAD ia currently being considered for inclusion in Virginia's Coastal Resources Management Program. In accordance with Virginia law, this agency has drafted regulations requiring localities within the Chesapeake Bay drainage to adopt land use measures for the explicit purpose of water quality protection. Application of the Chesapeake Bay Preservation Act to non-Chesapeake Bay drainage is a local option.

Finally, the Marine Resources Commission is the agency that regulates development in wetlands and along coastal primary sand dunes. Local governments may establish boards to administer state

policies in these arenas. However, ultimate authority is vested in the Marine Resources Commission (Office of Ocean and Coastal Resource Management et al., 1986).

Local Agencies

Strategies employed by Currituck County and the City of Virginia Beach provide examples of county and municipal management within the Currituck Sound drainage basin.

Currituck County

Currituck County is among North Carolina's 20 coastal counties and, thereby, comes under the provisions of the Coastal Area Management Act of 1974 (G.S. 113A-100 to 113A-134.3). According to this law, each local government in the coastal region must prepare a land use plan which details how the governing body will achieve the goal of balanced preservation and development. This plan is submitted to the Coastal Resources Commission for approval.

The 1982 Currituck County land use plan detailed the county's existing demographic and economic patterns; discussed land-suitability for development; and detailed policies concerning resource protection, management of Areas of Environmental Concern, zoning, and industrial development. Notable selected policies included protecting estuarine and public trust waters by reducing development on soils unsuitable for on-lot sewage disposal and plans to try to attract light industry to the area (Coastal Consultants, Ltd., 1982).

Currently, Currituck County is in the process of updating its CAMA land use plan. A major objective of county officials is to include the public in decisions affecting Currituck County and the future of its resources (Jack Simoneau, personal communication).

Maintaining good water quality in Currituck Sound is also a high priority for the county, but there are pressures to develop (Bill Richardson, personal communication). County leaders fear that development will result in further degradation of Currituck Sound. The Currituck County Board of Commissioners, therefore, has passed a severe ordinance to prevent discharge of wastes into Currituck Sound:

> "No discharge of any nature whatsoever of water, chemicals, treated water, backwash from reverse osmosis systems, or discharge whatsoever shall be deposited directly or indirectly into the waters of Currituck Sound, or its adjoining tributaries, rivers, streams, creeks, canals, or other connecting water ways. A developer intending to use reverse osmosis or other water purification system shall comply in all respects to State requirements for the operation and maintenance of such systems but in no event shall such water system discharge any substance or water whatsoever into the waters of Currituck Sound or adjacent waters" (Article 6, Section 615, Unified Development Ordinance of Currituck County, 1989).

This ordinance is more strict than North Carolina law regarding discharge of point source pollution into the waters of the state, but it has not yet been challenged.

City of Virginia Beach

Across the state border from Currituck County is the City of Virginia Beach. In the early 1980s, the city hired Roy Mann Associates to develop a management plan for Back Bay. The Mann plan recommended that the City of Virginia Beach maintain the rural qualities of the Back Bay watershed including agricultural uses and the diversity of wildlife. Three land management strategies representing different levels of departure from the status quo were presented in the final report. The alternative requiring the least change recommended

-extension of the "green line" northward,
-elimination of "spot" zoning, and
-maintenance of the current capital improvements program for the Back Bay and North Landing River watersheds.

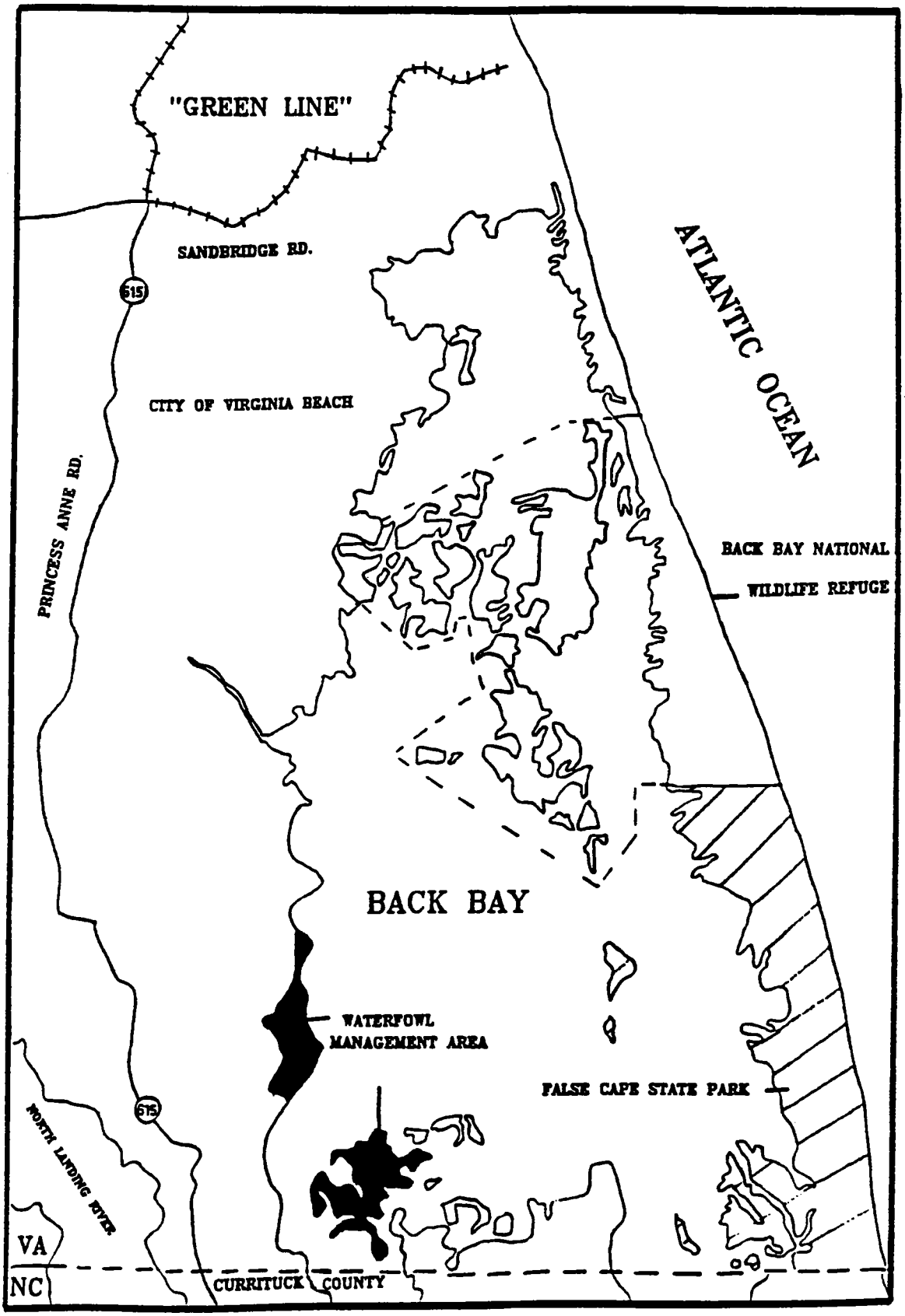
Virginia Beach's "green line" (Figure 4) is a boundary between the area which the city presently wishes to develop and the area which the Comprehensive Plan recommends retain its rural character. Currently, this "green line" runs east along Princess Anne Road to the intersection with Sandbridge Road, and then continues along Sandbridge Road to the Atlantic Ocean. The majority of the Back Bay watershed lies to the south of the "green line" and, therefore, in the less developed portion of the city (Mann, 1984).

The alternative leading to the most drastic change in existing management strategies called for

-creation of a Back Bay Management District to "articulate goals and policies for development and resource conservation",
-adoption of zoning for areas of critical concern such as wetlands,
-creation of a Virginia Beach Land Bank to acquire land threatened by development, and
-institution of a system for private land owners to transfer development rights (Mann, 1984)

Neither alternative, in its entirety, was selected by the City Council. "Bits and pieces from each alternative have been chosen" (Clayton Bernick, personal communication).

Currently, city planners are working on a comprehensive plan that includes zones for areas of critical community value. In addition, the transfer of development rights proposal is being considered. However, there has been no creation of a Back Bay Management District and the "green line will never be extended northward" (Clayton Bernick, personal communication).


"GREEN LINE"
SANDBRIDGE RD.
615
CITY OF VIRGINIA BEACH
PRINCESS ANNE RD.
ATLANTIC OCEAN
BACK BAY NATIONAL
WILDLIFE REFUGE
BACK BAY
WATERFOWL
MANAGEMENT AREA
FALSE CAPE STATE PARK
615
NORTH LANDING RIVER
VA
NC
CURRITUCK COUNTY

Private Organizations

Several nonprofit, grassroots organizations participate in activities aimed to "save the sounds": advocacy, education, land management, preservation, research, and water quality monitoring. Composed of concerned citizens, these groups work closely with natural resource managers in the Albemarle-Pamlico drainage basin. Environmental organizations such as Albemarle Environmental Association, Audubon Society, Back Bay Restoration Foundation, Coast Alliance, Natural Resources Defense Council, Nature Conservancy, North Carolina Coastal Federation, North Carolina Environmental Defense Fund, North Carolina Wildlife Federation, and Pamlico-Tar River Foundation are involved in shaping management strategies for the study area. However, no group has adopted the Currituck Sound watershed as a specific candidate for preservation, restoration, or enhancement.

In the Virginia portion of the watershed, the Back Bay Restoration Foundation "has initiated and fosters cooperation and coordination with users and communities whose activities affect Back Bay along with local, state, and federal agencies whose authority extends to Back Bay" (Back Bay Restoration Foundation, undated). The primary concern of the Foundation is improvement of the Bay's water quality through abatement of point and nonpoint pollution, optimization of salinity, and restoration of aquatic grasses. Back Bay Restoration Foundation monitors major tributaries to the Bay for nitrogen, phosphorus, and suspended solids. In addition, the Foundation has planted aquatic grasses, provided wood duck nesting boxes, sponsored annual interagency conferences, and worked with the

Soil Conservation Service and members of the agricultural community to institute the use of water control structures (Back Bay Restoration Foundation, undated).

In the North Carolina portion of the Currituck Sound drainage basin, the Pamlico-Tar River Foundation monitors water quality. Volunteers collect dissolved oxygen, pH, salinity, temperature, and turbidity data at 11 sites in Currituck Sound and 1 site in Back Bay (Tom Perlic, personal communication).

Other nonprofit organizations assume, primarily, advocacy, education, and preservation roles. The North Carolina Coastal Federation (NCCF), for example, "assists members and organizations working to seek the enforcement of laws and regulations that protect coastal resources" (North Carolina Coastal Federation, undated). NCCF also organizes the Albemarle-Pamlico Estuarine Study annual meeting. A major goal of NCCF is to increase public awareness regarding the A/P study: "If the A/P Comprehensive Management Plan is to succeed, the plan must have public support" (Neil Armingeon, personal communication).

Members of grassroots environmental groups also participate in the A/P Study through the Citizens' Advisory Committees (CACs). There are two 32-member CACs, one for the Albemarle region and another for the Pamlico region. The Currituck Sound drainage basin is included in the Albemarle region. Making recommendations for research and educational projects is the major function of the CACs. Citizen members represent a wide variety of interests including agriculture, education, fish/wildlife, industry, and governmental concerns.

The National Audubon Society and the Nature Conservancy own tracts of land on the Currituck Outer Banks and, thus, within the

Currituck Sound drainage basin. Preserving a portion of the natural barrier island habitat is a major goal of these two environmentally-oriented landowners. The Nature Conservancy has also acquired nearly 2000 acres of bottomland hardwood forest along the North Landing River in the Virginia portion of the study area. No development is allowed on either group's property.

Although no group concentrates solely on the Currituck Sound-Back Bay drainage basin, nonprofit organizations have an impact on current management strategies in the study area. Advocacy, information-sharing, land preservation, and water quality monitoring are the most common forms of grassroots participation in the watershed.

ALTERNATIVE MANAGEMENT MECHANISMS

Federal, state, and local government officials agree that the State of North Carolina and Commonwealth of Virginia must cooperate in order to best manage the Currituck Sound watershed. The resource is perceived to be declining with respect to water quality, the fishery, and wildlife habitat. Thus, some action is warranted.

An old adage admonishes that one must have jurisdiction over a resource if one aspires to manage it. Presently, responsibility for managing the Currituck Sound drainage basin is split among many agencies and regions. The study area has no comprehensive environmental management plan to guide the resource managers in a concerted effort. Such a plan could act as a collecting point for all existing federal, state, and local policies. In addition, a comprehensive plan would contain new policies to guide future resource management in the drainage basin.

This section will discuss an array of prospective management

alternatives and coordinative mechanisms for the Currituck Sound-Back Bay complex. While reading this section, one should keep in mind the following attributes of a successful natural resource management agency:

-complete geographic jurisdiction,
-continuity in time,
-flexibility,
-political and public acceptability,
-power to enforce plans, and
-wide special interest appeal.

These characteristics enable the agency to perform its requisite duties: public education, planning, regulatory and enforcement functions, research, receiving and administering funds, and fostering intergovernmental cooperation. This report considers six prospective alternatives for future management of the Currituck Sound drainage basin. These alternatives, in turn, can be grouped into three classes:

1. Alternatives which require no new institutions
   -Maintenance of the status quo
   -Increased local government action
2. Alternatives which require formation of new, non-statutory institutions
   -Adoption of an administrative agreement
   -Creation of an interstate planning agency
3. Alternatives which require formation of new, statutory institutions
   -Adoption of an interstate compact
   -Formation of a federal-interstate compact.

Which, if any, of these possible management options possesses the attributes and powers necessary for successful management of the study area?

ALTERNATIVES REQUIRING NO NEW INSTITUTIONS

Maintenance of the Status Quo

The first alternative, maintenance of the status quo, simply involves continuing the current management efforts at the same funding, staffing, and implementation levels. In other words,

this alternative offers no/marginal change. The preceding section combined with the Task II report on issue perception serves as a case study for this option.

One of the primary contentions of political science is that "things don't change very much or very fast" (Jones, 1984). Typically, policymakers prefer incremental change that builds slowly on the status quo (Philip Pavlik, personal communication). Maintaining current management strategies in the Currituck Sound-Back Bay complex would allow time for scientists to gather and analyze data on the status of the resource. This new information, in turn, would more definitively answer the questions of whether and why Currituck Sound is in a state of decline. In this scenario, the basis for future action would be fact rather than perception. No difficult decisions or binding commitments would have to be made at this time. Thus, maintaining the status quo is politically attractive.

There are, however, negative aspects to this simple alternative. The Currituck Sound-Back Bay watershed has experienced rapid population growth in the past decade and is forecasted to undergo more development in the 1990s (North Carolina Office of State Budget and Management, 1981; Southeastern Virginia Planning District Commission, 1987). Therefore, growth-related problems such as urban runoff, declining wildlife habitat, and wastewater discharge will increase. At this time, there is no plan at the drainage basin level to deal with expected future problems. James (Pete) Kornegay, a biologist with the North Carolina Wildlife Resources Commission, cautions that we have not yet seen the full impact of present development on Currituck Sound. In natural systems, changes occur slowly: reactions are often delayed. If this is true, what are the implications for

Currituck Sound in light of predicted future growth?

Dwarfed by Chesapeake Bay to the north and North Carolina's Albemarle-Pamlico Estuary to the south, Currituck Sound does not receive abundant attention. Currently, problems in the Currituck Sound drainage basin are overshadowed by the larger-scale issues of the neighboring estuaries. This problem is compounded by the fact that resource managers tend to practice curative rather than preventive management: they often do not seek to manage a problem until it grows to crisis proportions. Issues in the Currituck region will not be considered until they become a serious political problem and are placed on the working government agenda.

Under the current management system, the responsible agencies have failed to manage and monitor Currituck Sound/Back Bay. This is evident from the shortage of published material dealing with the study area. Limited data exist because studies have not been conducted in a continuing manner. In addition, enforcement of existing programs has been inadequate. Local governments such as Currituck County have not received sufficient expert help in managing the Sound resources (Yates Barber, personal communication). Inadequate funding and manpower at the state and federal governmental levels have contributed to these problems. In some cases, however, local governments in the watershed have acted without drawing on the available expertise.

Finally, the current management strategies do not address the perceived need for cooperative management of the bi-state resource, especially in the critical areas of growth management, water quality control, and water supply. Currently, North Carolina and Virginia work independently on problems related to management of the Currituck Sound drainage basin. There is no concerted effort to manage the

watershed as a system.

Increased Local Government Action

Local governments in the Currituck Sound watershed constantly face two seemingly opposed forces: development pressure and demands for environmental protection. In addition, local governments must provide public services and facilities to serve existing populations. Preserving the natural character of the Currituck Sound-Back Bay complex and promoting development in the drainage basin is impossible without active local government participation. Federal and state agencies have only limited authority in this arena while "local governments have the jurisdiction--through zoning and police powers--to thoroughly address the wide variety of water quality problems and their sources" (Division of Coastal Management, 1986). Land use planning and growth management systems are methods whereby local governments such as Currituck County and the cities of Chesapeake and Virginia Beach can balance development and preservation.

Over the past twenty years, North Carolina has witnessed a shift from state-controlled environmental regulation to greater local government involvement (Green and Heath, 1984). The Coastal Area Management Act (G.S. 113A-100 to 113A-134.3) exemplifies this change in management strategy. Under the 1974 law, local governments in the 20 coastal counties must design a land use plan to guide development outside Areas of Environmental Concern. Accordingly, Currituck County prepared a plan in 1982 to direct future growth. This plan utilized conventional zoning as the primary means to regulate land use and control density of development in the county. This is not surprising as conventional zoning is the "most common regulatory device for guiding land development in North Carolina" (Finch and Brower, 1986).

North Carolina General Statute 153A-340 et seq. grants zoning authority to counties. The United States Supreme Court has upheld zoning as a legitimate exercise of police power (272 U.S. 365 (1926)).

In the Virginia portion of the Currituck Sound drainage basin, local governments also use zoning as the major tool to control land use. In Virginia Beach, for example, all land is zoned and all zoning designations conform to policies expressed in the city's Comprehensive Plan. Land uses covered in the Virginia Beach Comprehensive Zoning Ordinance include agricultural, apartments, commercial, high and low density residential, industrial, townhouses, and special uses. Additionally, the City of Virginia Beach uses the "green line", subdivision regulations and site plans, a Capital Improvements Program, and restrictions on flood plain construction as land use management tools (Mann, 1984). City leaders have also discussed implementation of traditional village center development, but no definitive action has resulted from these discussions (John Carlock, personal communication). Many small, village-like developments currently exist in the rural, southern sector of Virginia Beach. The city has considered favoring this traditional type of development over high density development in order to maintain the rural character of the Back Bay watershed.

According to a North Carolina Division of Coastal Management report (1986),

> "Land use plans are the most effective way to manage coastal water resources because they establish a framework that can resolve conflicting resource needs, address potential pollution problems, provide for comprehensive water quality management, encourage the use of natural areas to protect water resources, and maintain the traditional aspects of the community."

There are, however, many other innovative mechanisms local governments

may use in combination with conventional zoning to better guide development. "The formulation of a growth management system should be integrated into the land use planning process" (Finch and Brower, 1986). Among the many alternatives available to local governments for growth management are: transfer of development rights (TDR), preferential assessment, performance zoning, population caps, annual permit limits, and local environmental impact ordinances. Three of these options would require new state enabling legislation prior to local enactment: TDR, performance zoning, and population caps.

This is by no means an exhaustive list of growth management tools. These particular alternatives were chosen from Finch and Brower's "Management Programs and Options for the Albemarle-Pamlico Study" (1986). Selection of alternatives was based on applicability in the Currituck Sound drainage basin. Other more traditional options including density zoning and direct purchase of environmentally sensitive areas may work equally as well. The remainder of this section will define each of these growth management tools and discuss the advantages and disadvantages of increased local government action to solve the perceived problems in the study area.

Transfer of Development Rights

Transfer of development rights (TDR) operates on the premise that a specific parcel of land represents two additive value elements: existing use value and development potential or community value. This growth management tool "permits all or part of the density [development] potential of one tract of land to be transferred to a noncontiguous parcel" (Merriam, 1978). TDR thereby provides a means for compensating landowners whose property use is restricted by allowing them to sell their development rights. In turn, landowners

in more intensively developed zones pay for the right to develop beyond existing densities by purchasing development rights from preservation zone landowners. For instance, under a TDR system, a landowner can sell his development rights to another property owner. Then, the buyer must collect a specified number of development rights before he can develop his property at a desired density (Finch and Brower, 1986). Past TDR successes have occurred at the developing fringe in areas where there was a market for the development rights (Merriam, 1978).

Transfer of development rights is a reasonable potential growth management tool for land in the Currituck Sound drainage basin, especially the outward expanding boundary of the City of Virginia Beach. The 1984 Management Plan for Back Bay recommended TDR as part of a protective watershed management strategy (Mann, 1984). Since that time, city officials have considered adopting TDR as a growth management tool. Before such an action can be taken, however, the Virginia General Assembly must pass enabling legislation for TDR (Clayton Bernick, personal communication). Currently, neither North Carolina nor Virginia has enabling legislation for transfer of development rights.

Preferential Assessment

Preferential assessment is another possible growth management tool for the Currituck Sound drainage basin. A special taxation system, preferential assessment values land based on current income-producing capacity rather than market-value (Finch and Brower, 1986). This, in turn, reduces the likelihood that special zones such as agricultural land, forests, and wetlands will be developed. The North Carolina Sales and Use Tax (G.S. 105-277.2) permits preferential

assessment of farmland and forestland in North Carolina. Virginia law also provides for this growth management tool (John Carlock, personal communication). Alone, preferential assessment does not affect land development patterns around growing urban areas. This growth management mechanism works best when coupled with other land use regulations (Finch and Brower, 1986).

Performance Zoning

Performance zoning sets standards for permissible effects of development, but does not specify particular land uses. In the Currituck Sound drainage basin, local governments may use this tool in conjunction with conventional zoning to protect environmentally sensitive areas. One possible performance standard, for instance, might be a limit on permissible runoff from residential neighborhoods. New projects would have to meet the standard before development could proceed. North Carolina does not have specific enabling legislation for performance zoning. The North Carolina Supreme Court, however, upheld performance standards against taking and equal protection challenges in Responsible Citizens in Opposition to the Flood Plain Ordinance v. City of Asheville (308 N.C. 255, 302 S.E.2d 204 (1983)). "It seems that performance standards, if rationally devised and consistently applied, could qualify as a comprehensive plan, and zoning in conformance with those standards could be upheld under the broad grant of zoning authority" (Finch and Brower, 1986). In Virginia, the Chesapeake Bay Preservation Act (Section 10.1-2100, Chapter 21, Title 10.1, Code of Virginia) includes a variety of performance standards for development in the Chesapeake Bay watershed. Similar measures could be adopted for the Virginia portion of the Currituck Sound drainage basin.

Population Cap

In an extreme situation, local governments may choose to put a cap on population. Typically, this is accomplished by either setting a numerical limit on population or on the permissible number of housing units. Advocating this growth management tool for the entire Currituck Sound drainage basin is a politically infeasible idea. However, a population cap in smaller, environmentally sensitive areas could greatly limit stress on the resources of Currituck Sound and Back Bay. One would guess that this particular growth management mechanism might meet severe resistance in North Carolina and Virginia because it would restrict use of private property. Population caps have been criticized as unconstitutional violations of state and federal due process. In Boca Raton, Florida, a charter amendment limiting the total number of housing units in the city was invalidated as "having no rational relationship to a permissible municipal objective" (City of Boca Raton v. Boca Villas Corp., 371 So.2d. 154 (Fla. App. 1979)). A population cap might also be subject to challenge as a breach of equal protection. This challenge is applicable when local government action involves a classification. For instance, a population cap would result in certain areas being classified for limited population growth/development while other areas would experience no such restrictions. If consistent with a comprehensive plan, however, a population cap might survive judicial scrutiny. This growth management option is not a guaranteed solution for development-related natural resource problems, but it is worthy of local government consideration.

Annual Permit Limits

Similar to a population cap, annual permit limits curb effects of development by setting a quota on the number of building permits issued in a given area. North Carolina's building code enabling legislation (G.S. 160A-417) makes no reference to annual permit limits. According to this law, issuance of a building permit is conditional upon compliance with the state building code and all applicable local laws. In order to protect the environment, local governments may set standards for permit issuance. No communities in North Carolina or Virginia have instituted annual permit limits, thus, there has been no test of the legitimacy of this growth management tool.

Local Environmental Impact Ordinances

In 1971, the North Carolina General Assembly passed the North Carolina Environmental Policy Act (G.S. 113A-8 to 10). This law, modeled after the National Environmental Policy Act of 1969, gave North Carolina local governments the authority to require detailed environmental impact statements from developers of major development projects. Theoretically, an environmental impact statement encourages environmentally sound land use patterns by forcing developers "to account for environmental values in project design and site layout" (Finch and Brower, 1986). An environmental impact statement should include discussion of the following topics:

- environmental impacts of the proposed project,
- alternative project possibilities,
- mitigation measures for adverse environmental effects,
- short-term uses of the environment versus long-term productivity, and
- irreversible environmental changes.

There would also be opportunity for public input in the environmental

impact analysis process. Although this alternative has "potential to improve land use decision making" (Finch and Brower, 1986), only Pamlico County and the municipalities of Chapel Hill and Holden Beach have taken advantage of it (Division of Coastal Management, 1986). Many Virginia localities require some elements of environmental impact assessment prior to development. All localities will soon require water quality assessments for development in Chesapeake Bay Preservation Areas (John Carlock, personal communication).

Increased local government action in management of the Currituck Sound drainage basin has inherent advantages and disadvantages. Involving local people who live in the watershed and depend upon the estuarine ecosystem for their livelihood is the primary advantage of this option. Traditionally, North Carolina has given local governments authority in the land use regulation arena due to the belief that "citizens should have maximum direct control over the specific areas within which they live and work" (Green and Heath, 1984). Local governments are already involved in management of the Currituck Sound watershed. They possess planning, permitting, and enforcement powers granted to them by the respective states. Under this alternative, no time would be wasted in negotiating an agreement between the multiple agencies involved in management of the resource. Local governments could act quickly and immediately to enact growth management measures.

No single local government has complete geographic jurisdiction over the Currituck Sound drainage basin and, for that reason, cannot single-handedly resolve the watershed's problems. In addition, the local governments lack resources such as money and manpower which are essential for education, research, and policy enforcement. Finally,

the local governments have a vested economic interest in promoting development: "They [local governments] have a legislative charge and public mandate to pursue economic development to some degree" (John Carlock, personal communication). Environmental problems resulting from rapid or unplanned growth may be ignored until the situation reaches crisis proportions. Interests of the local community often outweigh the "greater good" in the minds of local politicians.

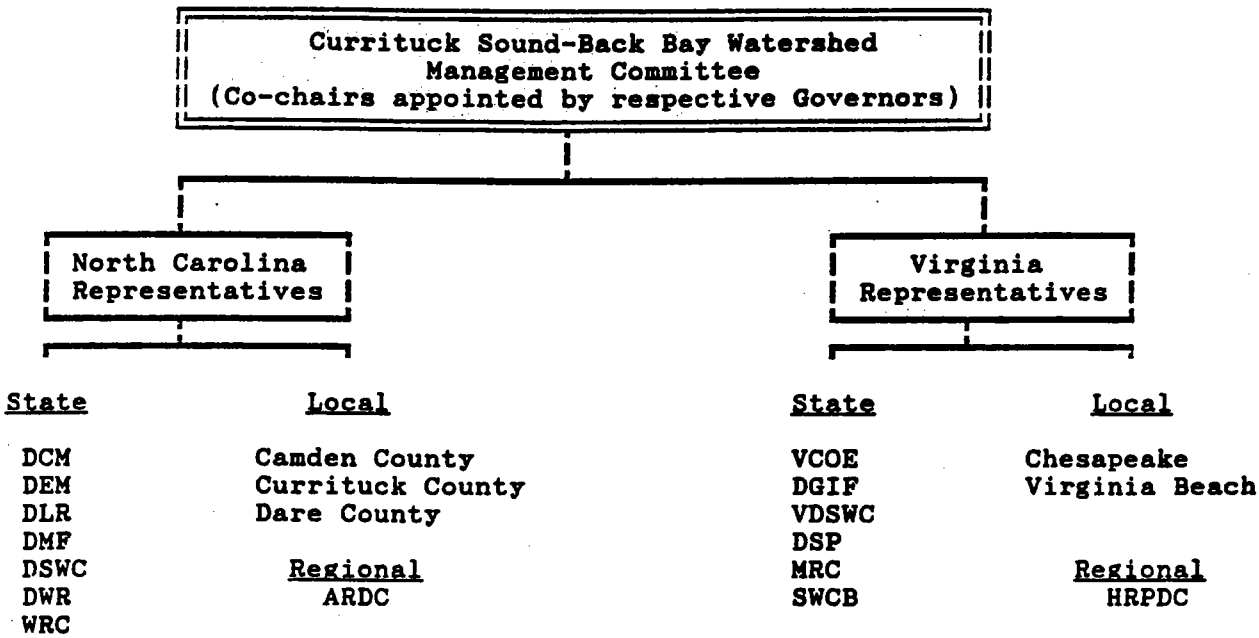
Land use planning and growth management measures offer flexibility in dealing with the study area's perceived problems. Using this approach, however, local governments cannot enact a comprehensive management strategy for the Currituck Sound drainage basin. Local governments may take part in comprehensive management through participation in regional efforts. For example, local officials may serve as advisors to interstate or federal-interstate compact commissions. In addition, local government officials can be included in regional planning efforts conducted under administrative agreement or authority of an interstate planning agency.

ALTERNATIVES REQUIRING NEW, NON-STATUTORY INSTITUTIONS

Administrative Agreement

According to Zimmerman and Wendell, the administrative agreement is " . . . an informal or a formal arrangement between administrative departments or officers of two or more states . . . " which does not require the approval of Congress (Figure 5). This third alternative for management of the Currituck Sound-Back Bay complex offers opportunity for cooperative action at the state level outside the confines of a legally binding interstate compact. In addition, there is a precedent for cooperation between the State of North Carolina and

Figure 5. Conceptual Organization Chart: Agency Formed by Administrative Agreement between the Governors of North Carolina and Virginia.



Functions/Powers:
1. Discuss management issues of mutual interest
2. Develop institutional arrangements for cooperation in resolving management issues

Pros:
- Flexible
- Immediate
- Can operate within presently existing agencies
- Politically acceptable

Cons:
- Discontinuous (meets only when there is a crisis)
- Lack of complete geographic jurisdiction
- No planning, regulatory, or enforcement powers
- Not a distinct agency
- Uncertain legal status
- Voluntary

See Table 4, Page 24 for key to abbreviations.

the Commonwealth of Virginia on water resource issues via this mechanism.

In 1974, Governors Godwin and Holshouser created the North Carolina-Virginia Water Resources Management Committee by written agreement. The Committee concentrated on water resource problems in the North Carolina-Virginia Tidewater area, of which the Currituck Sound drainage basin is a significant portion. Two primary objectives of the bi-state committee were development of institutional arrangements for cooperation on water resource matters of mutual interest and formation of joint positions on major issues in the broad arenas of water resources management and water quality control (North Carolina-Virginia Water Resources Management Committee et al., 1982). Meeting on an "ad hoc" basis, the Committee was a valuable forum for discussion; however, it proved unsuccessful in resolving interstate water conflicts. Currently, the Committee is inoperative because the present administrations have failed to renew the agreement. Regardless, this attempt at interstate cooperation shed light on the advantages and disadvantages of the administrative agreement as a mechanism for dealing with water resources issues in the Currituck Sound-Back Bay drainage basin.

The North Carolina-Virginia Water Resources Management Committee conducted a self-examination in 1982 that identified the following benefits of administrative agreements over alternative interstate institutions:

1. This less formal mechanism can avoid the "delays and political repercussions . . . involved with legislative ratification."
2. Committees formed by administrative agreement generally operate within pre-existing agencies, thereby, they place a low financial burden on the participating states.

In addition, the creation of the bi-state Committee demonstrated the desire of North Carolina and Virginia to work together on water resource issues of mutual concern.

This voluntary arrangement, however, suffered from severe organizational and structural problems including lack of planning, regulatory, and enforcement powers; inability to influence water resources decisions made by local and regional governing bodies; lack of accountability; inadequate financial resources; and poor continuity (North Carolina-Virgina Water Resources Management Committee et al., 1982). Neither state was willing to give the Committee sufficient authority to act effectively in resolving water resources issues. In this case, the formation of an interstate committee by administrative agreement was a "quick" solution that failed in the long-run. This is not to imply that an administrative agreement could not satisfactorily address the currently perceived issues in the study area. A new agreement between the State of North Carolina and Commonwealth of Virginia, however, would need to avoid the pitfalls of the former agreement in order to be successful. At the very minimum, a future bi-state committee would need planning authority if it is to be anything more than a figurehead. Regulatory and enforcement powers would greatly increase the responsibility of such an agency. Finally, legislative approval and appropriations would provide a clearer mandate and a means for dealing with water resources issues (North Carolina-Virginia Water Resources Management Committee et al., 1982). Legislative approval, moreover, would be mandatory if the new agency is to have regulatory power. Legitimizing an administrative agreement with legislative approval, however, would be equivalent to forming a statutory interstate compact commission.

A final disadvantage of the administrative agreement is its somewhat uncertain legal status. Article I, Section 10 of the Constitution of the United States prohibits agreements and compacts among states without the consent of Congress. A literal interpretation of this directive would construe the term "agreement" to include every agreement, written or verbal, formal or informal. However, states have entered numerous agreements without Congressional approval. For instance, as early as 1785, Virginia and Maryland worked out an interstate arrangement for protection of fish in boundary waters (Thursby, 1953). A little more than a century later, in 1893, the Supreme Court made the following ruling on the subject:

> "Constitutional prohibition as to compacts or agreements among the States without the consent of Congress was directed to the formation of any combination tending to increase the political power in the States, which may encroach upon or interfere with the just supremacy of the United States" (148 U.S. 503, 519 (1893)).

Thus, any agreement or compact between the states should not upset the balance of powers inherent in our federalistic system. Clearly, an administrative agreement between North Carolina and Virginia designed to deal with water resources issues in the Currituck Sound drainage basin would not interfere with the power relationship between the two states and the nation. Inclusion of a federal representative on any new interstate committee would further reduce this threat.

Over the years, "agreement" and "compact" have come to possess different meanings. "Compact" implies a more formal, contractual understanding between two or more parties. An administrative agreement can be contrasted with an interstate compact in several respects:

1. The administrative agreement does not require legislative approval in the party states.

2. There is no judicial precedent from which it can be concluded that the courts will enforce all types of administrative agreement.
3. The agreement is not embodied in state statutes.
4. Administrative agreements are inferior to state legislative action (Zimmerman and Wendell, 1953).

The validity of the North Carolina-Virginia Water Resources Management Committee was never questioned or challenged in court. Based on this fact and the preceding discussion of interstate agreements, one might conclude that an administrative agreement between North Carolina and Virginia would be a reasonable avenue for cooperation in the study area. Still, a slight uncertainty about the legality of this approach remains.

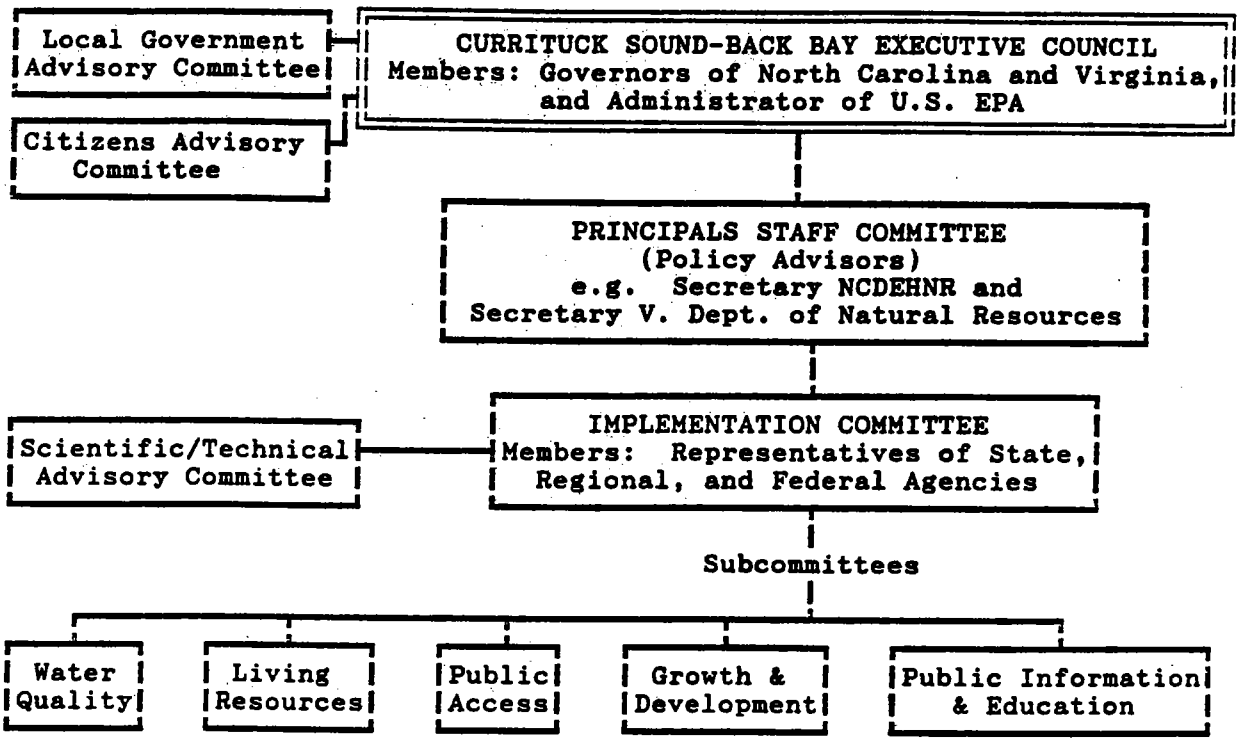
Interstate Planning Agency

A flexible coordinative mechanism, the interstate planning agency functions to develop and encourage planning processes between the states (Advisory Commission on Intergovernmental Relations, 1972). Normally, interstate planning commissions have the power to:

> "collect, analyze, and distribute data; conduct studies and prepare reports on existing or potential problems; serve as an advisory board; and identify and recommend actions to local, state, or Federal jurisdictions for more coordinated management" (North Carolina-Virginia Water Resources Management Committee et al., 1982).

In the case of the Currituck Sound drainage basin, an interstate planning agency would prepare plans to direct management of the Sound complex and its many resources (Figure 6). These plans, however, should be consistent with the two basin states' existing coastal area management programs. The North Carolina Coastal Area Management Act directs all state agencies to keep informed of federal and interstate agency plans, activities, and procedures within their areas of expertise that affect the coastal area:

Figure 6. Conceptual Organization Chart: Interstate Planning Agency (Modeled after the Chesapeake Bay Program (Chesapeake Executive Council, 1989b))



Functions/Powers:
1. Collect, analyze, and distribute data
2. Conduct studies and prepare reports on existing problems
3. Serve as an advisory board
4. Recommend actions to local, state, and federal jurisdictions for more coordinated management

Pros:
- Easily established
- Can serve as steppingstone to more formal agreement
- Flexible
- Possesses planning authority

Cons:
- Lack of regulatory and enforcement powers
- Fragmentation
- Voluntary

See Table 4, Page 24 for a list of federal, state, and local government

> "Where federal or interstate agency plans, activities, or procedures conflict with State policies, all reasonable steps shall be taken by the State to preserve the integrity of its policies" (G.S. 113A-127).

North Carolina and Virginia would be free to voluntarily implement the recommendations of such an interstate planning agency. The remainder of this section will discuss the procedures for forming an interstate planning agency, present a case study of the Chesapeake Bay Commission, and consider the advantages and disadvantages of this cooperative institution.

An interstate planning agency may be formed by informal agreement between governors or legislation passed by the respective states' legislatures. Congressional consent is not necessary: the reasoning behind this idea is identical to that discussed in the section on administrative agreements. The organization of an interstate planning commission "can be adapted to the desires and needs of the member states" (North Carolina-Virginia Water Resources Management Committee et al., 1982). Participating states appoint representatives to the agency and appropriate supporting funds. The federal government can also make grants "to assist any group of two or more coastal States to create and maintain a <u>temporary</u> planning and coordinating entity" (16 U.S.C. 1456(d)). Such a federal action, however, must be consistent with the involved states' coastal zone management programs (86 Stat. 1286).

Created in 1980 by the legislatures of Maryland and Virginia, the Chesapeake Bay Commission stands as an excellent example of an interstate planning agency. Initially, this bi-state commission coordinated interstate planning and programs for the Maryland and Virginia portions of the Chesapeake Bay watershed. The basic goal of

the Commission was to formulate plans with special attention to the legislative perspective. Today, however, the Commission is much more than a planning agency. During the 1980's, the Chesapeake Bay Commission evolved into a powerful agency with widespread public and political appeal.

In 1983, Virginia, Maryland, Pennsylvania, the District of Columbia, the United States Environmental Protection Agency, and the Chesapeake Bay Commission made a formal commitment to "save the Bay" with their signing of a brief declaration of purpose. This agreement created the Chesapeake Bay Program which was headed by the Chesapeake Executive Council. Carrying the Chesapeake Bay restoration effort to a high level of governmental cooperation and scientific understanding, the joint commitment was termed a success (Chesapeake Executive Council, 1989a). The 1983 agreement lead to a cooperative spirit among the many agencies responsible for management of continental America's largest estuary. The program, however, failed to solve the many complex problems of Chesapeake Bay and its 64,000-square-mile watershed. Therefore, in 1987, the parties to the 1983 declaration of purpose signed a new, in-depth agreement to "further commit to specific actions" to restore and protect Chesapeake Bay (Chesapeake Executive Council, 1989a). The new agreement contained specific goals and priority commitments for living resources, water quality, population growth and development, public information, education and participation, public access, and governance. For each of these seven categories of concern, the agreement outlined objectives and methods for achieving these desired goals. For example, in the water quality arena, the goal was stated as follows:

> "Reduce and control point and nonpoint sources of pollution to attain the water quality condition necessary to support the living resources of the Bay. The improvement and maintenance of water quality are the single most critical elements in the overall restoration and protection of the Chesapeake Bay. Water is the medium in which all living resources of the Bay live, and their ability to survive and flourish is directly dependent on it. To ensure the productivity of the living resources of the Bay, we must clearly establish the water quality conditions they require and must then attain those conditions . . . . To be most effective, we will develop basin-wide implementation plans for the control and reduction of pollutants which are based on our best understanding . . . of the Bay and its tributaries as an integrated system" (Chesapeake Executive Council, 1989a).

The methods to meet this goal included, among others, a 40 percent reduction of nitrogen and phosphorus entering the main stem of the Chesapeake Bay by the year 2000. Most commitments in the Agreement were assigned deadlines for realization. The 1987 Chesapeake Bay Agreement, in its entirety, is included in Appendix D.

The Chesapeake Bay Program has not resolved every issue surrounding Chesapeake Bay. It has, however, produced at least measured improvement in all seven categories of concern. Progress in the arena of living resources, for example, has included adoption of fishery management plans for blue crabs, herring, oysters, shad, and striped bass. The plans describe actions that will be taken by Bay jurisdictions to protect and enhance these fisheries (Chesapeake Executive Council, 1989b). Successes in the water quality category include a 29 percent decrease in phosphorus discharges into the Bay, increased use of Best Management Practices by farmers in the watershed, and implementation of a toxics reduction strategy. To curb the negative effects of population growth and development, member states have instituted comprehensive management programs or commissions to study such programs. One of the most encouraging

developments is the widespread public interest and involvement in the Chesapeake Bay restoration effort (Chesapeake Executive Council, 1989b). These are just a few of the many actions taken by the Chesapeake Bay Program and its members to revitalize the Bay.

The Chesapeake Bay Commission sparked a larger cooperative effort. Currently, the informal structure of the Chesapeake Bay Program has not been embodied in legislation at the state or federal level. Section 117 of the 1987 amendments to the Water Quality Act (101 Stat. 7) did establish a Chesapeake Bay liaison office within the Environmental Protection Agency, but this cooperative arrangement between the federal government and Bay states lacks the formality of a Federal-interstate compact commission. At this time, cooperation of the signatories is voluntary. The informal approach to management of the Chesapeake Bay watershed seems to be working. In the Foreword to the Second Progress Report under the 1987 Chesapeake Bay Agreement, former Virginia Governor Gerald Baliles (acting Chairman of the Chesapeake Executive Council) stated:

> "Now, as in the past, the key factors in our struggle to save the Bay are widespread awareness and support. We have attracted significant support from the public and State and Federal leaders. We must continue to pursue greater partnerships between State governments and the private sector in this great endeavor" (Chesapeake Executive Council, 1989b).

Currently, there is some thought of establishing a more formal agreement among the members of the Chesapeake Bay program, but the future of this possibility is uncertain (Carol Ann Barth, personal communication).

From the Chesapeake Bay Commission case study, one can deduce a great advantage of the interstate planning agency as a coordinative institution: it can serve as a steppingstone to more formal

cooperative efforts. Simply and expediently established, an interstate planning commission can be in operation much more quickly than a more formal coordinative mechanism such as an interstate compact commission (Chesapeake Bay Legislative Advisory Commission, 1979). Thus, an interstate planning agency could easily be designed as a precursor to a formal cooperative management program. Serving as a foundation for cooperation, the agency's first priority would be exchange of information and identification of basinwide problems. The interstate planning agency "can serve as a visible regional focus for water problems and can help develop a regional perspective toward water resources management" (North Carolina-Virginia Water Resources Management Committee et al., 1982).

As with any option, the interstate planning agency mechanism does have drawbacks. First, this form of agency lacks the regulatory and enforcement powers needed to implement its plans. Member states participate on a voluntary basis and are not obliged by law to put the interstate agency's plans into effect. Thus, the interstate planning agency is reduced to an advocacy role (Advisory Commission on Intergovernmental Relations, 1972). In addition, this type of agency usually must rely on federal, state, and local agencies for information, aid in preparing plans, and execution of plans. The Currituck Sound drainage basin is split into many different jurisdictions. This fragmentation would slow the work of an interstate planning agency just as it currently prevents effective management of the Currituck Sound-Back Bay system. These disadvantages have hindered many interstate planning commissions to the point that they had only "marginal impact on improving basinwide water resources management" (North Carolina-Virginia Water Resources Management Committee et al., 1982).

ALTERNATIVES REQUIRING NEW, STATUTORY INSTITUTIONS

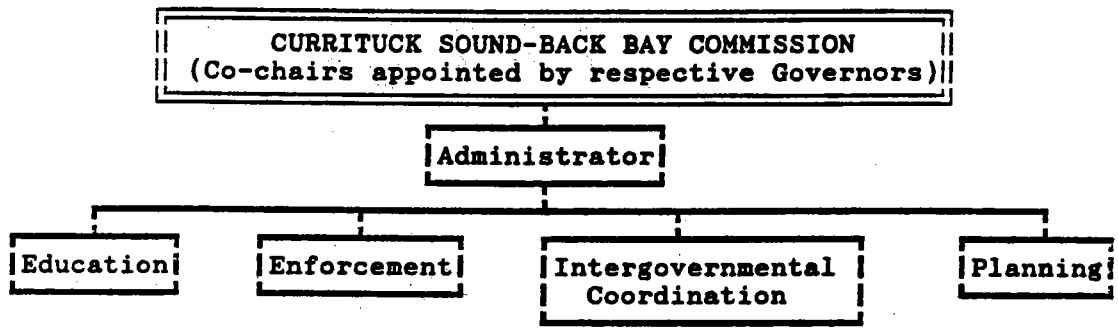
Interstate Compact Commission

Since the inception of America, states have entered legally binding compacts in order to address bi- or multi-state issues in a cooperative fashion (Figure 7). These compacts are contractual in nature and take precedence over other state statutes. An early Supreme Court decision ruled that an interstate agreement or compact is a contract within the meaning of the Contract Impairment Clause of the United States Constitution (21 U.S. 1, 91-92 (1823)). If necessary, an interstate compact can be enforced by suit in the Supreme Court.

Article I, Section 10 of the Constitution of the United States provides for interstate compacts: "No state shall, without the Consent of Congress . . . enter into any Agreement or compact with another state; or with a foreign power . . . ." Thus, creation of a compact between the State of North Carolina and Commonwealth of Virginia would require that the states' respective legislatures pass identical laws authorizing the compact. Then, Congress would have to give consent through resolution or ratifying legislation. Congressional approval, however, is not a large obstacle as Congress generally grants consent to compacts drawn and agreed to by the party states (Leach and Sugg, 1959). Moreover, the Federal Coastal Zone Management Act (90 Stat. 1019) granted consent of Congress to any two or more coastal states to negotiate and enter into agreements or compacts which do not conflict with any law or treaty of the United States, for

1. "developing and administering coordinated coastal zone planning, policies, and programs . . . and

Figure 7. Conceptual Organization Chart: Interstate Compact Commission



State Representatives

North Carolina	Virginia
Legislative	
2 State Senators	2 State Senators
2 State Reps.	2 State Reps.
Administrative	
DCM	VCOE
DEM	DGIF
DLR	VDSWC
DMF	DSP
DSWC	MRC
DWR	SWCB
WRC	

Local Representatives

North Carolina	Virginia
Camden County	Chesapeake
Currituck County	Virginia Beach
Dare County	

Regional Representatives

North Carolina	Virginia
ARDC	HRPDC

Powers/Functions:
1. Develop a comprehensive plan for the compact region.
2. Serve as principal regulatory and coordinating body for water resources management.

Pros:
- Comprehensive planning approach
- Complete geographic jurisdiction
- Legally-binding
- Power to manage from ecosystem perspective
- Provides strong cooperative framework
- Receives and administers funds

Cons:
- Lengthy negotiation and ratification period
- Inflexible
- Threat of "regional supergovernment"
- Member state jealousy and distrust
- Requires consent of Congress

See Table 4, Page 24 for key to abbreviations

2. establishing executive instrumentalities or agencies which such States deem desirable for the implementation of such agreements or compacts" (16 U.S.C. 1456b(b)).

Similar in content, wording, and form to an international treaty (Zimmerman and Wendell, 1951), interstate compacts are, essentially, treaties between two or more states. "It is generally accepted that the compact device affords the most appropriate legal base for administration of a single facility that stretches across state lines" (Barton, 1967). This reasoning may also be applied to natural systems such as the Currituck Sound-Back Bay complex which straddles the North Carolina-Virginia border. The interstate compact is a tool to insure intergovernmental cooperation on activities affecting interjurisdictional resources. This form of agreement has been successfully utilized to abate and control pollution in shared watersheds as well as to facilitate development of water and related land resources.

As of 1979, North Carolina was a member of 20 compacts, including boundary settlements with the states of Georgia, South Carolina, and Tennessee (Council of State Governments, 1979). This number grew during the 1980's as the state joined other compacts such as the Southeast Compact which deals with disposal of hazardous wastes. Most notably, North Carolina entered the Interstate Environmental Compact in 1971. Although this compact was never granted Congressional consent, it is embodied in North Carolina law as an enabling instrument for the formation of interstate compacts in the environmental arena. The Environmental Compact Act (G.S. 113A-21 to 113A-23) was "directed at improving environmental protection by acting in concert and cooperation with other states and the federal government" (Finch and Brower, 1986).

North Carolina also has a Council on Interstate Cooperation which

is responsible "to advance cooperation between the State and other units of government whenever it seems advisable to do so by formulating proposals and by facilitating . . . " the adoption of compacts (G.S. 143B-379). The Council on Interstate Cooperation is composed of the Governor, President of the Senate, Speaker of the House, three senators, three representatives, and three administrative officials chosen by the Governor.

Participating states choose the form, membership, and level of authority for interstate compact commissions. Typically, these commissions are organized in one of three ways:

-forum-type compact commission,
-planning-type compact commission, or
-regulatory-type compact commission.

Possessing little planning capability and no regulatory power, the forum-type compact commission is simply a device to promote discussion and information dissemination. Thus, it is similar in practice to the former North Carolina-Virginia Water Resources Management Committee which was discussed in the section on administrative agreements. A forum-type commission would have no power to resolve the perceived problems in the Currituck Sound drainage basin. It could do no more than is already being done by the A/P Study to bring North Carolina and Virginia together to work on mutual problems. A planning-type compact commission would have the authority to develop and adopt a regional plan to guide conservation and development in the study area (Advisory Commission on Intergovernmental Relations, 1972). Such a commission, however, would have only limited power to effect its plans. Like the interstate planning agency mechanism discussed earlier, the planning-type compact commission device results in a role of advocacy rather than action. Both the forum and planning-type

forms are used by signatory compact states to weaken interstate compact agencies.

A regulatory-type compact commission is the most powerful form of compact agency and may be given very broad authority. "Such a compact commission can serve as the principal planning, regulatory, and coordinating body for water resources management in the region . . ." served by the compact (North Carolina-Virginia Water Resources Management Committee et al., 1982). States usually enter regulatory-type compacts only when it is impossible to solve a problem by other means. Due to the increased responsibilities, this type of commission requires a larger staff and greater monetary support than either of the other interstate compact commission forms.

Interstate compacts have some advantages over other coordinative mechanisms in addressing interstate problems. First, the compact is a formal, legally-binding agreement indicative of the participating states' commitment to resolving the issue at hand. After the agreement is finalized, execution of compact terms is mandatory rather than voluntary. As stated earlier, states which fail to comply with the rulings of the compact are subject to suit in the Supreme Court of the United States. Thus, this mechanism is much more powerful than the administrative agreement or interstate planning agency. In addition, the interstate compact commission is a more permanent and stable agency than those formed by informal means. Generally, compact representatives meet on a regular basis, thereby maintaining a continuous interactive relationship among the member states.

The 1982 study completed by the North Carolina-Virginia Water Resources Management Committee noted that "interstate compacts may be used for focusing on regional problems, and particularly on natural

resources problems that are contained within a certain region like a river basin". The Currituck Sound drainage basin could benefit immensely from the comprehensive planning and management approach of an interstate compact agency. An interstate compact would assure cooperation among the many different government agencies that have jurisdiction in the study area by providing them with a common framework within which to operate (Advisory Commission on Intergovernmental Relations, 1972). An interstate compact commission, with aid from existing management institutions, could manage the Currituck Sound-Back Bay complex from an ecosystem perspective. The other cooperative mechanisms discussed thus far are too weak to achieve this ultimate goal.

Although this alternative has great potential, it has been utilized, primarily, when all else failed. States are reluctant to enter an interstate compact until they are convinced that independent federal, state, and local efforts cannot resolve the problem. Public and political acceptability of the compact mechanism is generally low because this formal coordinative device is often viewed as an infringement on traditional state and local jurisdictions. Acceptability of the compact mechanism as a coordinative tool for management of the Currituck Sound drainage basin may be further hampered by North Carolina's recent controversial involvement in the Low Level Radioactive Waste Compact and the Southeastern Compact. Both compacts deal with disposal of hazardous materials. As a result of the compact affiliations, North Carolina has been selected as the site for a low level radioactive waste repository and a hazardous waste incinerator. Exhibiting the Not In My Backyard (NIMBY) Syndrome, many North Carolinians have revolted against the respective

compacts' waste disposal decisions. The State of North Carolina, however, is legally obligated to fulfill compact duties.

The amount of time required to negotiate and ratify an interstate compact is also a major negative aspect of this alternative. The average time needed for compact formation is greater than 8 years (Muys, 1971). During the negotiation and ratification periods, the party states usually engage in few or limited cooperative efforts. As a result, immediate problems receive little attention and may worsen. There is no reliable way to estimate how long it would take North Carolina and Virginia to agree on terms for a compact. Perhaps, the two states could never reach a mutually satisfactory agreement. It is reasonable to assume that the current controversy and litigation surrounding the City of Virginia Beach's plans to withdraw water from Lake Gaston would slow the compact-building process. Ironically, this very controversy illustrates the need for a speedy commitment to resolve water resources issues in the entire A/P study area as well as the Currituck Sound drainage basin. An interstate compact commission might be extended to cover a much larger geographic area than the Currituck Sound-Back Bay complex. Logically, an interstate compact commission would be more suitable for the <u>entire</u> Albemarle Sound watershed.

Other predominant drawbacks of the interstate compact mechanism stem from member states' jealousy and distrust of compact commissions (Leach and Sugg, 1959). Often, state and local government officials fear that a compact commission will become a "regional supergovernment" that will ride roughshod over their interests (North Carolina-Virginia Water Resources Management Committee et al., 1982). This distrust and fear prompts states to limit the powers of compact commissions to the

point that they become ineffective in resolving issues. Then, the compact commission may be perceived as an "additional layer of needless government or bureaucracy" (North Carolina-Virginia Water Resources Management Committee et al., 1982). Another result of distrust on part of the member states is that the compact commission is purposefully alienated from the respective states' administrations and legislatures: the commission stands alone as a regional agency (Leach and Sugg, 1959). Lack of integration into the administrative fabric, in turn, leads to inadequate liaison and coordination (Chesapeake Bay Legislative Advisory Commission, 1979). An interstate compact commission simply cannot function without the faith and cooperation of member states.

To circumvent the problems caused by distrust of a compact commission, signatory states have several options at their disposal. For example, they can require the commission to win legislative approval on a year-to-year basis. Gubernatorial supervision and judicial control can also be included in the compact provisions. These measures of control over the compact commission provide the participating states with an assurance that their interests will be served. Maintaining open channels of communication between the member states and the compact commission is essential in alleviating the "regional supergovernment" fear. Frequent meetings and progress reports promote interaction and cooperation.

Finally, the interstate compact commission must be accepted into the administrative and legislative fabrics of the participating states. Including the compact agency within the existing executive structure would prevent alienation from state administration. For instance, North Carolina could place participation in a Currituck

Sound-Back Bay commission under supervision of the Department of Health, Environment, and Natural Resources. The Virginia Council on the Environment could serve as the lead agency representing Virginia on such a compact commission. Appointing state administrators to membership on the compact commission would further solidify the liaison between the state and the newly created regional agency. These state administrators should not be ex-officio members, however. Commission members must be able to commit sufficient time to their duty (Leach and Sugg, 1959). Appointed commissioners should also represent varied interests. Finally, in order to formulate policy with the legislative point of view in mind, the compact commission should include legislators from the respective states (Leach and Sugg, 1959).

An interstate compact commission could effectively manage the Currituck Sound drainage basin if granted sufficient acceptance and power. The State of North Carolina and Commonwealth of Virginia should not consider this alternative, however, unless they are convinced that the identified problems need a regional solution. In order to succeed, this option would require enormous commitment, cooperation, and effort.

Federal-Interstate Compact Commission

A compact in which the federal government is a full and formal participant, the federal-interstate compact acts as a "mechanism to unite the constitutional powers of state and federal government while creating a regulatory agency of all party jurisdictions" (Council of State Governments, 1979). Enactment of a federal-interstate compact requires ratification by the signatory states' legislatures and, also, Congressional approval. Congress must give consent to the compact

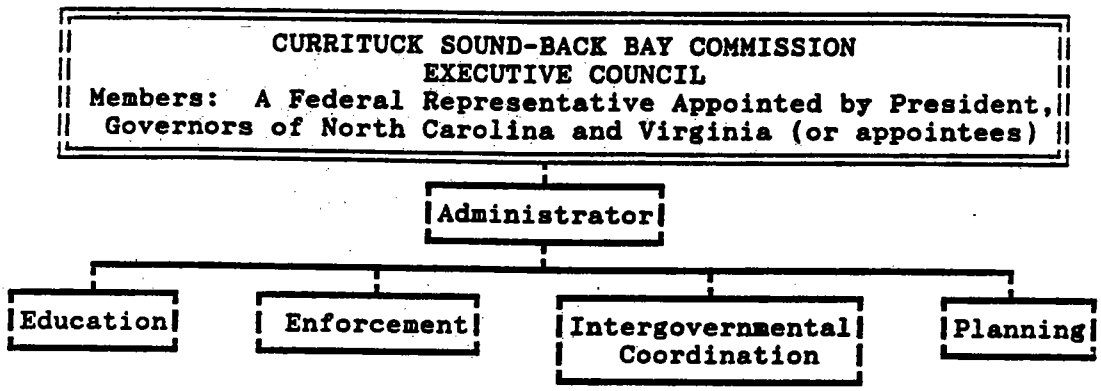
itself and to federal participation on the resulting compact agency. Typically, federal-interstate compact commissions are composed of the governors of the respective member states and one representative appointed by the President of the United States (North Carolina-Virginia Water Resources Management Committee et al., 1982).

The federal-interstate compact mechanism is very similar to the regulatory-type interstate compact commission discussed in the previous section (Figure 8). The federal government serves as a full member of a federal-interstate compact commission. In contrast, ordinary interstate compact commissions exclude the federal government from membership.

The federal-interstate compact agency claims broad authority in the planning and regulatory arenas. To gain a better perspective on the breadth of this coordinative mechanism, one might consider the nation's most famous federal-interstate compact commission: the Delaware River Basin Commission (DRBC).

Created in 1961, DRBC is the major planning, regulatory, and coordinative body for water resources management in the Delaware River Basin. The parties in this cooperative venture include the states of Delaware, New Jersey, New York, and Pennsylvania as well as the United States of America. The Delaware River Basin Commission has primary jurisdiction over flood protection, hydroelectric power, pollution control, recreation, regulation of water withdrawals and diversions, water management, and water supply for the Delaware River Basin (Chesapeake Bay Legislative Advisory Commission, 1979). All actions of this agency, however, must be based on a comprehensive plan (Advisory Commission on Intergovernmental Relations, 1972).

Figure 8. Conceptual Organization Chart: Federal-Interstate Compact Commission



Agency Representation

Federal	State		Local
	North Carolina	Virginia	
EPA	DCM	VCOE	Camden County
FWS	DEM	DGIF	Currituck County
COE	DLR	VDSWC	City of Chesapeake
SCS	DMF	DSP	City of Virginia Beach
	DSWC	MRC	
	DWR	SWCB	Regional
	WRC		ARCD
			HRPDC

Powers/Functions:
1. Develop a comprehensive plan for the compact region.
2. Serve as principal regulatory and coordinating body for water resources management.

Pros:
- Comprehensive planning approach
- Complete geographic jurisdiction
- Legally-binding
- Power to manage from ecosystem perspective
- Provides strong cooperative framework
- Receives and administers funds
- Liaison with federal government

Cons:
- Lengthy negotiation and ratification period
- Inflexible
- Threat of "regional supergovernment"
- Member state jealousy and distrust
- Requires consent of Congress

See Table 4, Page 24 for key to abbreviations

A majority of the funding for the Delaware River Basin Commission comes from the member states and the federal government. DRBC possesses power to raise additional funds through sale of revenue bonds. In addition, this interstate agency may negotiate loans and grants, charge fees and user rates for services, exercise the power of eminent domain, and acquire or dispense real property (North Carolina-Virginia Water Resources Management Committee et al., 1982).

Prior to establishment of the Delaware River Basin Commission, the basin states and New York City struggled against one another for control of the Delaware River and its water supply. Litigation failed to solve the problem. Finally, the states negotiated an interstate compact with the federal government as a full and formal participant. Serving as a locus for basinwide water resources management, this federal-interstate compact commission has been successful in coordinating federal, state, and local plans for water and land resources in the Delaware Basin (Advisory Commission on Intergovernmental Relations, 1972).

Federal-interstate compact agencies such as the Delaware River Commission have one distinct advantage over other mechanisms for interstate cooperation: they require cooperation between the states and the federal government. In the Currituck Sound drainage basin, the United States Fish and Wildlife Service alone is responsible for management of more than 125,000 acres of land. In addition, the Environmental Protection Agency, Army Corps of Engineers, and Soil Conservation Service play a significant role in land and water resources management. Thus, the states of North Carolina and Virginia could not ignore the federal government presence and, simultaneously, achieve total watershed management. The federal-interstate compact

mechanism provides the opportunity for the highest attainable level of cooperation between the multiple agencies responsible for management of the study area. Additionally, a federal-interstate compact would have sufficient power and authority to address the water supply and land space issues in the Currituck Sound drainage basin. Neither existing institutions nor other discussed alternatives for management of the study area can deal with these critical problems.

There are, of course, distinct disadvantages to this cooperative mechanism. First, a federal-interstate compact commission would suffer all the drawbacks common to the interstate compact commission: lengthy negotiation and approval period; jealousy and distrust on the part of the member states; and alienation from the signatory states' administrative and legislative bodies. Furthermore, formation of a federal-interstate compact commission to deal with the perceived issues in the Currituck Sound drainage basin would present a significant departure from the water laws and institutions of North Carolina and Virginia. One can imagine that it would be very difficult to build the broad public and political support necessary to create such an agency (North Carolina-Virginia Water Resources Management Committee et al., 1982).

COMPARISON OF THE ALTERNATIVE MANAGEMENT STRATEGIES

Discussion in the preceding section focused on three classes of alternative management strategies for the Currituck Sound drainage basin:

- Alternatives requiring no new institutions,
- Alternatives requiring new, non-statutory institutions, and
- Alternatives requiring new, statutory institutions.

Each prospective coordinative mechanism possesses distinct advantages and disadvantages. Ultimately, selection and implementation of a management alternative will depend upon the priorities of the many managing agencies in the study area and of the citizens in the two states. Comparing the prospective management alternatives in terms of critical attributes and capabilities will provide the information necessary for final decision making (Tables 5 and 6).

After studying Tables 5 and 6, one can see that no single alternative possesses all the desirable characteristics and capabilities of the ideal natural resource management agency. For example, maintenance of the status quo ranks high for public and political acceptability; however, this alternative does not vest complete geographic jurisdiction in a single managing agency. In contrast, a federal-interstate compact commission would have jurisdiction over the entire study area, but would probably fail to gain widespread political and public support. The compact mechanism would represent a significant departure from current management strategies.

The prospective management alternatives fall along continuums for flexibility and power. Flexibility allows a natural resource management agency to take more innovative approaches to solving problems. A flexible agency is not restrained by controls and standard operating procedures. Ranking the Task III management alternatives in order from most to least flexible produces the following list:

1. Maintenance of the status quo
2. Increased local government action
3. Adoption of an administrative agreement
4. Creation of an interstate planning agency
5. Formation of an interstate compact commission
6. Formation of a federal-interstate compact commission.

Table 5. Comparison of the Prospective Management Alternatives.

Attributes of a Successful Natural Resource Management Agency	Management Alternatives* 1	2	3	4	5	6
Complete geographic jurisdiction	No	No	No	Yes	Yes	Yes
Continuity in time	No	No	No	Yes	Yes	Yes
Flexibility	Yes	Yes	Yes	Yes	No	No
Political/Public acceptability	Yes	Yes	Yes	Yes	No	No
Power to enforce plans at ecosystem level	No	No	No	No	Yes	Yes
Wide special interest appeal (Represent varied interests)	Yes	Yes	Yes	Yes	Yes	Yes

* No new institutions
1=Maintenance of status quo
2=Increased local government action

New, Non-statutory Institutions
3=Agency formed by administrative agreement
4=Interstate planning agency

New, Statutory Institutions
5=Interstate compact commission
6=Federal-interstate compact commission

Table 6. Comparison of the Prospective Management Alternatives (b).

Duties of a Natural Resource Management Agency (after Matthews, 1976)	Management Alternatives* 1	2	3	4	5	6
Planning	Yes	Yes	No	Yes	Yes	Yes
Public education	Yes	Yes	Yes	Yes	Yes	Yes
Regulatory/enforcement functions	Yes	Yes	No	No	Yes	Yes
Receiving and administering funds	Yes	Yes	No	Yes	Yes	Yes
Research	Yes	No	No	Yes	Yes	Yes
Fostering intergovernmental relations	No	No	Yes	Yes	Yes	Yes

* No new institutions
1=Maintenance of status quo
2=Increased local government action

New, Non-statutory Institutions
3=Agency formed by administrative agreement
4=Interstate planning agency

New, Statutory Institutions
5=Interstate compact commission
6=Federal-interstate compact commission

Compact commissions are inflexible because their duties are explicitly stated in their ratifying legislation. The formality and contractual nature of compacts limit flexibility (Leach and Sugg, 1959). Ironically, the exact attributes of the compact mechanism which curb flexibility serve to empower compact agencies. Typically, compact commissions have planning, regulatory, and enforcement powers (North Carolina-Virginia Water Resources Management Committee et al., 1982) as well as complete geographic jurisdiction. Flexibility and power are inversely related. Thus, arranging the prospective management alternatives from most to least powerful results in a list that is the inverse of the one above:

1. Formation of a federal-interstate compact commission
2. Formation of an interstate compact commission
3. Creation of an interstate planning agency
4. Adoption of an administrative agreement
5. Increased local government action
6. Maintenance of the status quo.

It is interesting to note that an interstate planning agency or an agency formed by administrative agreement would occupy the middle ground in terms of flexibility and power. In addition, these two coordinative mechanisms more closely approximate existing conditions than the formal compact commissions. As stated earlier, an interstate planning agency can serve as a steppingstone to a more binding agreement. The interstate planning agency represents only a slight departure from the status quo; therefore, it is more politically acceptable than a compact commission. One additional prospective alternative for management of the Currituck Sound drainage basin would be initial creation of an interstate planning agency followed by formation of a federal-interstate compact commission. This two-phased alternative would take early advantage of the flexibility and

political acceptability of the interstate planning agency. Then, as the cooperative relationship matured, the member states could move toward a more powerful, long-term mechanism.

The interstate planning agency could be the initial step in the two-phased alternative because such an agency would claim complete geographic jurisdiction. An agency formed by administrative agreement could also play this role. A federal-interstate compact commission could be the final step in the two-phased alternative. This mechanism claims all the advantages of the ordinary interstate compact commission. In addition, federal-interstate compact commissions mandate cooperation with federal agencies such as EPA, COE, SCS, and USFWS.

"Environmental management can be considered as a process of discovering, analyzing, and making decisions about issues and problems concerning man's impact upon the world and its resources" (Matthews, 1976). Decisionmakers must soon select an alternative that will allow for comprehensive environmental management of not only the Currituck Sound drainage basin but also the entire Albemarle-Pamlico watershed. The discussion and analysis of prospective management alternatives presented in this report can serve as a starting point in the selection process.

OTHER COORDINATIVE MECHANISMS

Regardless of which management alternative is eventually chosen and implemented in the Currituck Sound drainage, there are other coordinative mechanisms that would help provide an <u>ideal</u> management atmosphere.

Public Education

The 1987 Chesapeake Bay Agreement declared that "the understanding and support of the general public and interest groups are essential to sustaining the long-term commitment to the restoration and protection of the Chesapeake Bay system" (Chesapeake Bay Commission, 1989b). Similar reasoning may be applied in the case of the Currituck Sound-Back Bay watershed. Citizens need to understand natural systems and how each person can play an important role in maintenance of these systems. According to Bill Hegge, manager of Mackay Island National Wildlife Refuge, education should be ranked as the first priority in any coordinated management effort for the Currituck Sound watershed. (Bill Hegge, personal communication).

The Albemarle-Pamlico Estuarine Study has focused on education and public involvement as necessary components of a comprehensive management strategy for North Carolina's estuaries. For example, the A/P study has worked with WRAL-TV in developing public service announcements which describe the values of the coastal region. In addition, the agency sponsors a quarterly informational newsletter called the Albemarle-Pamlico Advocate. Other public education efforts include production of an environmental education calendar for 1990 and workshops on such topics as water quality.

In March 1990, the North Carolina Agricultural Extension Service conducted four sessions of a workshop on important water quality policy issues and decisions. Funded by the A/P study, the workshop offered an opportunity for concerned citizens to play a larger role in the decisions leading to the Comprehensive Conservation and Management Plan for the Albemarle-Pamlico region. At the workshop session conducted in Nashville, North Carolina, participants identified early

education as crucial to the successful future management of the A/P study area. Children must learn stewardship and respect for the environment at an early age. Member states in the Chesapeake Bay Commission concur with this notion. During the 1988-89 academic year, Virginia's Bay Team teachers traveled over 27,000 miles and provided instruction to more than 15,000 students. Sponsored by the Virginia Council on the Environment, the team teachers covered a wide variety of topics related to the restoration of Chesapeake Bay (Chesapeake Executive Council, 1989b). In Maryland, the State Board of Education adopted a bylaw "requiring comprehensive environmental education for all school age children" (Chesapeake Executive Council, 1989b). A statewide environmental education program in North Carolina could place special emphasis on coastal zone management and the efforts of the A/P study. In addition, any new education program could stress the importance of governmental cooperation in management of natural resources.

Another approach taken in the Chesapeake Bay initiative has been special targeting of farmers to encourage their participation in the cleanup program. The Maryland State Soil Conservation Committee aimed to make farmers and the general public aware of agriculture's role in pollution of the Chesapeake Bay. However, the committee also wanted to stress that "farmers have traditionally been stewards of soil and water resources, a majority of farmers are good managers and do not knowingly pollute the environment, and farmland is not the only contributor of pollutants to the Bay" (Magette et al., 1985). The Maryland program had several components including theme selection and logo development, a special campaign kickoff, promotional items such as lapel pins and caps, newspaper articles, radio and television

releases, fact sheets, slide programs, a state fair exhibit, and an information kit. "Maryland Farmers: Partners with the Bay" was chosen as the slogan for the educational campaign. Federal, state, and local agencies as well as private organizations united to conduct this successful program.

A similar approach might be taken in the Currituck Sound-Back Bay watershed. Agriculture is perceived to be a significant contributor of nonpoint source pollution to this freshwater estuary. In addition to targeting farmers, educational programs in the study area should also focus on urbanites. Urban runoff from the City of Virginia Beach stands as a probable prime source of pollution to the Sound system. The outcome of such a targeted program would be increased awareness of the results of one's actions. In turn, this new awareness should lead the potential polluter to curb his/her negative impacts on the Currituck Sound ecosystem.

Careful planning must precede any successful educational campaign. First, the resource professional must identify the educational problem and goal. For example, the objective may be to increase farmers' awareness of their contribution to the pollution problem in Currituck Sound. Next, one must gain an understanding of the target audience. The third step is to define and develop specific messages "aimed at changing attitudes, improving knowledge, or influencing the behavior of the target audience" (Hoban, undated). These messages should motivate the target audience to action. Finally, the resource professional must select a variety of educational media and implement the education campaign (Hoban, undated).

Leading to a better understanding of the study area's problems

and needs, education can play a key role in total ecosystem management. Resource managers must recognize the value of an educated public. Everyone -- farmers, urbanites, developers, environmentalists, school children, and all other residents of North Carolina and Virginia -- needs to realize that the coastal area is an irreplaceable resource. Competing uses and intensive development, if not managed, could "destroy the very features that make our coast so attractive" (Rhodes, 1985).

Applying the Ecoregion Concept

Jurisdictional boundaries often do not coincide with boundaries of natural systems. The North Carolina-Virginia state border divides the Currituck Sound drainage basin into two separate portions. Then, within the respective states, the watershed is further subdivided into cities, counties, public trust lands, and federal holdings. As a result, the Currituck Sound-Back Bay complex is not treated as a single system. Rather, responsibility for management of this ecosystem is split among a multitude of governmental agencies (Table 4, Page 24), with no single agency having complete geographic jurisdiction.

The North Carolina-Virginia state line serves as a regional boundary for EPA and USFWS. Thus, the North Carolina and Virginia portions of the Currituck Sound watershed belong to different EPA and USFWS regions. The regional boundaries were set administratively, within the respective agencies. When the boundaries were established, there was no attempt to group areas based on their natural attributes. Instead, administrators concentrated on creating convenient regions in terms of size and location (Randy Bowman, personal communication). Such agency boundaries along state borders ignore natural delineations.

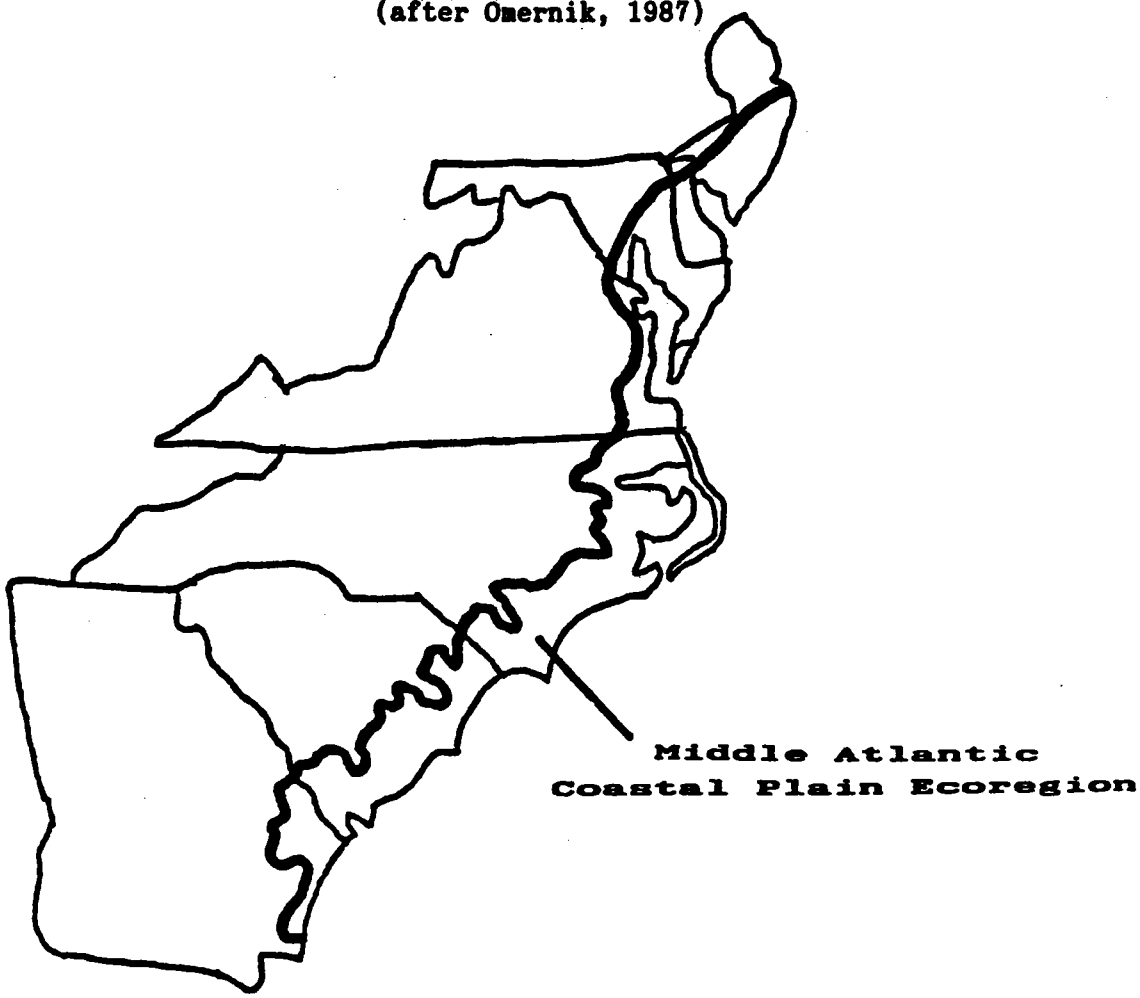
In addition, these artificial boundaries hinder ecosystem-level management. Fragmented management and unnecessary duplication of effort result. Redrawing EPA and USFWS regional boundaries to correspond to natural system boundaries stands as a logical recourse. Similar ecosystems could be grouped and managed together as a distinct ecoregion:

> "Geographic patterns of similarity among ecosystems can be grouped into ecoregions. Naturally occurring biotic assemblages, as components of the ecosystem would be expected to differ among ecoregions but be relatively similar within a given ecoregion. The ecoregion concept thus provides a geographic framework for more efficient management of aquatic ecosystems and their components" (Plafkin et al., 1989).

Based on regional patterns in land-surface form, soil, potential natural vegetation, and land use, Omernik (1987) developed an ecoregional framework for the contiguous United States. According to this geographical model, the middle Atlantic coastal plain forms a distinct ecoregion. This ecoregion includes the entire Albemarle-Pamlico study area; the Chesapeake Bay; Delaware; Maryland; coastal South Carolina; and portions of Georgia and New Jersey (Figure 9). One might reasonably argue that the Georgia coast should belong in the southern coastal plain ecoregion or coastal New Jersey should be included in the northeastern coastal zone ecoregion. Omernik's ecoregional framework for the conterminous United States is only one example of how the country could be divided into ecologically-based sectors for management purposes.

Reorganizing EPA and USFWS regional boundaries to correspond with natural systems would greatly facilitate interstate cooperation and federal-interstate cooperation on management of natural resources.

Figure 9. The Middle Atlantic Coastal Plain Ecoregion (after Omernik, 1987)



Institution of ecoregion management would also result in identical regional boundaries for these agencies. Omernik identified 76 distinct ecoregions in the conterminous United States. In many cases, a single ecoregion extends across several states. Classifying each of the 76 ecoregions as an independent EPA/USFWS region would not be administratively feasible. Larger regions, however, could be composed of several states with similar ecoregions.

Inevitably, portions of a single state would have to be placed in differing EPA/USFWS regions. This is the major negative aspect of

applying the ecoregion concept. The states are distinct political and territorial units. Splitting a state among two or more federal regions would complicate governance at the state level. For example, suppose that the mountains of North Carolina were placed in a separate EPA region from the remainder of the state. As a result, state agencies such as the Division of Environmental Management would have to deal with two regional EPA offices. This is a problem because no two regions would be identical due to variations in management style, concerns, and protocol. Although it would be an inconvenience, dealing with more than one regional EPA office would not be an insurmountable difficulty. State agencies already deal with multiple Corps of Engineers district offices. COE, the nation's primary water resources development agency, draws district boundaries along watershed divides. As a result, North Carolina is split among five Corps districts.

A second disadvantage of reorganizing EPA and USFWS regional boundaries stems from agency inertia or resistance to change. These agencies have been operating under the current system for many years. Furthermore, the regions were not initially intended to serve as loci for complete ecosystem management. One would not expect the idea of ecoregion management to be readily embraced until these agencies examine all the pros and cons of such a departure from the status quo. The agencies would need time to study the economic and political feasibility of such massive reorganization. This is not a change, therefore, that will happen immediately. Perhaps, reorganization will never occur at this scale.

The Assessment and Watershed Protection Division of EPA recently published rapid bioassessment protocols for use in streams and rivers.

This manual referenced two major applications of the ecoregion approach:

- use of a relatively small number of minimally impacted regional reference sites to assess feasible but protective biological goals for an entire region, and
- use of regions as a statistical framework for sampling of lakes in a national survey of the effects of acid deposition (Plafkin et al., 1989).

Scientists can establish baseline conditions and assess water quality for an entire region based on data from a relatively small number of sites within an ecoregion.

The ecoregion concept can be applied on a large or relatively small scale. For example, this idea could be put to use at the national, state, or local level. An Ohio EPA report concluded that similar water quality standards, criteria, and monitoring strategies would be valid in the ecoregions of the United States as defined by Omernik (Ohio EPA, 1987). The North Carolina Division of Environmental Management is currently defining ecoregions within the state. Clearly, the Environmental Protection Agency and other resource management agencies have already given thought to possible applications for the ecoregion concept. Why not extend the idea further?

Application of the ecoregion concept to management of America's natural resources would result in a more comprehensive approach. This change could be made administratively within each respective managing agency or through the legislative process. Regardless of the route to implementation, however, the ecoregion approach would benefit all levels of government in this country by serving as an unprecedented coordinative mechanism for management of natural systems.

CONCLUSIONS

Task II revealed two broad issue categories surrounding management of the Currituck Sound drainage basin. First, Currituck Sound is perceived to be a declining resource with respect to water quality, the fishery, and waterfowl wintering grounds. Insufficient data exist to confirm the opinion that Currituck Sound is a declining resource, however. No comprehensive study has been conducted for the Currituck Sound-Back Bay complex since the early 1960's when the Bureau of Sport Fisheries and Wildlife, North Carolina Wildlife Resources Commission, and Virginia Commission of Game and Inland Fisheries carried out a cooperative study popularly referred to as the "Sincock Study".

Second, no single resource management agency has complete geographic jurisdiction over the watershed. Since the time of the "Sincock Study", the Currituck Sound watershed has experienced rapid population growth and development. Much change has occurred in the study area. Throughout this period of growth and change, North Carolina and Virginia have failed to cooperate in the management of their shared ecosystem. Responsibility for management of the Currituck Sound-Back Bay system was, and still is, split among multiple federal, state, and local jurisdictions.

The objective of Task III was to analyze an array of prospective management alternatives and coordinative mechanism for the Currituck Sound-Back Bay complex. This report focused on six possible management options:

-maintenance of current management strategies,
-increased local government action,
-adoption of an administrative agreement,
-creation of an interstate planning agency,

-adoption of an interstate compact, and
-formation of a federal-interstate compact.

Each alternative has distinct advantages and disadvantages. With the exception of maintenance of the status quo and increased local government action, any of the prospective alternatives would result in a higher level of intergovernmental cooperation in management of the drainage basin and its many resources. An interstate planning agency, interstate compact commission, or federal-interstate compact commission would exert complete geographic jurisdiction over the watershed, a necessary ingredient in total ecosystem management. In addition, the compact mechanism provides regulatory and enforcement power. Without power to enforce its plans, an interstate agency would be nothing more than an advocacy group. The more formal cooperative mechanisms, however, lack the flexibility that is inherent in other options such as increased local government action. Before selecting and implementing any management option, resource managers must decide which characteristics and functions are essential in an agency designed to manage the Currituck Sound drainage basin.

Education can help build a solid constituency for cooperative management of the Currituck Sound drainage basin. Educational efforts should target specific audiences such as school children, farmers, urbanites, and developers. People who understand the dynamics of a system are best equipped to make critical decisions pertaining to management and, also, to comprehend the implications of those decisions. Resource managers should make an additional effort to bring the citizens of North Carolina and Virginia to one accord on management of the study area because public support is essential for the success of any future bi-state agency or program.

Finally, redrawing EPA and USFWS regional boundaries to coincide with ecoregions would greatly facilitate interstate cooperation in management of ecosystems such as the Currituck Sound watershed. Under this new management strategy, the Currituck Sound-Back Bay complex would be managed as part of a designated ecoregion. As a result, the smaller watershed could be protected within two contexts--as an individual water body and as a piece of the larger ecoregion. This is not to imply that such reorganization is a prerequisite for successful coordinated management of the study area.

Many resource managers perceive a crisis situation for Currituck Sound. Now is the time to act. Resource managers must reach a consensus on the best course of action. Selection of a management strategy stands as the first step toward resolving the issues of the Currituck Sound drainage basin as well as the entire Albemarle-Pamlico Estuarine study area.

LITERATURE CITED

Adams, D.A. and M.F. Overton. 1984. The impact of salinity introduction upon fish habitat in Currituck Sound-- results of species-habitat modeling. Report prepared for the North Carolina Department of Natural Resources and Community Development, Office of Water Resources. Water Resources Research Institute of the University of North Carolina, Raleigh, NC.

Advisory Commission on Intergovernmental Relations. 1972. Multistate regionalism: A commission report. Washington, DC.

Albemarle-Pamlico Estuarine Study. undated. Brochure on the Albemarle-Pamlico Estuarine Study. Washington, NC.

Albemarle-Pamlico Estuarine Study. 1989. Albemarle-Pamlico Status and Trends Draft Technical Report. Albemarle-Pamlico Estuarine Study, Raleigh, NC.

Back Bay Restoration Foundation. undated. Brochure on the Back Bay Restoration Foundation. Virginia Beach, VA.

Barton, W.V. 1967. Interstate compacts and the political process. University of North Carolina Press: Chapel Hill, NC. 197 pp.

Blankenship, K. 1990. Saving SAV: Surveys and seeds are tools to preserve Bay resource. In Alliance for the Chesapeake Bay. Chesapeake Citizen Report. Alliance for the Chesapeake Bay, Baltimore, MD. July-August 1990.

Carlock, J.M. 1989. Institutional enhancement and public involvement program for Southeastern Virginia. Southeastern Virginia Planning District Commission, Chesapeake, VA.

Carter, V. and N.B. Rybicki. 1990. Light attenuation in Back Bay, Virginia. In H.G. Marshall (ed.) Abstracts for the Back Bay Ecological Symposium. November 2-3, 1990. Old Dominion University, Norfolk, VA.

Chesapeake Executive Council. 1989a. The first progress report under the 1987 Chesapeake Bay Agreement.

Chesapeake Executive Council. 1989b. The second progress report under the 1987 Chesapeake Bay Agreement. USEPA Rep. 720-080/06332. U.S. Gov. Print. Office, Washington, DC.

Chesapeake Bay Legislative Advisory Commission. 1979. Description of available institutional alternatives for improved Chesapeake management. Annapolis, MD.

Clark, W.F. 1990. North Carolina's estuaries: A pilot study for managing multiple use in the state's public waters. Draft Albemarle-Pamlico Estuarine Study Report. UNC Sea Grant College Program, Raleigh, NC.

Coastal Consultants, Ltd. 1982. Currituck County land use plan. Southern Pines, NC.

Congressional Information Service. 1973. CIS/Annual 1973 Part One: Abstracts of publications and legislative histories. CIS, Washington, DC.

Copeland, B.J. and J. Gray. 1989. The Albemarle-Pamlico estuarine system. A summary of the preliminary status and trends report of the Albemarle-Pamlico Estuarine Study. Albemarle-Pamlico Estuarine Study Report 89-13B.

Council of State Governments. 1979. Interstate compacts and agencies. Lexington, KY.

Currituck Sound Task Committee. 1980. Water quality, salinity, and fisheries in Currituck Sound. North Carolina Department of Natural Resources and Community Development, Raleigh, NC.

Division of Coastal Management. North Carolina Department of Natural Resources and Community Development. 1986. A guide to protecting coastal waters through local planning. North Carolina Department of Natural Resources and Community Development, Raleigh, NC.

Ferguson, R.L., L.L. Wood and B.T. Pawlak. 1990. Towards an inventory of submerged aquatic vegetation habitat in the sounds and bays of eastern North Carolina. In H.G. Marshall (ed.) Abstracts of the Back Bay Ecological Symposium. November 2-3, 1990. Old Dominion University, Norfolk, VA.

Finch, D. and D.J. Brower. 1986. Management programs and options for the Albemarle-Pamlico Estuarine Study. Albemarle-Pamlico Estuarine Study Project 86-01.

Gale, J.A. 1983. Report on Currituck Sound for laypeople. Prepared for the North Carolina Department of Natural Resources and Community Development, Office of Water Resources. Water Resources Research Institute of the University of North Carolina, Raleigh, NC.

Garlo, E. 1982. Currituck Sound Bibliography. Prepared for the North Carolina Department of Natural Resources and Community Development, Office of Water Resources. Water Resources Research Institute of the University of North Carolina, Raleigh, NC.

Goldman, D. 1989. Papyrus version 6.0 user's manual. Research Software Design, Portland, OR.

Gottovi, K.E. 1985. Laying the groundwork. p. 11-13. In Division of Coastal Management. Striking a balance: Reflections on ten years of managing the North Carolina coast. Raleigh, NC.

Green, P.P., Jr., and Heath, M.S., Jr. 1985. Building, land use, and environmental regulation. p. 47-55. In C.D. Liner. State-local relations in North Carolina: Their evolution and current status. Institute of Government. University of North Carolina at Chapel Hill. Chapel Hill, NC.

Hoban, T.J. undated. Teamwork for conservation education. (Paper to be published in Journal of Soil and Water Conservation). Department of Sociology, Anthropology, and Social Work. North Carolina State University. Raleigh, NC.

Jones, C.A. 1984. An introduction to the study of public policy. Wadsworth, Inc., Belmont, CA.

Kornegay, J.W. 1989. Currituck Sound fish population survey. Final Report, Federal Aid in Fish Restoration Project F-22-14. North Carolina Wildlife Resources Commission, Raleigh, NC.

Leach R.H. and R.S. Sugg, Jr. 1959. The administration of interstate compacts. Louisiana State University Press: Baton Rouge, LA. 256 pp.

Lynch, L.L. and S.B. Benton. 1985. Potential inlet zones on the North Carolina coast from Virginia to Cape Hatteras. North Carolina Department of Natural Resources and Community Development, Division of Coastal Management, Raleigh, NC.

Magette, W.L., R.A. Weismiller and K.C. Gugulis. 1985. Saving the Chesapeake: Maryland's agricultural education program. Journal of Soil and Water Conservation. January-February 1985.

Mann, R. 1984. A management plan for Back Bay. Volume 1: main report. Roy Mann Associates, Inc.

Matthews, W.H. 1976. Resource materials for environmental management and education. MIT Press, Cambridge, MA.

Merriam. 1978. Making TDR work. North Carolina Law Review. Chapel Hill, NC. (56)77-147.

Muys, J.C. 1971. Interstate water compacts: The interstate compact and federal interstate compact. National Water Commission, Arlington, VA.

Neilson, B.J. 1982. Water quality trends in the Northwest River. Virginia Institute of Marine Science, College of William and Mary, Gloucester Point, VA.

Norman, M.D. 1988. What happened to Back Bay? Va. Wildlife. August, 1988, p. 22-29.

Norman, M.D. and R. Southwick. 1987. Back Bay: Report on salinity and water quality in 1986. Virginia Commission of Game and Inland Fisheries.

North Carolina Coastal Federation. Brochure on the North Carolina Coastal Federation. Newport, NC.

North Carolina State Office of Budget and Management. 1981. Profile of North Carolina counties. 6th ed. NC Office of Budget and Management, Raleigh, NC.

North Carolina-Virginia Water Resources Management Committee, Virginia State Water Control Board, and North Carolina Department of Natural Resources and Community Development. 1982. The North Carolina-Virginia tidewater area: Developing a process for resolving water resource management issues.

Office of Ocean and Coastal Resource Management, National Oceanic and Atmospheric Administration and Commonwealth of Virginia Council on the Environment. 1986. Commonwealth of Virginia Coastal Resource Management Program and Final Environmental Impact Statement.

Ohio Environmental Protection Agency. 1987. Biological criteria for the protection of aquatic life. Volume II. User's manual for biological assessment of Ohio surface waters. Ohio Environmental Protection Agency. Columbus, OH.

Omernik, J.M. 1987. Ecoregions of the conterminous United States. United States Ann. Assoc. Am Geograph. 77(1): 118-125.

Plafkin, J.L., Barbour, M.T., Porter, K.D., Gross, S.K., and R.M. Hughes. 1989. Rapid bioassessment protocols for use in rivers and streams: Benthic macroinvertebrates and fish. EPA/444/4-89-001. United States Environmental Protection Agency. Assessment and Watershed Protection Division. Washington, D.C.

Rhodes, T.S. 1985. Introduction. In Division of Coastal Management. Striking a balance: Reflections on ten years of managing the North Carolina Coast. Raleigh, NC.

Solesbury, W. 1976. Issues and innovations in environmental policy in Britain, West Germany, and California. Policy Analysis 2 (Winter 76). p.13.

Southeastern Virginia Planning District Commission. 1987. Hampton Roads economic forecast. Southeastern Virginia Planning District Commission. Chesapeake, VA.

Southwick, R. 1989. Results of Back Bay salinity and water quality monitoring, 1987 and 1988. Virginia Department of Game and Inland Fisheries.

Southwick, R. and M.D. Norman. 1987. Results of Back Bay nutrient sampling, April 1986-March 1987. Virginia Department of Game and Inland Fisheries.

Thursby, V. 1953. Interstate cooperation: A study of the interstate compact. Public Affairs Press. Washington, DC.

U.S. Army Corps of Engineers. 1989. Water resources development in North Carolina.

Zimmerman, F.L. and M. Wendell. 1951. The interstate compact since 1925. Council of State Governments: Chicago, IL. 132 pp.

PERSONAL COMMUNIQUE

Anderson, Evan. December 1990. North Carolina State Data Center. Raleigh, North Carolina.

Armingeon, Neil. September 1990. North Carolina Coastal Federation. Swansboro, North Carolina.

Ball, Todd. November 1990. North Carolina Department of Environment, Health, and Natural Resources. Division of Coastal Management. Elizabeth City, North Carolina.

Barber, Yates. January and September 1990. Albemarle Citizens' Advisory Council. Elizabeth City, North Carolina.

Barth, Carol Ann. June 1990. Alliance for the Chesapeake Bay. Rockville, Maryland.

Bernick, Clayton. December 1989. City of Virginia Beach Planning Department. Virginia Beach, Virginia.

Bowman, Randy. July 1990. United States Fish and Wildlife Service. Washington, D.C.

Carlock, John. December 1989. Southeastern Virginia Planning District Commission. Chesapeake, Virginia.

Corcoran, Mike. September 1990. North Carolina Wildlife Federation. Raleigh, North Carolina.

Cross, Gene. April 1990. North Carolina Department of Agriculture. Division of Plant Conservation. Raleigh, North Carolina.

Darr, Deborah. December 1990. Hampton Roads Planning District Commission. Chesapeake, Virginia.

Dorney, John. March 1990. North Carolina Department of Environment, Health, and Natural Resources. Division of Environmental Management. Raleigh, North Carolina.

Hamilton, Richard. February 1990. North Carolina Wildlife Resources Commission. Raleigh, North Carolina.

Hegge, Bill. January 1990. United States Fish and Wildlife Service. Mackay Island National Wildlife Refuge.

Hinson, Dwane. March 1990. United States Soil Conservation Service. Elizabeth City, North Carolina.

Kornegay, James W. March 1990. North Carolina Wildlife Resources Commission. Raleigh, North Carolina.

Lewis, Jim. February, 1990. Virginia Division of Soil and Water Conservation. Richmond, Virginia.

Luszcz, Dennis. August 1990. North Carolina Wildlife Resources Commission. Edenton, North Carolina.

Norman, Mitchell. March 1990. Virginia Fish and Game Department. Division of Game and Inland Fisheries. Chesapeake, Virginia.

Pavlik, Philip. April 1988. Department of Political Science and Public Administration. North Carolina State University. Raleigh, North Carolina.

Perlic, Tom. September 1990. Pamlico-Tar River Foundation. Washington, North Carolina.

Reid, Dianne. June 1990. North Carolina Department of Environment, Health, and Natural Resources. Division of Environmental Management. Raleigh, North Carolina.

Richardson, Bill. January 1990. Currituck County Government. Currituck, North Carolina.

Simoneau, Jack. January 1990. Currituck County Government. Currituck, North Carolina.

Southwick, Ron. March 1990. Virginia Department of Game and Inland Fisheries. Chesapeake, Virginia.

Williams, Bruce. January 1990. United States Army Corps of Engineers. Norfolk District. Norfolk, Virginia.

A P P E N D I C E S

Appendix A: Papyrus Operating Instructions

This section is not intended to provide complete Papyrus operating directions. For further help, consult the Papyrus User's Manual (Goldman, 1989).

In order to search the Currituck Sound bibliography, one must meet certain system requirements:

1. Possess right to utilize Papyrus Version 6.0.
2. Use an IBM-compatible computer with at least 512K memory.
3. Boot the computer with Dos Version 2.1 or higher operating system.
4. Use any display adaptor/monitor combination <u>except</u> IBM colorgraphics adaptor and monochrome monitor.
5. Have access to a printer.

Entering Papyrus

(A) If Papyrus is installed on hard disk, put data disk into Drive A. Type a: ; <Return> ; PAP ; <Return>.

(B) If Papyrus is on a set of floppy disks, put the disk entitled PAP1.OVR into Drive A and the data disk into Drive B. Type b: ; <Return> ; a:PAP ; <Return>.

Searching for References

When searching the bibliography for references of interest, the user must create an output group. This requires several steps:

1. Select GROUP option by typing G ; <Return>.
2. Insert disk containing PAP2.OVR into Drive A.
3. Strike any key.
4. Create an output group. (See Example 1)
   a. Name the group.
   b. Answer Y to the question, "Is this a new group?".
   c. Describe the group.
   d. Hit the <Return> key to put the references in standard Papyrus format.
5. Select a method for sorting the references. The user can choose to sort references according to author, citation order, reference number, title, type of reference, or year of publication.
6. Select SEARCH option by typing S ; <Return>
7. Type ?
   Papyrus will respond with a list of search choices.

The user can search by author, editor, comments, keywords, title, journal, type of reference, reference number, year, or term. (Term search will allow the user to search through titles, keywords, and comments/abstracts for a given word or phrase)
EXAMPLE: author="Adams, DA" EXAMPLE: year="1988"

8. When asked, "Shall I proceed with the Search?", Type Y ; <Return>.
9. After viewing Papyrus' list of prospective references, hit ESCAPE key to return to the main menu.

Viewing/Printing References

Papyrus allows the user to view/print the GROUP references via the LIST option. To view/print references, one must do the following:

1. Select the LIST option.
2. Insert the disk containing PAP1.OVR into Drive A.
3. Strike any key.
4. Select the GROUP option.
5. Give the Group name from user-created output group.
6. Choose SCREEN to view references or PRINTER to print the group. DO NOT choose FILE: This may damage the database.
7. When finished, delete user-created output group from the data disk by choosing the GROUP option and, then, DELETE.

** After viewing or printing, press ESCAPE key until program ends with a friendly message such as "Well, would you rather be working at Burger King?".

** ALWAYS go from Papyrus to DOS environment before removing the data disk. Failure to do so may cause damage to the database.

Example 1: Creating an output group

Group name:	BackBay
Is this a new group?	Y
Group description:	All references for which Back Bay is used as a keyword
Format:	Standard
Reference sorting method:	Reference number
SEARCH	
Keyword="Back Bay"	

RESULT: Papyrus searches and finds 17 references described by the keyword Back Bay. It lists these references on the screen by reference number. Each reference can be viewed in greater detail by placing the highlighted bar over the desired reference and hitting the <Return> key.

Appendix B: Currituck Sound Bibliography
Alphabetic List

Adams, D.A. and M.F. Overton. 1984. The impact of salinity introductions upon fish habitat in Currituck Sound. Results of species-habitat modeling. Prepared for North Carolina Department of Natural Resources and Community Development, Office of Water Resources. Water Resources Research Institute of the University of North Carolina, Raleigh, NC. Currituck Sound Resource Management Project Task 1. 29 pages.

Adams, D.A., M.F. Overton and S.E. Reed. 1983. The Currituck Sound management project: An integrated approach to resource decision-making. In J. Hernandez (ed.) A healthy economy and a healthy environment. Proceedings of a conference in Raleigh, NC, May 11-12, 1983. The University of North Carolina Environmental Studies Council, Chapel Hill, NC. 432 pages. (p. 295 - 311).

Alexandria Drafting Company. 1978. Back Bay fishing map. Alexandria, VA.

Anderson, R.R. 1981. Ecology and mineral nutrition of Myriophyllum spicatum l. M.S. Thesis, University of Maryland, College Park, MD. 50 pages.

Ansell, H.B. 1905. Recollections of my boyhood on Knotts Island. (Unpublished manuscript).

Baker, W.D. 1965. A study of turbidities caused by re-dredging the intracoastal waterway in Currituck Sound, North Carolina. Special Report. Federal Aid in Fish Restoration Project Job I-B, Project F-16-R. North Carolina Wildlife Resources Commission, Raleigh, NC.

Baker, W.D. and W.B. Smith. 1965. Survey and classification of the Perquimans-Pasquotank, North River and tributaries, North Carolina. Final Report. Federal Aid in Fish Restoration. Job I-B, Project F-14-R. North Carolina Wildlife Resources Commission, Raleigh, NC. 14 pages.

Barick, F.B. and J.S. Critcher. 1975. Wildlife and land use planning with particular reference to coastal counties. Unpublished report. North Carolina Wildlife Resources Commission, Raleigh, NC.

Bayley, W., V.D. Stottis, P.F. Springer and J. Steenis. undated. Changes in submerged aquatic macrophyte populations at the head of Chesapeake Bay, 1958-1975. Estuaries 1(3), 73-84.

Beal, E.O. 1977. A manual of marsh and aquatic vascular plants in NC with habitat data. Agricultural Experiment Station, Technical Bulletin no. 247. 298 pages.

Bellis, V., M.P. O'Connor and S.R. Riggs. 1975. Estuarine shoreline erosion in the Albemarle-Pamlico region of North Carolina. East Carolina University, Greenville, NC. 40 pages.

Benner, C.S., P.L. Knutson, R.A. Brochu and A.K. Hurme. 1982. Vegetative erosion control in an oligohaline environment, Currituck Sound, North Carolina. Wetlands 2, 105-117.

Boc, S.J. and J. Langfelder. 1977. An analysis of beach overwash along North Carolina's coast. Center for Marine and Coastal Studies, North Carolina State University, Raleigh, NC. 17 pages.

Borawa, J.C. 1979. An evaluation of age and growth of largemouth bass (Micropterus salmoides lacepede) in Currituck Sound, North Carolina, before and after Eurasian water-milfoil infestation. M.S. Thesis, North Carolina State University, Raleigh, NC. 71 pages.

Bourn, W.S. 1934. Sea-water tolerance of Vallisneria spiralis and Potamogeton foliosus. Raf. contrib. from Boyce Thompson Institute 6(3), 303-308. (Taken from: Critcher, 1949).

Bourn, W.S. 1932. Ecological and physiological studies on certain aquatic angiosperms. Raf. contrib. from Boyce Thompson Institute 4(4), 425-496. (Taken from: Critcher, 1949).

Bourn, W.S. 1929. The destruction of aquatic duck food plants in Back Bay and Currituck Sound. In Transactions of the 16th North American Game Conference.

Bowden, W.B. and J.E. Hobbie. 1977. Nutrients in Albemarle Sound, North Carolina. Sea Grant Publication UNC-SG-75-25. UNC Sea Grant, Raleigh, NC. 187 pages.

Boyd, W.K. 1967. Introduction to Byrd, 1728, histories of the dividing line between Virginia and North Carolina. Dover Publications.

Brown, A.C. 1970. The Dismal Swamp Canal, Norfolk County. Historical Society of Chesapeake, Virginia.

Bureau of Sport Fisheries and Wildlife, North Carolina Wildlife Resources Commission and Virginia Commission of Game and Inland Fisheries. 1961. Annual progress report on the cooperative study of Back Bay, Virginia and Currituck Sound, North Carolina: May, 1960 through May, 1961. Unpublished report. North Carolina Wildlife Resources Commission, Raleigh, NC.

Bureau of Sport Fisheries and Wildlife, North Carolina Wildlife Resources Commission and Virginia Commission of Game and Inland Fisheries. undated. Back Bay-Currituck Sound data report. North Carolina Wildlife Resources Commission Project F-5-R-8; unpublished report. North Carolina Wildlife Resources Commission, Raleigh, NC.

Chamberlain, E.B., Jr. 1948. An investigation of certain waterfowl food plants and a botanical survey of Back Bay National Wildlife Refuge, Princess Anne County, Virginia. M.S. Thesis, Virginia Polytechnic Institute and State University, Blacksburg, VA.

Chesapeake Department of Parks and Recreation and Chesapeake Office of Public Communications. undated. Chesapeake scenic waterways.

Chesapeake Department of Planning. 1989. City of Chesapeake comprehensive plan. The City, Chesapeake, VA.

Chesapeake Department of Planning. 1977. City of Chesapeake park, open space, and recreation plan. The City, Chesapeake, VA.

Chesapeake Executive Council. 1987. 1987 Chesapeake Bay Agreement.

Chestnut, A.F. and H.S. Davis. 1975. Synopsis of marine fisheries of North Carolina. Statistical information, 1880-1973. UNC Sea Grant Publication UNC-SG-75-12. UNC Sea Grant, Raleigh, NC. 425 pages.

City of Virginia Beach. 1978. Salinity station locations: 1965-1968. Highway Commission, Virginia Beach, VA.

Clark, J. 1967. Fish and man: Conflict in the Atlantic estuaries. Special publication no. 5. Atlantic Littoral Society, Highlands, NJ. 76 pages.

Clark, J., W.F. Smith, A.W. Kendall and M.P. Fakay. 1969. Studies of estuarine dependence of Atlantic coastal fishes. Technical paper no. 28. United States Bureau of Sport Fisheries and Wildlife. 132 pages.

Comegys, R.R. 1977. A seasonal study of phytoplankton composition, abundance, and productivity in Back Bay, Virginia. M.S. Thesis, Old Dominion University, Norfolk, VA.

Critcher, T.S. 1949. An investigation of the waterfowl resources on Currituck Sound, North Carolina during the 1947-1948 and 1948-1949 hunting seasons. M.S. Thesis, North Carolina State University, Raleigh, NC. 111 pages.

Crowell, T.E., J.H. Steenis and J.L. Sincock. 1967. Recent observations on Eurasian Watermilfoil in Currituck Sound, NC, and other southeastern states. North Carolina Wildlife Resources Commission and Bureau of Sport Fishery and Wildlife, Patuxent Wildlife Center. 8 pages.

Currituck Sound Task Committee. 1980. Water quality, salinity, and fisheries in Currituck Sound. North Carolina Department of Natural Resources and Community Development. Raleigh, NC. 21 pages.

Davis, G.J. and M.M. Brinson. 1989. Submersed aquatic vegetation of the Currituck Sound and western Albemarle-Pamlico estuarine system. Final Report to the Albemarle-Pamlico Estuarine Study. 123 pages.

Davis, G.J. and M.M. Brinson. 1983. Trends in submersed macrophyte communities of the Currituck Sound: 1909-1979. J. Aquat. Plant Manage. 21, 83-87.

Davis, G.J. and D.F. Carey. 1981. Trends in submersed macrophyte communities of the Currituck Sound: 1977-1979. J. Aquat. Plant Manage. 19, 3-8.

Davis, G.J. and D.F. Carey. undated. Turbidity, turbulence and trends in submersed macrophyte communities of Currituck Sound, NC: 1977-1979. Unpublished report. Department of Biology, East Carolina University, Greenville, NC. 18 pages.

Davis, G.J., M.N. Jones, C.Z. Lunney and G.M. Clark. 1974. Inhibition of sodium chloride toxicity in seedlings of Myriophyllum spicatum L. with calcium. Plant Cell Physiol. 15, 577-581.

Davis, G.J. and J.H. Stennis. 1973. Eurasian Watermilfoil: Problems and proposed solutions. Friend O' Wildlife.

Department of the Army. Norfolk District Corps of Engineers. Environmental Analysis Branch. 1990. Water quality monitoring proposal for Canal #2.

Dickson, A.W. 1958. Some ecological observations in Currituck Sound. Mimeo. rept. North Carolina Wildlife Resources Commission, Raleigh, NC. 11 pages.

Dickson, A.W. 1957. Some aspects of salinity variations in Currituck Sound (January 1956 - November 1956). North Carolina Wildlife Resources Commission, Raleigh, NC. 12 pages.

Division of Coastal Management, North Carolina Department of Natural Resources and Community Development. 1986. A guide to protecting coastal waters through local planning. North Carolina Department of Natural Resources and Community Development, Raleigh, NC. 91 pages.

Division of Community Assistance, North Carolina Department of Natural Resources and Community Development. 1987. Inventory of land management controls of local governments within the Albemarle-Pamlico Estuarine Study area. Raleigh, NC.

Division of Environmental Management. 1981. Stored retrieval data from Currituck Sound at Aydlett, NC and Point Harbor from August 30, 1977 to October 28, 1981. Division of Environmental Management, North Carolina Department of Natural Resources and Community Development, Raleigh, NC. 33pp.

Doumlele, D.G. and G.M. Silberhorn. 1976. City of Virginia Beach Marsh Inventory, Vol. 1. Virginia Institute of Marine Science. Gloucester Point, VA.

Dubach, H.W. 1977. The North Carolina coastal zone and its environment: A compilation of resource materials covering the coastal plain, estuaries, and offshore waters. 2 vols. E.I. Du Pont de Nemours and Co., Savannah River Laboratory, Aiken, SC.

Ecolsciences Environmental Group. 1981. Environmental Impact Statement, Currituck County, North Carolina, Outer Banks Access. Ecolsciences Environmental Group, Vienna, VA. 216 pages.

Envirotek, Inc. 1972. The Currituck plan, Outer Banks: Development situation. Raleigh, NC. 76 pages.

Esch, G.W. and T.C. Hazen. 1980. The ecology of Aeromonas hydrophila in Albemarle Sound. Report No. 153. Water Resources Research Institute of The University of North Carolina, Raleigh, NC.

Esch, G.W. and T.C. Hazen. 1980. Stress and body condition in a population of largemouth bass: Implications for red-sore disease. Trans. Am. Fish. Soc. 109(5), 532-536.

Finch, D. and D.J. Brower. 1986. Management programs and options for the Albemarle-Pamlico Estuarine Study. Project No. 86-01. North Carolina Department of Natural Resources and Community Development, Raleigh, NC.

Fish, F.F. 1965. Sport fishery creel census, Currituck Sound, 1964. Annual Report, Job I-D, Federal Aid in Fish Restoration. Project F-16-R. North Carolina Wildlife Resources Commission, Raleigh, NC. 7 pages.

Florshutz, O., Jr. 1972. The importance of Eurasian milfoil (Myriophyllum spicatum) as a waterfowl food. Proc. Annu. Cong. Southeast. Assoc. Game Fish Comm. 26, 189-194.

Frost, C.C., H.E. LeGrand, Jr. and R.E. Schneider. 1990. Regional inventory for critical natural areas, wetland ecosystems, and endangered species habitats of the Albemarle-Pamlico Estuarine Region: Phase 1. Project No. 90-01. North Carolina Department of Environment, Health, and Natural Resources, Raleigh, NC.

Gale, J. 1983. Report on Currituck Sound for Laypeople. Prepared for the North Carolina Department of Natural Resources and Community Development, Office of Water Resources. Water Resources Research Institute of The University of North Carolina, Raleigh, NC. Currituck Sound Resource Management Project Task 5. Unpublished report.

Garlo, E. 1982. Currituck Sound bibliography. Prepared for North Carolina Department of Natural Resources and Community Development, Office of Water Resources. Water Resources Research Institute of the University of North Carolina, Raleigh, NC. Currituck Sound Resource Management Project Task 2.

Giese, G.L., H.B. Wilder and G.G. Parker, Jr. 1985. Hydrology of major estuaries and sounds of North Carolina. US Geological Survey water -supply paper 2221. US Government Printing Officing, Alexandria, VA.

Giese, G.L., H.B. Wilder and G.G. Parker, Jr. 1979. Hydrology of major estuaries and sounds of North Carolina. Water Resources Investigations 79-46. U.S. Geological Survey, Raleigh, NC. 175 pages.

Gilbert Associates Inc. 1970. Supplemental report: Northwest River water supply project. Gilbert Associates Inc., Reading, PA.

Gilbert Associates Inc. 1969. Engineering feasibility study and report: Northwest River water supply project (Draft). Gilbert Associates Inc., Reading, PA.

Godfrey, P.J. and M.M. Godfrey. 1974. The role of overwash and inlet dynamics in the formation of salt marshes on North Carolina Barrier Islands. Academic Press.

Godwin, W.F., M.W. Street and T.R. Rickman. 1977. History and status of North Carolina's marine fisheries information no. 2. North Carolina Department of Conservation and Development, Division of Commercial and Sports Fisheries, Raleigh, NC. 77 pages.

Goldsmith, V. (ed.) 1977. Coastal processes and resulting forms of sediment accumulations: Currituck Spit, Virginia/North Carolina. Virginia Institute of Marine Science and Society of Economic Paleontologists and Mineralogists. Gloucester, VA.

Guier, C.R., W.G. Miller, A.W. Mullis and L.E. Nichols. 1978. Comparison of growth rates and abundance of largemouth bass in selected North Carolina coastal rivers. Proc. 32nd Annu. Conf. Southeast. Assoc. Fish. Wildl. Agencies, 391-400.

Gutman, A.L. 1978. The interaction of eolian sand transport, vegetation, and dune geomorphology: Currituck Spit, Va/NC. College of William and Mary, Williamsburg, VA.

Harris, W.H. and H.B. Wilder. 1966. Geology and groundwater resources of the Hertford-Elizabeth City Area, North Carolina. Groundwater Bulletin No. 10. North Carolina Department of Water Resources, Division of Ground Water, Raleigh, NC. 89 pages.

Hennigar, H.P. 1979. Historical evolution of coastal sand dunes: Currituck Spit, Va/NC. M.S. Thesis, Virginia Institute of Marine Science, Gloucester VA. 120 pages.

Howard Needles Tammen & Bergendoff. 1989. Currituck Sound transportation improvement feasibility study. Prepared for the North Carolina Department of Transportation. State Project No. 8.1040401 (M-140). Howard Needles Tammen & Bergendoff, Raleigh, NC. 140 pages.

James R. Reed and Associates. 1988. Southeastern expressway project anadromous fish study final report: Spring sampling. James R. Reed and Associates, Newport News, VA.

Johnson, E.R. 1930. Save Currituck: Statement and argument for the installation of a tidal guard lock in the Albemarle and Chesapeake Canal. Hearings before Committee on Rivers and Harbors, House of Representatives. 75th Congress, Second Session.

Johnston, K.H. and J.R. Davis. 1963. Annual progress report: Currituck Sound Investigations, March 7, 1962 to March 6, 1963. Project F-13-R-3. North Carolina Wildlife Resources Commission, Raleigh, NC.

Johnson, K.H. and J.R. Davis. undated. Brackish-waters investigations. Fisheries Research Investigations, Project F-13-R, Unpublished Report. North Carolina Wildlife Resources Commission, Raleigh, NC. 21 pages.

Kearson, L.L. 1976. Observations of the flora of Currituck Sound during August, 1973. Unpublished report. North Carolina Wildlife Resources Commission, Raleigh, NC.

Knowles, E. 1976. A simple diagnostic model to determine the feasibility of salinity control of Eurasian Watermilfoil. UNC-SG-76-07. UNC Sea Grant, Raleigh, NC.

Kornegay, J.W. 1989. Currituck Sound fish population survey. Period covered: July 1989 - September 1989. Final Report: Coastal Fisheries Investigation. Federal Aid in Fish Restoration Project F-22-14. North Carolina Wildlife Resources Commission, Division of Boating and Inland Fisheries, Raleigh, NC.

Kuo, A.Y., B.J. Neilson and P.V. Hyer. 1982. A water quality study of the Northwest River, Virginia. A Report to the Hampton Roads Water Quality Agency. 49 pages.

Leithold, E. 1988. Sediment dynamics in Currituck Sound: Baseline study and historical reconstruction to evaluate the impact of tidal-inlet opening. Proposal to the Marine and Estuarine Management Division of the National Oceanic and Atmospheric Administration.

Levy, G.F. 1976. Vegetative survey at the Duck Field Research Facility, Duck, NC. Misc. Report No. 76-6. US Army Corps of Engineers, Fort Belvoir, VA. 80 pages.

Lynch, L.L. and S.B. Benton. 1985. Potential inlet zones on the North Carolina coast from Virginia to Cape Hatteras. North Carolina Department of Natural Resources and Community Development, Division of Coastal Management, Raleigh, NC.

Marshall, H.G. 1988. Seasonal phytoplankton composition and abundance patterns in Back Bay, Virginia. Final Report. Prepared for the Virginia Commission of Game and Inland Fisheries under Cooperative Agreement F-58. Department of Biological Sciences, Old Dominion University, Norfolk, VA.

Marshall, H.G., R. Southwick and B. Wagoner. 1988. Seasonal zooplankton composition and abundance patterns in Back Bay, Virginia. Final Report. Prepared for the Virginia Department of Game and Inland Fisheries under Cooperative Agreement F-58-R-1. Department of Biological Sciences, Old Dominion University, Norfolk, VA.

Marshall, H.G. undated. Special report on the environmental appraisal of the Canal Number 2 project. Prepared for the United States Army Corps of Engineers, Norfolk District.

Martin, R.G. 1976. Northwest River. Virginia Wildlife 32(June), 4-5.

Mayne, K.L. and M. Vecchione. 1980. Virginia Beach Streams, Canal Number Two, Virginia Beach, Virginia: Fish and Wildlife Coordination Act Report. United States Fish and Wildlife Service. Division of Ecological Services. Gloucester Point, VA.

McAtee, W.L. 1919. Notes on the flora of Churches Island, North Carolina. J. Elisha Mitchell Sci. Soc. 35, 61-75.

McCoy, E.G. and K.H. Johnston. 1964. The effects of wind and salinity upon sedimentation rates of soils from dredging sites in the Albemarle Sound, North Carolina. Proc. Southeastern Assoc. Game and Fish. Comm., 358-370.

McGahee, C.F. and G.J. Davis. 1971. Photosynthesis and respiration in Myriophyllum spicatum as related to salinity. Limn. Oceanog. 16(5), 826-829.

Neilson, B.J. 1982. Water quality trends in the Northwest River. Department of Physical Oceanography and Environmental Engineering, Virginia Institute of Marine Science, College of William and Mary, Gloucester Point, VA.

Norman, M.D. 1988. What happened to Back Bay? Virginia Wildlife (August), 22-29.

Norman, M.D. and R. Southwick. 1987. Results of Back Bay fish population sampling, 1985-86. Virginia Department of Game and Inland Fisheries. July, 1987.

Norman, M.D. and R. Southwick. 1987. Back Bay: Report on salinity and water clarity in 1986. Virginia Department of Game and Inland Fisheries. April, 1987.

Norman, M.D. and R. Southwick. 1981. Completion report for Virginia Dingell-Johnson Project F-39-P Back Bay. Period covered December 1, 1978 to March 31, 1981. Study I. Background investigations.

Norman, M.D. and R. Southwick. 1980. Back Bay management report: Period covered April 1, 1979 - March 31, 1980. Virginia Dingell-Johnson Project F-39-P-2. Virginia Commission of Game and Inland Fisheries. 14 pages.

Norman, M.D. and T.R. Busiahn. 1979. Back Bay fishery investigations: Period covered December 1, 1978 to March 31, 1979. Virginia Dingell-Johnson Project F-39-R-1. Virginia Commission of Game and Inland Fisheries. 5 pages.

North Carolina Commercial Fisheries Study Commission. 1973. Final Report. North Carolina Commercial Fisheries Study Commission, Raleigh, NC.

North Carolina Department of Environment, Health, and Natural Resources. 1990. Albemarle-Pamlico Estuarine Study Status and Trends Technical Report. Unpublished draft. Raleigh, NC.

North Carolina Department of Natural and Economic Resources, Division of Environmental Management. 1975. Water quality management plan. Chowan River Basin. Sub basin 54. Environmental Management Commission, Raleigh, NC.

North Carolina Department of Natural Resources and Community Development. 1987. Source document for the Albemarle-Pamlico Estuarine Study: 5-year Plan. Draft. Raleigh, NC.

North Carolina Department of Natural Resources and Community Development. 1980. Public meeting on Currituck Sound: Fisheries, water quality, and salinity. (Meeting held at Currituck County High School in Barco, North Carolina).

North Carolina Division of Environmental Management and North Carolina Division of Marine Fisheries. 1975. Follow-up Report: Fish diseases and mortality, Albemarle Sound and Chowan River. Unpublished Report. North Carolina Division of Marine Fisheries, North Carolina Department of Natural Resources and Community Development, Raleigh, NC. 7 pp.

North Carolina Legislative Research Commission. 1979. Report to the 1979 General Assembly of North Carolina- Fisheries. Legislative Research Commission, Raleigh, NC.

North Carolina Office of State Budget and Management. 1988. North Carolina population projections: 1988-2010. Management and Information Services, Raleigh, NC.

North Carolina Office of State Budget and Management. 1981. Profile of North Carolina Counties. 6th ed. NC Office of Budget and Management, Raleigh, NC.

North Carolina State University Division of Economics and Business. 1989. NC State Economist: Coastal Management Issues. North Carolina Agricultural Extension Service, Raleigh, NC. 4 pages.

North Carolina-Virginia Water Resources Management Committee, Virginia State Water Control Board and North Carolina Department of Natural Resources and Community Development. 1982. The North Carolina-Virginia Tidewater Area: Developing a process for resolving water resource management issues. 76 pages.

North Carolina Wildlife Resources Commission. 1958. Inventory of fish populations in Currituck Sound and aquatic vegetation studies. Unpublished Report. North Carolina Wildlife Resources Commission, Raleigh, NC. 32 pages.

Odum, H.T., B.J. Copeland and E.A. McMahan. 1969. Coastal ecological systems of the United States: A source book for estuarine planning. Contract Rep 68-128. Federal Water Pollution Cont. Administration, Morehead City, NC. 1878 pages.

Owens, D.W. 1985. Coastal management in North Carolina. Journ. Amer. Planning Assoc. (Summer), 322-329.

Owens, D.W. 1980. The future of the Currituck Outer Banks. Carolina Planning. 6(2), 44-52.

Parnell, J.F. and R.F. Soots, Jr. 1979. Atlas of colonial waterbirds of North Carolina estuaries. UNC-SG-78-10. UNC Sea Grant. 269 pages.

Pilkey, O.H., Jr. and W.J. Neal. 1978. From Currituck to Calabash: Living with North Carolina's Barrier Islands. North Carolina Science and Technology Research Center, Research Triangle Park, NC. 228 pages.

Rabb, J.C. 1943. Fur Resources investigation and survey. Federal Aid in Wildlife Restoration Project 6-R. North Carolina Division of Game and Inland Fisheries.

Rice, D.A. 1975. Estuarine lands of North Carolina: Legal aspects of ownership, use, and control. University of North Carolina Institute of Government, Chapel Hill, NC.

Roelofs, E.W. 1953. Distribution of fishery resources in relation to hydrographic conditions in North Carolina estuaries. Gulf and Carib. Fish. Inst. Fifth Annual Proc., 141-145.

Roy Mann Consultants and Jason M. Cortell and Associates, Inc. 1985. A management plan for Back Bay. Vol 1. Main Report. City of Virginia Beach, VA. 54 pages.

Roy Mann Consultants and Jason M. Cortell and Associates, Inc. 1985. A management plan for Back Bay. Vol. 2. Water Quality Report. City of Virginia Beach, VA. 122 pages.

Rulison, M. 1983. Socioeconomic status and potential of trapping, sport fishing, and hunting in Currituck County. Prepared for North Carolina Department of Natural Resources and Community Development, Office of Water Resources. Water Resources Research Institute of The University of North Carolina, Raleigh, NC. Currituck Sound Resource Management Project Task 4. 23 pages.

Rulison, M. 1982. Socioeconomic status and potential of the commercial fishery of Currituck Sound. Prepared for North Carolina Department of Natural Resources and Community Development, Office of Water Resources. Water Resources Research Institute of the University of North Carolina, Raleigh, NC. Currituck Sound Resource Management Project Task 3. 44 pages.

Sincock, J.L., A.W. Dickson, and J.L. Coggin. undated. Annual progress report: Back Bay-Currituck Sound cooperative study; May 1958 through May 1959. Mimeographed report. North Carolina Wildlife Resources Commission.

Soucie, G. 1976. Fare-thee-well, Currituck Banks. Audubon, 22-35.

Southeastern Virginia Planning District Commission. 1989. Regional stormwater management strategy for Southeastern Virginia. Southeastern Virginia Planning District Commission, Chesapeake, VA.

Southeastern Virginia Planning District Commission. 1988. The Waters of Southeastern Virginia. Vol. 1. An Analysis of Water Access Needs. National Oceanic and Atmospheric Administration Coastal Resources Management Program Grant No. NA-86-AA-D-CZ116.

Southeastern Virginia Planning District Commission. 1988. The Waters of Southeastern Virginia. Vol. 2. A Regional Waterways Guide. National Oceanic and Atmospheric Administration Coastal Resources Management Program Grant No. NA-86-AA-D-CZ116.

Southeastern Virginia Planning District Commission. 1987. Agriculture in Southeastern Virginia. Southeastern Virginia Planning District Commission, Chesapeake, VA.

Southeastern Virginia Planning District Commission. 1987. Hampton Roads Economic Forecast. Chesapeake, VA.

Southeastern Virginia Planning District Commission. 1985. Virginia Beach scenic waterway plan. Southeastern Virginia Planning District Commission, Norfolk, VA.

Southeastern Virginia Planning District Commission. 1981. Virginia Beach waterfront access study. Southeastern Virginia Planning District Commission, Norfolk, VA.

Southwick, R. 1989. Results of Back Bay salinity and water clarity monitoring, 1987 and 1988. Virginia Department of Game and Inland Fisheries. March, 1989.

Southwick, R. and M.D. Norman. 1987. Results of Back Bay nutrient sampling, April 1986 - March 1987. Virginia Department of Game and Inland Fisheries. December, 1987.

Stick, D. 1958. The Outer Banks of North Carolina. University of North Carolina Press, Chapel Hill, NC.

Stockton, M.B. and C.J. Richardson. 1987. Wetland development trends in coastal North Carolina, USA, from 1970 to 1984. Environmental Management 11(5), 649-657.

Students of North Carolina State University. undated. Currituck Banks. North Carolina State University, Raleigh, NC. 32 pages.

Syndor, W.K. undated. The relationship between mowing and nitrogen content in Myriophyllum spicatum L. Cancas 24(1), 25-27.

Taggart, J. and K. Henderson. 1988. A Field Guide to Exploring the North Carolina National Estuarine Research Reserves. North Carolina Department of Natural Resources and Community Development, Raleigh, NC. 110 pages.

Taylor, H.F. 1955. Survey of marine fisheries of North Carolina. University of North Carolina Press, Chapel Hill, NC. 555 pages.

Taylor, Z. 1978. Currituck's grand old hunting clubs. Sports Afield (December).

Tebo, L.B. and E.G. McCoy. 1964. Effect of seawater concentration on the reproduction and survival of largemouth bass and bluegill. Unpublished report. North Wildlife Resources Commission, Raleigh, NC.

Tschetter, P.D. 1989. Characterization of baseline demographic trends in the year-round and recreational population in the Albemarle-Pamlico Estuarine Study area. Albemarle-Pamlico Study Project #AP89-03.

United States Army Corps of Engineers. 1980. Virginia Beach Streams, Canal Number Two, Virginia Beach, Virginia: Flood control project, phase I general design memorandum. Army Corps of Engineers, Norfolk, VA.

United States Army Corps of Engineers. 1977. Albemarle and Chesapeake Canal. Environmental Impact Statement. U.S. Army Corps of Engineers, Wilmington, NC.

United States Army Corps of Engineers. 1972. Flood plain information: Coastal flooding, City of Chesapeake, Virginia. Army Corps of Engineers, Norfolk, VA.

United States Army Corps of Engineers. 1969. Flood plain information: Coastal flooding, City of Virginia Beach, Virginia. Army Corps of Engineers, Norfolk, VA.

United States Department of Agriculture, Soil Conservation Service and Virginia Polytechnic Institute and State University. 1985. Soil survey of City of Virginia Beach, Virginia. Soil Conservation Service, Washington, DC.

United States Department of Agriculture, Soil Conservation Service, North Carolina Department of Natural Resources and Community Development, North Carolina Agricultural Extension Service, North Carolina Agricultural Research Service and Currituck County Board of Commissioners. 1980. Soil survey of Currituck County, North Carolina. Soil Conservation Service, Washington, DC. 102 pages.

United States Department of Agriculture, Soil Conservation Service and Virginia Agricultural Experiment Station. 1959. Soil survey: Norfolk County, Virginia. Soil Conservation Service, Washington, DC.

United States Fish and Wildlife Service. 1989. Final environmental assessment: Proposal to expand the boundary of the Back Bay National Wildlife Refuge, Virginia Beach, Virginia. United States Fish and Wildlife Service, Newton Corner, MA.

United States Fish and Wildlife Service. 1985. Habitat evaluation procedures report for proposed state access through Back Bay National Wildlife Refuge, Virginia. United States Fish and Wildlife Service, Newton Corner, MA.

Appendix C: Task II Survey

CURRITUCK SOUND WATERSHED ADVISORY COMMITTEE
TASK II SURVEY

Name:_____

Agency:_____

Date:_____

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1. Please rank the following management concerns and issues in terms of their detrimental effects on the Currituck Sound drainage basin (1= issue of greatest concern; Please put an "X" if you feel the problem does not apply to Currituck Sound).

_____ Lack of cooperation among agencies within North Carolina

_____ Lack of cooperation between the managing governments (state & local) in North Carolina and Virginia

_____ Lack of cooperation within/among federal agencies
e.g. Lack of cooperation/rapport between regional offices of the same agency

_____ Water quality problems
Define:

_____ Rapid development

_____ Over-development

_____ Conflicts between sports fishermen and commercial fishermen

_____ Under-utilization of the resource

_____ Other:_____

_____

_____

Comments:

2. Should there be a contingency plan for the management of Currituck Sound in the event of natural inlet opening? If so, what should this include?

3. What steps must North Carolina and Virginia take to solve the problems facing the Currituck Sound watershed? Is there a need for new laws/regulations, education programs, research, etc.?

4. Please list name, agency, telephone number, and other applicable information for anyone I should contact about management issues in Currituck Sound.

5. Describe the philosophy of the agency you represent and how the agency is involved in the management of the Currituck Sound drainage basin.

1987 CHESAPEAKE BAY AGREEMENT

THE CHESAPEAKE BAY IS A NATIONAL TREASURE and a resource of worldwide significance. Its ecological, economic, and cultural importance are felt far beyond its waters and the communities that line its shores. Man's use and abuse of its bounty, however, together with the continued growth and development of population in its watershed, have taken a toll on the Bay system. In recent decades, the Bay has suffered serious declines in quality and productivity. ◊ *REPRESENTING* the Federal government and the States which surround the Chesapeake Bay, we acknowledge our stake in the resources of the Bay and accept our share of responsibility for its current condition. We are determined that this decline will be reversed. In response, all of our jurisdictions have embarked on ambitious programs to protect our shared resource and restore it to a more productive state. ◊ *IN* 1980, the legislatures of Virginia and Maryland established the Chesapeake Bay Commission to coordinate interstate planning and programs from a legislative perspective. In 1985, Pennsylvania joined the Commission. And, in 1983, Virginia, Maryland, Pennsylvania, the District of Columbia, the U.S. Environmental Protection Agency and the Chesapeake Bay Commission formally agreed to a cooperative approach to this undertaking and established specific mechanisms for its coordination. Since 1983, ar joint commitment has carried us to new levels of governmental cooperation and scientific understanding. It has formed a firm base for the future success of this long-term program. The extent and complexity of our task now call for an expanded and refined agreement to guide our efforts toward the twenty-first century. ◊ *RECOGNIZING* that the Chesapeake Bay's importance transcends regional boundaries, we commit to managing the Chesapeake Bay as an integrated ecosystem and pledge our best efforts to achieve the goals in this Agreement. We propose a series of objectives that will establish a policy and institutional framework for continued cooperative efforts to restore and protect Chesapeake Bay. We further commit to specific actions to achieve those objectives. The implementation of these commitments will be reviewed annually and additional commitments developed as needed.

GOALS AND PRIORITY COMMITMENTS

THIS NEW AGREEMENT CONTAINS Goals and Priority Commitments for Living Resources; Water Quality; Population Growth and Development; Public Information, Education and Participation; Public Access; and Governance. ◊ The parties to this 1987 Agreement are the U.S. Environmental Protection Agency representing the Federal government, the District of Columbia, the State of Maryland and the Commonwealths of Pennsylvania and Virginia (hereinafter the "States") and the Chesapeake Bay Commission. This Agreement may be amended and attachments added in the future by unanimous action of the Chesapeake Executive Council.

LIVING RESOURCES

GOAL: *PROVIDE FOR THE RESTORATION AND PROTECTION OF THE LIVING RESOURCES, THEIR HABITATS AND ECOLOGICAL RELATIONSHIPS.* The productivity, rsity and abundance of living resources are the best ultimate mea- s of the Chesapeake Bay's condition. These living resources are the n focus of the restoration and protection effort. Some species of lfish and finfish are of immense commercial and recreational value nan. Others are valuable because they are part of the vast array of nt and animal life that make up the Chesapeake Bay ecosystem on ich all species depend. We recognize that the entire natural system st be healthy and productive. We will determine the essential ele- nts of habitat and environmental quality necessary to support living urces and will see that these conditions are attained and maintained. will also manage the harvest of and monitor populations of com- rcially, recreationally and ecologically valuable species to ensure sus- ned, viable stocks. We recognize that to be successful, these actions st be carried out in an integrated and coordinated manner across the ole Bay system.

BJECTIVES:

Restore, enhance, protect and manage submerged aquatic vegetation.

Protect, enhance and restore wetlands, coastal sand dunes, forest buffers and other shoreline and riverline systems important to water quality and habitat.

Conserve soil resources and reduce erosion and sedimentation to protect Bay habitat.

Maintain freshwater flow regimes necessary to sustain estuarine habitats, including, where appropriate, establishing minimum in-stream flows.

Develop compatible Bay-wide stock assessment programs.

- Develop Bay-wide fisheries management strategies and develop complementary state programs and plans to protect and restore the finfish and shellfish stocks of the Bay, especially the freshwater and estuarine spawners.
- Provide for the restoration of shellfish stocks in the Bay, especially the abundance of commercially important species.
- Restore, enhance and protect waterfowl and wildlife.

COMMITMENT:

TO ACHIEVE THIS GOAL WE AGREE:

- by *January 1988*, to develop and adopt guidelines for the protection of water quality and habitat conditions necessary to support the living resources found in the Chesapeake Bay system, and to use these guidelines in the implementation of water quality and habitat protection programs.
- by *July 1988*, to develop, adopt and begin to implement a Bay-wide plan for the assessment of commercially, recreationally and selected ecologically valuable species.
- by *July 1988*, to adopt a schedule for the development of Bay-wide resource management strategies for commercially, recreationally and selected ecologically valuable species.
- by *July 1989*, to develop, adopt and begin to implement Bay-wide management plans for oysters, blue crabs and American Shad. Plans for other major commercially, recreationally and ecologically valuable species should be initiated by 1990.
- by *December 1988*, to develop a Bay-wide policy for the protection of tidal and non-tidal wetlands.
- Provide for fish passage at dams, and remove stream blockages wherever necessary to restore natural passage for migratory fish.

WATER QUALITY

GOAL: *REDUCE AND CONTROL POINT AND NONPOINT SOURCES OF POLLUTION TO ATTAIN THE WATER QUALITY CONDITION NECESSARY TO SUPPORT THE LIVING RESOURCES OF THE BAY.* The improvement and maintenance of water quality are the single most critical elements in the overall restoration and protection of the Chesapeake Bay. Water is the medium in which all living resources of the bay live, and their ability to survive and flourish is directly dependent on it. ◇ To ensure the productivity of the living resources of the Bay, we must clearly establish the water quality conditions they require and must then attain and maintain those conditions. Foremost, we must improve or maintain dissolved oxygen concentrations in the Bay and its tributaries through a continued and expanded commitment to the reduction of nutrients from both point and nonpoint sources. We must do the same for toxics and conventional pollutants. To be effective, we will develop basin-wide implementation plans for the control and reduction of pollutants which are based on our best understanding (including that derived from modeling) of the Bay and its tributaries as an integrated system.

OBJECTIVES:

- ◇ Provide timely construction and maintenance of public and private sewerage facilities to assure control of pollutant discharges.
- ◇ Reduce the discharge of untreated or inadequately treated sewage into Bay waters from such sources as combined sewer overflows, leaking sewage systems, and failing septic systems.
- ◇ Evaluate and institute, where appropriate, alternative technologies for point source pollution control, such as biological nutrient removal and land application of effluent to reduce pollution loads in a cost-effective manner.
- ◇ Establish and enforce pollutant limitations to ensure compliance with water quality laws.
- ◇ Reduce the levels of nonpoint sources of pollution.
- ◇ Reduce sedimentation by strengthening enforcement of existing control regulations.
- ◇ Eliminate pollutant discharges from recreational boats.
- ◇ Identify and control toxic discharges to the Bay system, including metals and toxic organics, to protect water quality, aquatic resources and human health through implementation and enforcement of the states National Pollutant Discharge Elimination System permit programs and other programs.
- ◇ Reduce chlorine discharges in critical finfish and shellfish areas. Minimize water pollution incidents and provide adequate response to pollutant spills.
- ◇ Manage sewage sludge, dredged spoil and hazardous wastes to protect the Bay system.
- ◇ Manage groundwater to protect the water quality of the Bay.
- ◇ Quantify the impacts and identify the sources of atmospheric inputs on the Bay system.

COMMITMENT:

TO ACHIEVE THIS GOAL WE AGREE:

- ◇ by *July 1988*, to develop, adopt and begin implementation of a basin-wide strategy to equitably achieve by the year 2000 at least a 40 percent reduction of nitrogen and phosphorus entering the main stem of the Chesapeake Bay. The strategy should be based on agreed upon 1985 point source loads and on nonpoint loads in an average rainfall year.
- ◇ by *December 1991*, to re-evaluate the 40 percent reduction target based on the results of modeling, research, monitoring and other information available at that time.
- ◇ by *December 1988*, to develop, adopt and begin implementation of a basin-wide strategy to achieve a reduction of toxics consistent with the Water Quality Act of 1987 which will ensure protection of human health and living resources. The strategy will cover both point and nonpoint sources, monitoring protocols, enforcement of pretreatment regulations and methods for dealing with in-place toxic sediments where necessary.
- ◇ by *July 1988*, to develop and adopt, as required by the Water Quality Act of 1987, a basin-wide implementation strategy for the management and control of conventional pollutants entering the Chesapeake Bay system from point and nonpoint sources.
- ◇ by *July 1988*, the Environmental Protection Agency, acting for the federal government, will develop, adopt and begin implementation of a strategy for the control and reduction of point and nonpoint sources of nutrient, toxic and conventional pollution from all federal facilities.

POPULATION GROWTH AND DEVELOPMENT

GOAL: *PLAN FOR AND MANAGE THE ADVERSE ENVIRONMENTAL EFFECTS OF HUMAN POPULATION GROWTH AND LAND DEVELOPMENT IN THE CHESAPEAKE BAY WATERSHED.* There is a clear correlation between population growth and associated development and environmental degradation in the Chesapeake Bay system. Enhancing, or even maintaining, the quality of the Bay while accommodating growth will frequently involve difficult decisions and restrictions and will require continued and enhanced commitment to proper development standards. The states and the federal government will assert the full measure of their authority to mitigate the potential adverse effects of continued growth. ◇ Local jurisdictions have been delegated authority over many decisions regarding growth and development which have both direct and indirect effects on the Chesapeake Bay system and its living resources. The role of local governments in the restoration and protection effort will be given proper recognition and support through state and federal resources. ◇ States will engage in an active partnership with local governments to establish policy guidelines to manage growth and development.

OBJECTIVES:

- ◇ Designate a state-level office responsible for ensuring consistency with this Agreement among the agencies responsible for comprehensive oversight of development activity, including infrastructure planning, capital budgets, land preservation and waste management activities.
- ◇ Provide local governments with financial and technical assistance to continue and expand their management efforts.
- ◇ Consult with local government representatives in the development of Chesapeake Bay restoration and protection plans and programs.
- ◇ Identify and give public recognition to innovative and otherwise noteworthy examples of local government restoration and protection-related programs.
- ◇ Assure that government development projects meet all environmental requirements.
- ◇ Promote, among local, state and federal governments, and the private sector, the use of innovative techniques to avoid and, where necessary, mitigate the adverse impacts of growth.

COMMITMENT:

TO ACHIEVE THIS GOAL WE AGREE:

- ◇ to commission a panel of experts to report, by *December 1988*, on anticipated population growth and land development patterns in the Bay region through the year 2020, the infrastructure requirements necessary to serve growth and development, environmental programs needed to improve Bay resources while accommodating growth, alternative means of managing and directing growth and alternative mechanisms for financing governmental services and environmental controls. The panel of experts will consist of twelve members: three each from Virginia, Maryland and Pennsylvania, and one each from the District of Columbia, Environmental Protection Agency and the Chesapeake Bay Commission.
- ◇ by *January 1989*, to adopt development policies and guidelines designed to reduce adverse impacts on the water quality and living resources of the Bay, including minimum best management practices for development and to cooperatively assist local governments in evaluating land-use and development decisions within their purview, consistent with the policies and guidelines.
- ◇ to evaluate state and federal development projects in light of their potential impacts on the water quality and living resources of the Chesapeake Bay, and design and carry out each state and federal development project so as to serve as a model for the private sector in terms of land-use practices.
- ◇ by *December 1988*, to develop a strategy to provide incentives, technical assistance and guidance to local governments to actively encourage them to incorporate protection of tidal and non-tidal wetlands and fragile natural areas in their land-use planning, water and sewer planning, construction and other growth-related management processes.

GOVERNANCE

GOAL: *SUPPORT AND ENHANCE THE PRESENT COMPREHENSIVE, COOPERATIVE AND COORDINATED APPROACH TOWARD MANAGEMENT OF THE CHESAPEAKE BAY SYSTEM.*

GOAL: *PROVIDE FOR CONTINUITY OF MANAGEMENT EFFORTS AND PERPETUATION OF COMMITMENTS NECESSARY TO ENSURE LONG-TERM RESULTS.*

he cooperation necessary to sustain an effective Chesapeake Bay restoration and protection effort requires a formal working arrangement involving the states and the federal government. That institutional arrangement must allow for and promote voluntary individual actions coordinated within a well-defined context of the individual responsibilities and authorities of each state and the federal government. It must also ensure that actions which require a concerted, Bay-wide approach be addressed in common and without duplication. One of the principal functions of the coordinating institution is to develop strategic plans and oversee their implementation, based on advice from the public, from the scientific community and from user groups. ◇ In addition, the coordinating body must exert leadership to marshal public support, and it must be accountable for progress made under the terms of this agreement. The coordinating body will continue to be called the Chesapeake Executive Council. The Chesapeake Executive Council shall be comprised of the Governors, the Mayor of the District of Columbia, the Administrator of the Environmental Protection Agency and the Chairman of the Chesapeake Bay Commission. The chairmanship of the Council shall rotate annually as determined by the Council. The term of the Chairman shall be one year. The Administrator of the Environmental Protection Agency shall represent the federal government and the Chairman of the Chesapeake Bay Commission shall represent its members.

OBJECTIVES:

- Continue to demonstrate strong, regional leadership by convening an annual public meeting of the Chesapeake Executive Council.
- Continue to support the Chesapeake Executive Council and provide for technical and public policy advice by maintaining strong advisory committees.
- Coordinate Bay management activities and develop and maintain effective mechanisms for accountability.
- The Chesapeake Bay Liaison Office shall provide staff support to the Chesapeake Executive Council by providing analyses and data management, and by generating reports related to the overall program. The Implementation Committee shall provide guidance to the CBLO Director in all matters relating to support for the Council and their supporting committees, subcommittees and work groups including the development of all plans and other documents associated with the Council.
- ◇ Examine the feasibility of joint funding support of the Chesapeake Bay Liaison Office.
- ◇ Track and evaluate activities which may affect estuarine water quality and resources and report at least annually.
- ◇ Develop and maintain a coordinated Chesapeake Bay data management system.
- ◇ Continue to implement a coordinated Bay-wide monitoring system and to develop a Bay-wide living resources monitoring system.
- ◇ Develop and implement a coordinated Bay-wide research program.

COMMITMENT:

TO ACHIEVE THESE GOALS WE AGREE:

- ◇ to develop an annual Chesapeake Bay work plan endorsed by the Chesapeake Executive Council.
- ◇ to continue to support Bay-wide environmental monitoring and research to provide the technical and scientific information necessary to support management decisions.
- ◇ to strengthen the Chesapeake Bay Liaison Office by assigning, as appropriate, staff persons from each jurisdiction and from participating federal agencies to assist with the technical support functions of that office.
- ◇ by *July 1988*, to develop and adopt a comprehensive research plan to be evaluated and updated annually to address the technical needs of the Chesapeake Bay Program.
- ◇ by *July 1988*, develop a Bay-wide monitoring plan for selected commercially, recreationally and ecologically valuable species.
- ◇ by *March 1988*, to establish a local government advisory committee to the Chesapeake Executive Council and charge that committee to develop a strategy for local government participation in the Bay program.
- ◇ to consider and review the feasibility of establishing an independent Chesapeake Bay Executive Board.
- ◇ by *July 1988*, the Environmental Protection Agency, acting for the federal government, will develop, a coordinated, federal agency workplan which identifies specific federal programs to be integrated into a coordinated federal effort to support the restoration of the Chesapeake Bay.

BY THIS AGREEMENT, we reaffirm our commitment to restore and protect the ecological integrity, productivity and beneficial uses of the Chesapeake Bay system. We agree to report in *January 1989* on progress made in fulfilling the commitments in this agreement, and to consider at that time additional commitments. The implementation strategies which will be developed pursuant to this agreement will be appended as annexes, and annual reports will include an accounting of progress made on each strategy.

December 15, 1987
(Date)

FOR THE COMMONWEALTH OF VIRGINIA

FOR THE STATE OF MARYLAND

FOR THE COMMONWEALTH OF PENNSYLVANIA

FOR THE UNITED STATES OF AMERICA

FOR THE DISTRICT OF COLUMBIA

Mayor

FOR THE CHESAPEAKE BAY COMMISSION