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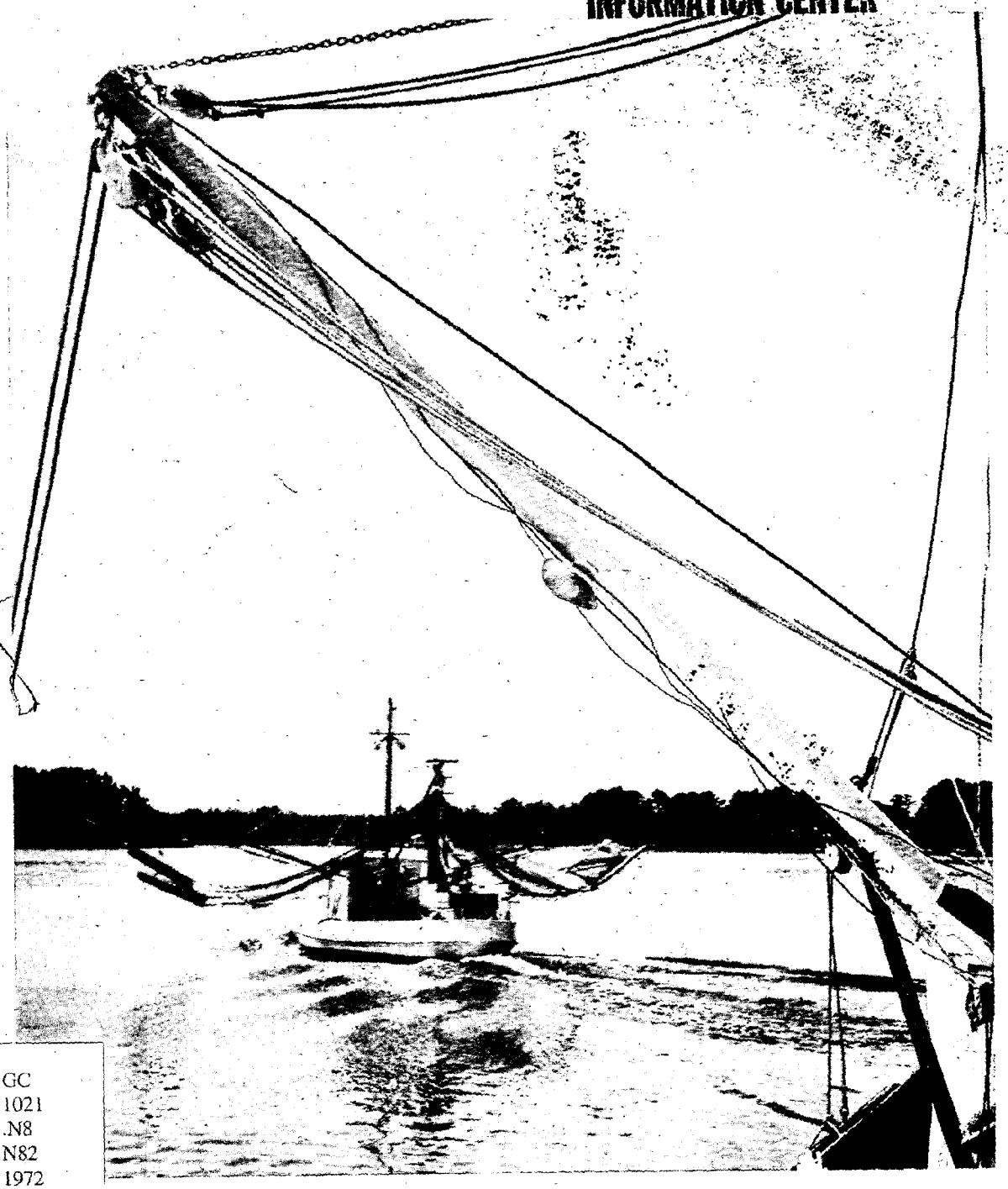

COASTAL RESOURCES

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NORTH CAROLINA'S COASTAL RESOURCES

A Preliminary Planning Report for
Marine and Coastal Resource Development
in North Carolina

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Prepared by the North Carolina Marine Science Council
in consultation with the North Carolina State-Federal
Planning Committee for Marine Resources

December 15, 1972
Raleigh, North Carolina

For additional copies write to North Carolina Marine Science Council, Department of Administration, 116 West Jones Street, Raleigh, North Carolina 27603.

December 20, 1972

The Honorable Robert W. Scott
Governor of North Carolina
Raleigh, North Carolina

Dear Governor Scott:

The North Carolina Marine Science Council respectfully submits to you a Preliminary Planning Report for Marine and Coastal Resource Development in North Carolina. This is in response to General Statutes creating the Marine Science Council which charges the Council with continuous planning in all areas relating to the marine environment. It also fulfills the requirements established by you, the Administrator of the National Oceanic and Atmospheric Administration, and the Federal Co-chairman of the Coastal Plains Regional Commission concerning the preparation of a preliminary plan.

This report is endorsed by the Marine Science Council and the North Carolina State-Federal Planning Committee for Marine Resources.

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Amor L. Lane
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Leigh H. Hammond
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PREFACE

This document is a preliminary planning report for marine and coastal resource development in North Carolina, and contains recommendations for certain key legislative and administrative actions and research programs needed in the State. This report was prepared by the North Carolina Marine Science Council in consultation with the recently created North Carolina State-Federal Planning Committee for Marine Resources. An earlier report, "North Carolina and the Sea," was prepared by the Marine Science Council in 1970. The next phase, to be built on these first efforts, will include the development of a comprehensive plan with specific guidelines, details and priorities, for its implementation. It is anticipated that such a plan will be periodically revised and updated as required.

The information in this report is organized into 10 chapters and a summary section. The introductory chapter includes a brief statement about North Carolina's marine and coastal resources and the basic concerns relating to them. A review of planning activities in recent years is also included in this chapter.

The second chapter discusses existing marine research and education facilities and the need for a new North Carolina Center for Marine Resources. This Center, construction of which is expected to begin in 1973, will play a vital role in the future development of the marine resources of the State. More details regarding the operations of the Center are available in a separate report.

Chapters three through ten include discussions - current status, problems, and recommendations - about each of eight major program areas: Mineral and Energy Resources, Transportation, Recreation and Tourism, Commercial Fishing, Aquaculture, Environmental Quality, Oceanographic Research, and Coastal Zone Management.

Chapter 10, the final chapter, addresses the important need at this time for effective coastal zone management in North Carolina. This report and especially the contents of this chapter, assumes even greater timeliness in view of the recent enactment of the Federal Coastal Zone Management Act of 1972.

In addition to the members of the North Carolina Marine Science Council and the North Carolina State-Federal Planning Committee for Marine Resources, there were significant contributions from State agencies, universities, the National Oceanic and Atmospheric Administration (NOAA) and other Federal agencies, and the private sector in the preparation of this report. However, it should be noted that the recommendations have not been submitted for any formal type of review by Federal agencies. Final responsibility for the approval of this report rests with the Marine Science Council and the State/Federal Planning Committee.

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EXECUTIVE SUMMARY
OF
GOALS, PROBLEMS, AND RECOMMENDATIONS

The overall goal of North Carolina in marine affairs is to bring about comprehensive development of all marine resources in North Carolina with careful consideration given to conservation, preservation, and the quality of the environment.

In order to accomplish this goal, an effective planning mechanism is essential. During the past year, the Marine Science Council along with the State-Federal Committee has helped to assure effective planning.

The new North Carolina Marine Resources Center will involve continuous interfacing of programs of education, advisory services, research, management and regulatory activities which will also contribute significantly to a cohesive effort in achieving the State's overall objective. Facilities at three locations on the coast - Dare, Carteret, and New Hanover Counties - are vital to the success of the Center.

There are eight program areas that were considered of major importance in this preliminary planning report. A brief statement giving goals, problems and recommendations in each of these areas is included in this summary section.

Program Area: Minerals and Energy Resources

Goal : To promote the development of the mineral and energy resources of the North Carolina Coastal Zone for the maximum benefit of the State and Nation in a manner compatible with the environment and other uses.

	PROBLEM		RECOMMENDATION
1.	Lack of an adequate comprehensive inventory of the mineral and energy resources which is needed for research planning and commercial development in the coastal zone.	1.	An appropriate State agency should be responsible for developing a coordinated inventory of mineral resources of the coastal zone through a compilation and assessment of existing data from State, Federal and commercial sources.
2.	Lack of verification and appropriate policies for ownership of mineral resources by State and private sectors.	2.	Develop a policy for allocation of State mineral resources in order to verify ownership. An appropriate State agency should be responsible for developing large scale maps depicting ownership.
3.	Lack of an adequate method to evaluate the envrionmental impact of present and future development of mineral resources to meet growing public concern for the quality of the environment.	3.	The State, in cooperation with academic and Federal government sectors, should develop a coordinated procedure for evaluating the environmental impact of present and future development of mineral resources. An appropriate State agency should be responsible for developing the data base upon which rational decisions can be made.

Minerals and Energy Resources (Con't.)

PROBLEM	RECOMMENDATION
4. Lack of information to properly manage ground water resources.	4. Accelerate the ground water resource studies presently being conducted by the State.
5. Lack of information on the market possibilities for coastal zone mineral resources.	5. Studies should be undertaken to evaluate, identify and promote potential markets for coastal zone mineral resources.

Program Area: Transportation

Goal: To facilitate the transfer of people and freight so as to improve the economic and social well being of the people with minimal environmental impact. In carrying out these programs, the principal modes of transportation, air, highways, rail, and water, should be coordinated to the maximum extent possible.

PROBLEMS	RECOMMENDATIONS
1. The conflict between the necessity to maintain channels by dredging and the environmental impact of dredging operations.	1. Develop a state policy in coordination with federal, regional, and local interests that will better define responsibilities and legal requirements for both environmental protection and continuation of maintenance dredging vital to the State's economy.
2. Inadequate policy for the selection of barrier island inlets to be stabilized.	2. Prepare a re-vitalized plan enumerating priority ranking for the inlet stabilization program.
3. The unknown economic impact upon the North Carolina ports by the possible construction of offshore deep-water terminals on the East and Gulf Coasts.	3. The State should initiate a comprehensive evaluation of the economic impact on North Carolina of the creation of super-ports in locations outside of the State.
4. The Coastal Region lack of highway facilities of Interstate quality for service and for economic growth of the region.	4. Certain existing highway construction programs in the Coastal Region should be accelerated by all possible means. In addition, a thorough study is recommended to

PROBLEMS	RECOMMENDATIONS
	relate highway access problems in the Coastal Region with plans for developmental, recreational, conservational, and other uses of the region.
5. Inadequate air service in the Coastal zone.	5. Encourage responsible Coastal area agencies to provide substantial input to the North Carolina State Airport System planning effort just underway.
6. Lack of a coordinated state planning effort directed to transportation matters in the Coastal Region.	6. A high-level multimodal transportation planning effort should be established in the North Carolina Department of Transportation and Highway Safety, and this planning function should be charged with the responsibility for coordination of Coastal Region transportation development.

Program Area: Recreation and Tourism

Goals:

1. To provide a system of well-managed and serviced outdoor recreation areas which are balanced with respect to geographic, demographic, and environmental considerations.
2. To provide high quality "commercial" recreation consistent with preserving the natural resource base to meet the demand of the touring public and to meet the needs for economic development of eastern North Carolina.
3. To encourage conservation and development of fish and wildlife resources for recreation purposes.

PROBLEM	RECOMMENDATION
1. Lack of adequate public access to recreation areas:	1.
a. Lack of good highways and airline transportation into the coastal region.	a. Initiate a study which would result in a policy for the adequate development of highway and air access into and within the coastal region in consonance with plans for recreational, conservational and other uses.
b. Inadequate publicly owned beaches and limited public access points to estuaries, rivers, and lakes.	b. Take steps to insure that adequate public beaches and public access points to estuaries, rivers, lakes and beaches are acquired.
2. Degradation of recreational facilities	2.
a. Overcrowding.	a. Avoid unnecessary intensive and destructive use of fragile natural areas by setting user capacity limits on public and private facilities where necessary.

PROBLEM	RECOMMENDATION
b. Pollution.	b. Take steps to develop new legislation and enforce existing laws and regulations relating to solid and liquid waste disposal.
3. Seasonality of recreation demand, especially in the northeastern coastal area.	3. Develop a program which would result in the maximum use of facilities and recreational areas on a year-round basis taking into account present and potential recreational demands and the need for additional parks and facilities having year-round appeal.
4. Insufficient public park lands.	4. Undertake an aggressive park land acquisition and development program.
5. Need for meaningful conservation and development of recreational fishery resources.	5.
a. Inadequate assessment of the resources, their use and habitat near access areas.	a. Coordinated assessment by State, Federal, and university researchers of stocks, their use and habitats taking into account present and potential economic impact, and the need to increase stock sizes by the construction of artificial reefs both offshore and in estuaries.
b. Destruction of juvenile fishes in nursery areas.	b. Continue and expand cooperative efforts and planning sessions with State, Federal, and university researchers gathering information on estuarine nursery areas and recommend protection.
c. Quality of fishing experience.	c. Implement the necessary zoning and regulation to control interactions of vehicles and sportsmen and commercial interests.
6. Uncontrolled land use accelerating demand for second homes with water fronts, mobile home parks on ocean front property, etc.	6. Immediate steps should be taken to initiate strict, uniform state and local zoning regulations to insure proper planning and orderly development of coastal areas.

PROBLEM	RECOMMENDATION
7. Inadequate insect pest management programs.	7. Continue the study by North Carolina State University to develop a program of insect pest management and implement as appropriate a program to control biting flies and mosquitoes.

Program Area: COMMERCIAL FISHERIES

Goals : To increase income from commercial fishing through improved efficiency in catching, processing and marketing, and to preserve the long-range viability of the industry through efforts to maintain stocks and reduce environmental hazards.

PROBLEM	RECOMMENDATION
Environment and Stocks	
1. Inadequate protection of nursery areas during critical stages of species juvenile development.	1. Accelerate the completion of surveys designed to identify nursery areas so that recently developed management methods to protect juvenile stocks can be employed in remaining areas of the coast.
2. The intrusion of foreign fishing upon traditional fishing stocks of state fishermen.	2. Increase efforts to work with pertinent federal agencies to facilitate establishment of the necessary controls for protection of those species traditionally fished by the North Carolina industry.
3. Insufficient management controls for major fish stocks.	3. Develop state-federal management plans using existing data and conduct additional research where required. North Carolina would work with the NMFS and other Atlantic coast states in developing and implementing the plans.

PROBLEM	RECOMMENDATION
Environment and Stocks (con't)	
4. Detrimental impact of estuarine modification on fish habitats.	4. More rapid and thorough identification of ecologically sensitive areas; implementation of state-federal coastal management plans; improvement of state-federal impact statement procedures; conduct research supportive of impact statements and other regulatory requirements for coastal alterations.
Processing and Marketing	
1. North Carolina market and processing facilities have never accommodated the State's commercial catch to a satisfactory degree. The problem is to determine why and to correct if feasible.	1. Sponsor a study from a business analysis viewpoint of the entire opportunity from catching through processing and marketing. The objectives of the study are to identify viable business opportunities in this area and to identify the reasons for the lack of commercial development in processing and marketing be they technical, financial, legal or otherwise.
2. There is a lack of adequate marketing services to meet industry needs.	2. Increase the capability of ongoing marketing service programs.
Statistics	
1. Lack of adequate statistical data required for the management of the State's fisheries, sport and commercial. (Catch-effort data, age and size composition of catch, etc.)	1. Implement comprehensive statistical program geared to acquire data needed for economic development and evaluation of stocks and legally require licensed commercial fishermen to provide needed data.

PROBLEM	RECOMMENDATION
Advisory Services	
1. Inability of much of the industry to evaluate fully the results of research and make needed technological and business changes. Advisory services are not adequate.	1. A full-time professional unit with competence in business administration should be employed to advise members of the fishing industry in business and financial methods, availability of financial assistance, management of fishermen's resources and socio-economic and legal problems.
Inlets	
1. Unsure and unsafe accessibility to fishing grounds, or to refuge limits fishing time and increases the cost of fishing.	1. Conduct a study to determine which inlets are most important from the view of economics, safety, ecology and engineering (for stabilizing). Select the appropriate inlets and accomplish the necessary improvements.

Program Area: Aquaculture

Goals :

1. To promote and coordinate the orderly development of an economically viable aquaculture industry based on selected species for which sufficient basic technological information is available.

2. To continue development refining of aquaculture systems by obtaining relevant biological, engineering, economic, and legal information regarding such selected species.

3. To investigate the feasibility of developing culture techniques and systems which utilize additional species.

PROBLEM	RECOMMENDATION
1. Aquaculture development in North Carolina for those species which appear among the most promising, such as oysters, hard clams, and bay scallops, has not progressed past the research and bench-scale process level.	1. Effect a linkage between research and projection through both joint industry-academia pilot-plant operations and State-Federal advisory services programs.
2. Gaps exist in the biological, engineering, and economic information with respect to the candidate species which prevent efficient and profitable aquaculture operations.	2. Institute specific research and development projects to fill in the knowledge gaps known to exist or identified by pilot-plant operations.
3. The culture potential of specific estuarine areas of North Carolina is unknown.	3. Based on small-scale controlled culture operations, identify estuarine areas of potential value for specific organisms and culture processes.
4. There are no genetically improved brood stocks available to potential culturists.	4. As technology permits, conduct a long-term program of selective breeding to develop such superior brood stocks.

PROBLEM	RECOMMENDATION
5. Legal-institutional constraints preclude or at least impede the development of aquaculture in public waters or in systems drawing upon public waters.	5. Investigate and identify the nature and significance of this legal-institutional problem and enact suitable legislation if needed. Such legislation should be drafted to optimize multiple use of areas with aquaculture potential wherever possible.
6. There are only a few species, such as oysters, hard clams, and bay scallops, which are immediate candidates for aquaculture in North Carolina.	6. Continue to investigate the potential of other species, both those native to North Carolina and those found in other areas, for use in aquaculture.
7. There is a lack of information on the impact of aquaculture operations (either open or closed systems) upon the environment, particularly with reference to meeting water quality standards.	7. Determine the effects of culture operations on the environment including the characteristics of all effluents discharged from such such systems.
8. An information clearinghouse is needed for up-to-date information on culture techniques, field developments, and biological breakthroughs.	8. Establish a clearinghouse for up-to-date information on aquaculture developments.

Program Area: Environmental Quality

Goal : To assure non-degradation of existing water quality and reclamation of low-quality waters to higher classification by instituting appropriate remedial measures, and to prevent the physical destruction and adverse alterations of estuaries, marshes, and dunes.

PROBLEM	RECOMMENDATION
1. Inadequate treatment and/or control of human, animal and industrial wastes and urban runoff discharging into coastal waters.	1. To provide proper treatment and control of waste: (1) upgrade all treatment facilities to provide for at least secondary treatment and develop regional waste collection and treatment facilities where they are lacking; (2) prohibit the use of septic tanks for high density development, phase them out in areas of moderate density and where used, stringently control them them; (3) monitor industrial discharges, set effluent standards for major industries and require adequate treatment; (4) develop a control and treatment program for urban runoff; (5) institute a program of permits to regulate discharges from animal rearing and processing facilities; and (6) require sewage pump-out facilities for boats at all marinas and that all vessels and boats have marine sanitation devices.
2. Insufficient information about and/or control of toxic heavy metals, pesticides, oil pollution, thermal effects and natural sources of pollution.	2. To control pollution of coastal waters by toxic and noxious materials and other sources: (1) identify sources of toxic heavy metals and reduce their discharges to minimum levels

PROBLEM	RECOMMENDATION
	attainable by present technology; (2) expand pesticide monitoring and improve regulatory programs; (3) enact new legislation to provide regulatory control over all phases of oil exploration development, production, transport and processing; (4) study the environmental impact caused by thermal pollution, take the proper actions to reduce unacceptable adverse effects to nonsignificant levels, develop power plant siting policy, and (5) assess the magnitude of natural pollution and its effect on water quality and biota for the purpose of developing control programs if needed and if feasible.
3. Deliberate destruction and adverse alterations of estuaries, marshes, and dunes by dredging, dredged material deposition, stream channelization and by inadequately controlled recreation and residential development.	3. In order to control the impact of deliberately destroying or altering the environment: (1) develop long-range plans for dredging and deposition of dredged material (2) limit dredged channels to sites which serve a major public interest and do not cause ecological imbalances; (3) require dredged material to be contained in diked ponding areas on uplands; when deposition in water areas cannot be avoided, it should be stabilized; (4) develop productive uses for dredged materials; (5) carefully assess on-going channelization and canal dredging projects until appropriate studies can be

PROBLEM	RECOMMENDATION
	completed and criteria developed to regulate such construction; (6) in dune areas restrict development to density levels and uses which will continue to provide for adequate high quality ground water for vegetation and which will not physically destroy the dune proper; and (7) identify all high value, ecologically sensitive areas, establish criteria for use and development which will prevent their destruction and damage, and implement the necessary controls to assure their protection.
4. An insufficient data base and data organization to assure maximum water quality program effectiveness.	4. Assemble all relevant water quality data for easy review and retrieval, introduce into appropriate data management system, identify data gaps and shortcomings, and initiate or intensify field data collection and monitoring programs. Cooperate with NOAA's Environmental Data Service.

Program Areas: Oceanographic Research

Goal: Identify and provide via a balanced research program the scientific information necessary for the management of the State's marine resources.

	PROBLEMS		RECOMMENDATIONS
1.	Lack of clearly defined needs as determined by the decision-makers and users for basic and applied research has impaired effective management of marine resources.	1.	Criteria for establishing research support priorities should be developed. These priorities should be set on an annual basis taking into account long term planning for the effective management of the State's marine resources.
2.	Inadequate scientific information and in many cases, lack of knowledge by the user and decision-maker of already existing information has impeded the solution of resource management problems.	2.	Scientific areas and geographical locations where data gaps exist should be closely identified and appropriate programs developed to fill these gaps. In addition, the State should ensure that all available data banks and information sources be made readily available to researchers and users.
3.	Lack of knowledge of availability of suitably equipped vessels has retarded planning for the acquisition of required scientific information and has prevented the determination of the existance of a possible vessel shortage.	3.	An inventory of the current annual use of all vessels suitably equipped for various types of research activities should be compiled by some agency that could assist in scheduling available ships in a manner consistent with established priorities for research in North Carolina.

PROBLEMS	RECOMMENDATIONS
4. Inadequate knowledge of current research programs by other investigators and users.	4. A description of research programs, their findings and future plans should be disseminated to the researc community, and appropriat state and federal agencies.

Program Area: Coastal Zone Management

Goal: The overall goal of a coastal zone management program in North Carolina is the establishment of a system that will insure that resources of the coastal zone are used and conserved for the economic and social well being of the people.

PROBLEMS	RECOMMENDATIONS
1. Lack of coordination of the various State and Federal management programs, lack of overall planning, and lack of responsiveness of coastal zone research programs to State needs.	1. A governmental structure for coastal zone management should be responsible for the following functions: (1) continued development of a comprehensive plan for the coastal zone and its subsequent administration, (2) provision for interagency and intergovernmental coordinating arrangements, (3) setting of priorities of the State's most important coastal zone research needs, (4) assured involvement of interested segments of the public.
2. Inadequate information concerning which portions of the coastal zone are most appropriate for existing and future use.	2. Criteria and classification system should be established for land and water use which will delineate various categories ranging from ecologically sensitive areas to those suitable for intensive development.
3. Inadequate funds to buy endangered lands and outdoor recreation sites.	3. Undertake study to determine extent of funds needed; consider alternative means for acquiring lands other than fee simple.

CHAPTER I

INTRODUCTION

The Resource Base

North Carolina, the 12 most populous state, has an abundance of marine resources. These resources include more than 3,375 miles of tidal shoreline, 15,000 square miles of continental shelf, and 4,650 square miles of estuaries. Only a few states have more of these basic marine resources than North Carolina.

The geographic area in which activities relating to marine resources are expected to have a significant impact includes all of eastern North Carolina. This involves 45 counties east of the Fall Line which comprise the area lying within the boundaries of the Coastal Plains Regional Commission. For purposes of this report the coastal zone, which is the area of immediate concern from the standpoint of management, includes the 26 counties which border on the ocean, estuaries, and lower reaches of the major rivers.* The population of this 26 county region in 1970 was 695 thousand.

Estuarine areas in North Carolina include a variety of habitats and biological communities -- salt marshes, oyster reefs, sand or mud bottoms, and intertidal mud flats. Four large river systems -- the Cape Fear, the Neuse, the Tar, Pamlico, and the Roanoke -- empty into the sounds and oceans and form several separate estuarine systems. Fresh water from the rivers mixing

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*These counties include Beaufort, Bertie, Bladen, Brunswick, Camden, Carteret, Chowan, Columbus, Craven, Currituck, Dare, Gates, Halifax, Hertford, Hyde, Jones, Martin, New Hanover, Northampton, Onslow, Pamlico. Pasquotank, Pender, Perquimans, Tyrrell and Washington.

with the water from the ocean results in a continuous gradient of salinity. The wide range of environmental conditions, habitats, and biotic communities represents a rich, natural area for study and development.

Marine related industries represent a significant part of the overall economy of coastal North Carolina. Fishery resources support commercial and sport fishing industries valued at almost $100 million annually. Commercial fishery catches alone averaged more than 207 million pounds annually for the period 1965 - 1971. The coastal area also serves as the primary attraction for a thriving, but seasonal, tourist industry. It provides for waterborne commerce and supports a potentially large mineral/chemical complex. These and other activities indicate the important link between coastal resources and the economy of eastern North Carolina.

II. Basic Concerns

A. Economic Development. Marine resources in eastern North Carolina have been the focus of considerable interest in recent years. One of the basic reasons for this interest in marine resources is the need for economic development in this region of the State. The Coastal Plains Regional Commission was created to help improve the economy of eastern North Carolina, South Carolina, and Georgia. This entire region lags the nation considerably in per capita income and in most other indices of socio-economic development.

The extent of the economic development lag in eastern North Carolina is indicated by a per capita income in 1970 in the Coastal Plains Region which was $1,042 less than in the nation as a whole. This income gap actually

increased between 1962 and 1970. In 1962 the gap was $848. Eastern North Carolina, which includes nearly 2 million people, had an unemployment rate of 4.7 percent in 1969. More serious than unemployment is the quality of employment and the tremendous amount of underemployment in the region.

In seeking ways to generate a high level of economic development, it is only natural that attention should be focused on the unique marine resource base in the region. There is a general concensus that, although these resources are being used to a considerable extent, they are not being used to their full potential. There are exciting prospects for the future development of marine and coastal resources with speculation regarding new products from the sea, a year-round tourist industry, mining, oil and gas production, fish farming, and a much improved fishing and seafood industry.

The enthusiasm at the State level for exploring the development potentials of marine resources is heightened by the interest expressed at the national level. The interest at both the state and national levels for developing these resources is tempered by an equal concern regarding their protection. It is anticipated that the development interest will be enhanced by the purely scientific interest at both levels. Many scientists view marine exploration as a challenge comparable to the exploration of outer space.

Marine research is of great significance to those concerned with economic development. Employment of people to conduct research and investment in research facilities has an immediate economic impact. A more significant impact over the long run is expected to be the products of research. Many of

the important problems in the coastal zone cannot be resolved without the answers that only research can provide.

B. Resource Conservation. Whereas the State and Federal governments want to improve the economic well being of people in eastern North Carolina, it has become increasingly evident that the scarce resources being developed are rightly the concern of people living outside the region. Every person in the State and nation has a stake in how these resources are developed or preserved. The other basic concern with these resources, therefore, has to do with conservation and/or preservation to prevent their destruction.

At the present time the people of the State and nation are concerned about the dredging and filling of estuaries for commercial development. Environmental quality has become a major problem and will become an even greater problem as additional developments take place. Serious attention has to be given to pollution problems to prevent the ultimate destruction of these resources. The impact of construction on the natural processes within the marine environment must be given serious attention. These and many other problems demand that proper attention be given to conservation at the same time ways are being sought to put these resources to more productive use.

III. Structure for Planning and Programming

In order to respond to these basic concerns in a meaningful way, it is evident that a mechanism for planning and coordination of the myriad of activities is essential. A large proportion of the research conducted in the past has been at the micro rather than at the macro level. The big issues associated with such things as conflicts among uses of marine resources have been debated

and regulated without any significant scientific information base.

A. North Carolina Marine Science Council. The Governor of North Carolina in the Fall of 1968 appointed the North Carolina Council on Marine Sciences to begin a process of rationalizing all marine related programs. This Council was endorsed by the following General Assembly and given permanent statutory authority in 1970.

The basic function of the Marine Science Council is to insure effective coordination, planning and programming in all aspects of marine affairs, including helping to insure coordination of new Federal programs into the overall State program. The program elements include everything from basic research to regulatory activities. The Council is also charged with making recommendations to the Governor and the General Assembly for actions needed to maintain a balanced program.

The Council has 21 members at the present time. Membership on the Council includes not only marine scientists and those who are considered experts in the field, but representatives of marine interests inside and outside of government. In other words, it is a combination of experts and citizens working together to insure the most effective utilization and conservation of coastal resources.

In creating the Marine Science Council, the Governor charged it to immediately develop an overall plan for marine resources. Priority attention was to be given to developing a basic program to guide the preparation of a proposal for an institutional Sea Grant. It was also charged to give immediate attention to programs that could be supported by the Coastal Plains Regional

Commission and to planning for marine science facilities in the State to accommodate this program and others.

B. North Carolina State-Federal Planning Committee for Marine Resources. A model State-Federal (NOAA) effort was initiated in early 1972 at the request of the Coastal Plains Regional Commission with participation from the State of North Carolina and the National Oceanic and Atmospheric Administration (NOAA). To accomplish this aim, a North Carolina State-Federal Planning Committee for Marine Resources was appointed to work with the Marine Science Council in preparing a comprehensive plan for marine resource development in North Carolina. A key objective of this committee was to insure that there was an optimal relationship between State and Federal (NOAA) efforts.

The State-Federal Planning Committee is composed of eleven members representing the State and Federal governments and the Coastal Plains Regional Commission. The Governor of North Carolina appointed five members from the State to this committee, the Administrator of the National Oceanographic and Atmospheric Administration appointed four Federal representatives, and the Coastal Plains Regional Commission Federal Co-chairman and Executive Director each appointed one member. This committee has worked very closely with the Marine Science Council which was already in the process of developing a comprehensive marine resource plan.

A specific responsibility of the State-Federal Committee was to insure that a preliminary plan (this document) was prepared. This plan should be adequate to insure the proper utilization of the North Carolina Center for Marine Resources that is scheduled to be constructed with State and Federal monies in 1973. The release of Regional Commission funds for the construction of these

facilities is dependent upon an endorsement of the plan by the State-Federal Committee. This committee has been very effective in bringing about a close working relationship among agencies and organizations within the State and those in the Federal government.

C. Planning Base. Planning involves delineation of goals, analysis of alternative means of achieving these goals, selecting the appropriate alternatives, obtaining a committment of resources consistent with the alternative selected, and other actions necessary to accomplish the goals.

The Marine Science Council and State-Federal Committee in developing this preliminary plan took advantage of decisions made and directions established in the earlier report, North Carolina and the Sea. The general goal which was set forth in that report is as follows:

> "To bring about comprehensive development of all marine resources in North Carolina with careful consideration given to conservation and preservation."

Ten program areas identified in North Carolina and the Sea are reduced in this plan to eight. They are as follows:

1. Minerals and Energy Resources
2. Transportation
3. Recreation and Tourism
4. Commercial Fishing
5. Aquaculture
6. Environmental Quality
7. Oceanographic Research
8. Coastal Zone Managment

Another important carry-over from North Carolina and the Sea is the conceptual plan for a North Carolina Center for Marine Resources. This Center is described in a general manner in the next chapter. Detailed information regarding operation of the Center is found in a separate report.

CHAPTER 2

THE NORTH CAROLINA CENTER FOR MARINE RESOURCES

I. Mission

The primary mission of the proposed North Carolina Center for Marine Resources is to bring about a better interface among all marine oriented programs and to assure that these programs closely relate to the needs of management agencies, marine industries, and other users. The Center, which will be an important element in the State's overall marine program, is viewed as the mechanism or link through which those who generate information will communicate with those who need such information for decision making.

The Center also will provide support for many research projects that need access to the marine environment, equipment or a base of operations. Because the Center will be in close proximity to users through facilities to be located at three different coastal locations, better communication should permit improved response to local and regional needs for research, education and regulatory programs.

Numerous organizations in the State have been working on marine problems for many years. A common problem has been that of packaging and processing available knowledge in a form useful to potential users. Even learning that such knowledge exists has presented problems. A feedback loop from those who use the results of research and trained manpower to those who do the research and training is essential to insure a high degree of relevance. It is intended that the Center for Marine Resources will fill these needs.

II. Regional Programs

Programs of several mission oriented organizations now operating adjacent to the coast, as well as those with facilities further inland, need to be interfaced through the Center. These include programs of the Atlantic Estuarine Fisheries Center of NOAA at Beaufort. Other relevant programs or organizations in the Beaufort area include the Duke Marine Laboratory and the Institute of Marine Sciences operated by the University of North Carolina at Morehead City. Both have large research vessels. Also, the State's Division of Commercial and Sport Fisheries has a laboratory and a 85-foot exploratory fishing vessel operating in this region.

Several significant programs in the Wilmington area are generating materials that would be more useful if they were tied in to a broader program. These include the Cape Fear Technical Institute with an advanced program of training in marine technology. This Institute has a 185-foot training and research vessel which provides support for all institutions in the State. The Wrightsville Beach Biomedical Laboratory is now part of a growing complex of activities associated with the University of North Carolina at Wilmington. Also in the Wilmington area is the F. J. LaQue Laboratory where a large nickel company conducts fundamental studies of the interaction between metals and the marine environment. The Coastal Plains Center for Marine Development Services also in Wilmington, was created in 1969 by the Coastal Plains Regional Commission to serve as a referral center and clearinghouse for scientific and technical information on marine resources and their potential for economic development. The Office of Saline Water

of the Department of Interior has a pilot desalination plant at Wrightsville Beach.

The Pamlico Marine Laboratory, operated by North Carolina State University at Aurora, is investigating the possible effects on estuaries of power plant effluents and phosphate mining. North Carolina State University also has a laboratory at Hatteras while East Carolina University is developing a marine science program at Manteo.

Four universities have marine science programs which relate directly to coastal problems even though their major activity base is further inland. The programs of Duke University at Durham, the University of North Carolina at Chapel Hill, and North Carolina State University at Raleigh have been going on for several years. East Carolina University has recently launched into the marine science field. To date, NOAA's Office of Sea Grant has funded new research and educational activities in the amount of $900 thousand; State has matched this with $450 thousand.

There are other mission oriented facilities and activities which are supportive to the marine resource effort. For example, NOAA's National Weather Service has warning and forecasting stations at a number of locations in the State which provide marine forecasts and other weather products which are useful to the public and to the transportation, fishing, recreation and other industries. These products are disseminated widely and are available to all segments.

III. Center Programs

The Center will include facilities at three coastal locations: Dare County in the northeastern section, Carteret County in the central section, and New Hanover County in the southeastern section. Each facility will be similar in basic functions but will have certain unique features to accommodate the different needs in these specific locations. Even though three facilities are planned, the Center will operate as one unit. It will be administered by one board to insure effective coordination among geographically different programs. The administrative board is to be comprised mainly of representatives of institutions that are expected to be the principal users of the facilities.

The overall program of the Center will include several related but distinctly different components:

1. Public Education - This program component will concentrate on children in the public schools and adults who desire to know more about the marine environment. Teaching aids will include small aquaria and dry exhibits. Short courses and conferences will be emphasized.

2. Extension Education - A continuous program of extension education will be conducted. The Center will serve as the major focal point for all marine oriented extension programs within the State. The programs will be comprehensive and serve as the principal means of relating research to action. Extension education will relate the more basic research conducted by universities and other research agencies to applied research.

3. Research - Part of each facility will be available for short-term research needs to be conducted on location or nearby. When a specific project is concluded, the space will be used to accommodate others who need it. The facilities will be available to all institutions in the State or even those outside the State if the research is relevant to North Carolina needs.

4. Management and Regulatory - There are several marine management programs operating in the coastal area. The facility will accommodate some of the more broadly based programs.

IV. Center Operation

The Center will operate as a supportive facility for all institutions, agencies and interests within the State. The administrative board comprised of representatives of user agencies and organizations and several members at large will be the principal administrative body to assure effective operation.

The Department of Administration will be responsible for employing a core staff for general housekeeping and administrative services. This staff would serve under the general guidance of the administrative board. It is expected that the Center would also have a small managerial staff to include an overall administrator with an associate administrator in each of the three facilities. The Managerial staff would be responsible for maintaining public education programs in each of the facilities. The director or his associate would work closely with tenants or potential tenants and the administrative board. Also, the managerial personnel would be expected to develop budgets and to insure balanced and functioning programs.

The research, extension, and other operational programs to be accommodated in the Center are expected to be funded from regular sources, not from the Center's fund. The Center would receive base support from the State. Detailed information regarding operation of the Center is found in a separate report.

CHAPTER 3

MINERAL AND ENERGY RESOURCES*

I. Introduction

Mineral and energy resources and related mineral-chemical industries are presently having limited impact on the economic development of the North Carolina coastal zone. This is due, in part, to need and demand factors, and in part, to the paucity of data regarding the occurrence and distribution of potential mineral and energy resources in the coastal zone.

By exercising sound judgement and the proper allocation of available financial resources, the State is in a position to develop an operational plan that will provide optimum utilization and minimal environmental degradation.

II. Goals

The goal is to promote the development of the mineral and energy resources of the North Carolina Coastal Zone for the maximum benefit of the State and the Nation in a manner compatible with the environment and with other uses.

III. Current Status

In 1971, the mineral industry of North Carolina contributed $112.5 million to the State's economy, establishing a record production.

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*Throughout this report, except where specifically noted, the term "Mineral" will be used to include energy resources (fuels) as well as hard minerals. Although ground water is not generally considered to be a mineral resource, a brief discussion on this subject is included in this chapter.

Stone was the leading mineral commodity produced, contributing 52 percent of the total mineral production value, followed by sand and gravel, which accounted for 13 percent. Cement, clays, feldspar, lithium minerals, and phosphate rock were also produced. Together, they accounted for 31 percent of the State's 1971 mineral production. The remaining four percent was derived from the production of asbestos, fire clay, gem stones, iron ore, kaolin, mica, olivine, talc and pyrophyllite, tungsten, and small quantities of gold, silver, copper, lead and zinc produced as a by-product of tungsten recovery. There was no production of mineral fuels in North Carolina during 1971.1/

Although limited to relatively few operations, mineral production from the Coastal Plain area accounted for about 20 percent of the mineral production of the State during 1971. A phosphate rock operation in Beaufort County and a cement plant located in New Hanover County, plus seven or eight sand, gravel, and crushed stone operations constituted the extent of mineral activity in this area. None of these resources are currently being mined from coastal waters. However, geophysical and geological surveys made to date indicate that the mineral resources of the coastal zone could become a valuable component of the coastal economy.

In the coastal zone, surficial Pleistocene-to-Recent sand and clays, largely unconsolidated, overlie older Cenozoic sediments. In addition, extensive Miocene phosphate deposits in Beaufort County and limestone from an Ecocene formation are mined in Craven, Jones, and Pender Counties and sands and gravels are utilized locally throughout the region.2/

The geology of North Carolina is of sufficient interest to have attracted a number of exploratory oil and gas ventures since 1925. At least 105 exploratory wells have been drilled by various companies in the area between the fall line and the coast, although none have revealed the presence of hydrocarbons in quantities of commercial significance. It is of interest to note, however, that Cities Service Oil Company holds an oil and gas lease on about 2.4 million acres of State-owned submerged lands underlying a major portion of Pamlico, Albemarle, and adjacent sounds. This company is presently engaged in a geophysical and drilling program to evaluate the petroleum potential of this area of the State. Terms of the lease agreement require 12,000 feet of exploratory drilling during each two-year renewal period.

Colonial Oil and Gas Company holds a lease on all of the remaining State-owned submerged lands (approximately 400,000 acres) and is currently sponsoring a drilling program in Carteret County designed to accomplish their biennial drilling requirement of 20,000 feet. These activities represent the only current exploration programs involving the State's marine minerals resources by private industry.

As a result of the "energy crisis" facing the United States, considerable interest is developing in possible petroleum deposits on the Atlantic Continental Shelf. A review of a report by the U. S. Geological Survey entitled, "Geologic Framework and Petroleum Potential of the Atlantic Coastal Plain and Continental Shelf," by John C. Maher, 1971, contains several references concerning offshore North Carolina which are quoted as follows:

"The continental shelf offers more promise as a potential petroleum province than the Coastal Plain because it has a thicker sedimentary column with better source beds and trapping possibilities."

"In discussing structural factors related to petroleum possibilities, Johnston, Trumbull, and Eaton (1959), gave favorable mention to the Cape Fear arch and its seaward extension..."

"Somewhat earlier, a brackish ground-water anomaly on the Cape Fear arch, a few miles inland from Wilmington, North Carolina, had been cited by LeGrand (1955) as deserving attention, 'if oil - prospecting becomes more active on the Atlantic Coast'."

"More recently, Emergy (1965) has stated that suitable petroleum-bearing structures may be associated with the seaward extension of the Cape Fear arch..."

"All the published suggestions for areas in which to conduct exploration operations for petroleum seem to have merit. However, the Bahama platform, the seaward extension of Cape Fear arch, the long basement ridge at the edge of the continental shelf off New England, and the Southeast Georgia embayment appear to this writer to be the areas most favorable for initial operations in waters controlled by the United States."

In anticipation of increasing petroleum exploration activities and the possibility of commercial discoveries, the 1971 North Carolina General Assembly amended the Oil and Gas Conservation Act of 1945 to make Part II of the Act effective as of July 1, 1971. Part II of the Act provides for the creation of a Petroleum Division to administer the Act and provides broad authority to control exploration, development and production activities. This Division was created and consists of the Director of the Department of Conservation, the State Geologist, and three members from the State Board of Conservation and Development appointed by the Governor.

With respect to other minerals in the coastal area, concentrations of ilmenite, an iron titanium mineral, occur in some localities near the coast and appear to have commercial possibilities. Also, oyster shell con-

centrations in some estuarine areas may have commercial possibilities.

IV. Current Programs

A. Academic Programs

A review of the workshop report on Marine Activities of the Coastal Plains Region, Southeastern United States, December 7-9, 1971, sponsored by the Coastal Plains Center for Marine Development Services reveals the following research presently being conducted:

1. University of North Carolina, Chapel Hill:

> "Marine oriented research projects presently being conducted by marine science curriculum faculty include the following with the indicated sources of support:
>
> > Investigation of potential oil and gas bearing rocks; Joel S. Watkins, from North Carolina Board of Science and Technology."

2. East Carolina University:

> "Orientation and emphasis of the new (1967) Geology Department is towards coastal processes and environments. Four years ago, Drs. Riggs and O'Conner initiated an intensive research program in the North Carolina coastal area around Roanoke Island. Their studies are currently a part of the North Carolina Sea Grant program and include:
>
> > An inventory of the potentially economic mineral resources of the coastal region."
>
> "Thus far, the study has revealed that the sub-bottom stratigraphy is very complex, both in composition and lateral continuity, and that deposits of gravel, shell and clay are much more common and extensive than the surface sediment distribution suggests. It appears likely that economic deposits of some of these constituents do exist within the area. One such deposit of gravel was discovered in Croatan Sound and considered for development, but subsequent investigations proved it to be uneconomic."

3. University of Wisconsin:

Under a Sea Grant Program, the University of Wisconsin is currently conducting a study entitled, "Exploration for High Energy Marine Placer Sites." Part I of the report, prepared by Craig H. Everts, (March 1972), deals with field and flume tests in North Carolina. In the forward to the report, J. Robert Moore, Professor, Minerals Program, Sea Grant Office, University of Wisconsin, makes the following statement:

"Basic to developing exploration guides for use in searching for marine placers is the need to understand the processes related to placer genesis. Thus, early in the University of Wisconsin's Sea Grant Minerals Program, we initiated investigations on the lower specific gravity heavy minerals and subsequently, tests on the intermediate high density mineral types of economic interest, but at other field localities.

"I chose the Oregon Inlet complex on the shore of North Carolina as our low density test site because the area is in a known heavy mineral province (black sands are mined farther south); the waves, currents and deposits could be studied and field measurements made using small craft; and, of importance to industry, this area is much like other high energy placer sites that several commercial groups are soon to explore elsewhere.

"Dr. Everts extended the study to include a rigorous flame investigation of sample material he collected at the field stations, which adds considerable evidence to the interpretations and conclusions. He assumed a major lead in this approach. Together, we have reviewed the data, and as supervisor of his research, I share with Dr. Everts the responsibility for the somewhat tenuous nature of several of the conclusions. Nevertheless, we believe that the summary of our findings (pages 165-170) provides several useful clues for locating economic placers in similar coastal marine environments. Furthermore, we view much

NOTE: Underscoring by the State/Federal Planning Committee.

of the technical detail reported herein as necessary to any applied placer research program, and in this regard, the reported results will help avoid industrial redundancy.

"Part II of this study -- a joint report by Drs. Moore and Everts on the gold, titanium and zirconium distribution in the study area, including sedimentary and environmental relationships -- is currently in preparation."

B. U. S. Geological Survey (Department of the Interior)

From 1961 to the present time, 16 permits have been issued by the Department of the Interior for offshore geophysical exploration on the Outer Continental Shelf which involved locations off North Carolina as part of an overall survey covering areas off several states. In 1968 and 1971, two of the permits involved groups of companies which included many of the major oil companies.

For the last six years, the U. S. Geological Survey has had a contract with Duke University to investigate the character and distribution of off-shore sediments and bedrock. The R/V Eastward, an oceanographic research vessel operated by Duke University has been used for this work. A one-degree grid geological map on a scale of 1:250,000 has been prepared for the Cape Lookout area. Present plans call for extending the area south. The U. S. Geological Survey is also engaged in a detailed regional study of the framework of the Atlantic Continental Shelf from Cape Hatteras to Georges Bank.

A comprehensive study on the structural and stratigraphic framework and spacial distribution of permeability in the Atlantic Coastal Plains from North Carolina to New York will be published by the U. S. Geological Survey as Professional Papers 795 and 796.

Anticipated publication date for these reports is December, 1972.

Recently an offshore drilling committee of State geologists has been formed which will afford a means by which the State will be kept informed of the work of the U. S. Geological Survey. North Carolina is represented on this committee.

C. National Ocean Survey (NOAA)

The National Ocean Survey (NOS) has conducted extensive work in the coastal areas of North Carolina. The hydrographic accomplishments for the period before 1969 are completely indexed in "An Environmental Inventory for Coastal Plain and Adjacent Waters of the Southeastern States," Pub. 726, June 1972, Part III, pages 7 through 39 by the Coastal Plains Center for Marine Development Services.

In addition, of importance, to the identification of mineral resources is the following work that has been performed since 1969 and is planned for FY 73-74:

1. Bathymetric mapping to nautical charting specifications from Cape Fear to Cape Hatteras and from about 10 miles offshore to the 100-fathom curve.
2. Bathymetric mapping to nautical charting specifications from 35° 30' N to 36° 10' and 75°W to about three miles offshore.
3. Geophysical mapping at five-mile spacing, including gravity, magnetics, and bathymetry, and at greater spacing for seis-

mic-reflection-profiles (SRP), from 74° 34' W to about 10 miles offshore and from 36° N to the North Carolina/ Virginia stateline.

4. Bathymetric mapping to nautical charting specifications from 35° to 30° 10' N and from 74° 25' W to 75° W.

5. FY 1973 - 74: Inshore hydrographic surveys from Cape Fear to Cape Hatteras from shore to about 10 miles out.

6. FY 1973 - 74: Offshore geophysical surveys from about 35° N to the latitude of Cape Fear. The eastern limit will be the limit of the scheduled bathymetric and other geophysical maps. These surveys will be at five-mile spacing with gravity, bathymetry, magnetics and at greater spacing for SRP (20 - 25 miles). This effort is in response to requirements for marine geophysical data for environmental studies, pollution transport effects, resource identification, engineering, scientific and coastal zone planning purposes. The information will be produced at a scale of 1:250,000 and will consist of bathymetric base maps, overprints of magnetic and gravity data, magnetic tapes, data lists, and data reports. The reports will contain seismic data, as well as analyses of the geophysics from the standpoint of scientific significance and application.

7. Bottom characteristics have been sampled in conjunction with hydrographic operations. In 1969 special bottom samples were collected for the North Carolina State Geologist.

D. Ground Water Programs

Under the Water Use Act of 1967, a Capacity Use Area has been established covering Beaufort and all or parts of seven other surrounding counties. This action allows the North Carolina Board of Water and Air Resources in the Department of Natural and Economic Resources to control the withdrawal and use of ground water from the area. Recognizing the need for obtaining information vital to ground water resource evaluation, the Board of Water and Air Resources has directed the Ground Water Division to conduct capacity-use studies in 13 areas covering the entire State.

The first four study areas which have the highest state priority, includes all of the North Carolina Coastal Plains. These studies will include test drilling and well construction for the purpose of testing, evaluating, and monitoring each major aquifer in the area. Further refinement of data and development of resource management plans will be conducted on a continuing basis.

E. U. S. Army Corps of Engineers

The U. S. Army Corps of Engineers has compiled extensive data on shoaling rates and compositions of shoaling materials associated with dredging activities required to maintain the Federal

navigation harbors and channels in Eastern North Carolina. Additional mineral data is currently being gathered for water resources studies and environmental impact statements being prepared for federally authorized projects in the coastal area.

V. Problems

1. Inventory and Evaluation

A comprehensive inventory of the mineral and energy resources is needed for resource planning and commercial development in the coastal zone. We must know what we have in the way of potential mineral resources, where they are, and how extensive they are before we can plan optimal marine resources development. Such preinvestment surveys are expensive and involved, but are necessary for the wise utilization of the coastal zone.

At the present time there is no systematic, coordinated approach to an evaluation of the mineral resources in the North Carolina coastal zone. Independent investigations are being conducted by Duke University and the U. S. Geological Survey and are being supported by Sea Grant at East Carolina University and the University of North Carolina, Chapel Hill. In addition, there is a University of Wisconsin Sea Grant project which centers around Oregon Inlet. However, this latter project is primarily one of basic research dealing with the movement of sediment and might well have been performed in another state if the project investigators had chosen to do so.

2. Ownership of Mineral Resource Rights

This is a continuing problem between the Atlantic Coastal States and the Federal government, the State and local governments, and private citizens. The State and Federal governments dispute is now before the U. S. Supreme Court for adjudication. The State and local governments and private citizen disputes seem to be covered by a 1967 State Law; however, there is an inadequate staff for processing claims.

3. Environmental Impact

There is a lack of adequate information to evaluate the environmental impact of present and future development of mineral resources to meet the growing public concern for the quality of the environment.

4. Ground Water

There is a lack of information to properly manage ground water resources. Although ground water may not generally be considered or defined as a mineral resource, it is a fundamental resource that will ultimately determine the amount and character of development within a given coastal area. The intensive and extensive development of ground and surface water during recent years has created ground water problems in many areas of the State, emphasizing the need for a program of overall surface and ground water use management.

5. Market Possibilities

Lack of information on the market possibilities for some of the

coastal zone "non-glamour" mineral resources such as gravel, shell aggregate, clay and heavy minerals definitely limits the potential of developing these resources.

VI. Recommendations

A. An appropriate State agency working in cooperation with the U. S. Geological Survey should be designated for developing an inventory of mineral resources of the coastal zone through a compilation and assessment of existing data available from State, Federal and commercial sources.*

Such an effort should include the following tasks:

1. Compilation of a complete coastal zone minerals inventory based upon presently available information and knowledge.
2. Initiation of reconnaissance surveys to fill in the blank spots in the resource inventory in cooperation with the National Ocean Survey in NOAA, the U. S. Geological Survey in the Department of the Interior, the U. S. Army Corps of Engineers and North Carolina universities.
3. Preparation and issuance of a series of resource maps which would include such parameters as substrate, soils, land forms, occurrence and distribution of sediment types, geophysical characteristics, oyster reefs, water resources and geologic structures, etc.

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*This agency should have data processing, storage/retrieval capabilities to permit updating of information and dissemination of material, and facilitate graphic displays on standard base maps.

4. Cooperative development of a set of uniform scale base maps acceptable for use by State, Federal and university activities as a standard to be used by researchers and others to present data.

B. A uniform policy for the allocation of State mineral resources should be developed in order to verify ownership by the State and private sector. An appropriate State agency should be responsible for developing large scale maps for depicting ownership.

C. The State, in cooperation with the academic and Federal government sectors, should develop a comprehensive plan for dealing with the environmental impact of present and future development of mineral resources. An appropriate State agency should be responsible for developing the data base upon which rational decisions can be made.

D. Accelerate the ground water resource studies presently being conducted by the State.

E. Studies should be undertaken to evaluate, identify and promote potential markets for North Carolina coastal zone mineral resources.

REFERENCES

1. The Mineral Industry of North Carolina in 1971; Mineral Industry Surveys, U. S. Department of the Interior, Bureau of Mines, Washington, D. C.

2. Stuckey, Jasper L., 1965, North Carolina: Its Geology and Mineral Resources, N. C. Department of Conservation and Development, Raleigh, North Carolina, 550 pp.

Program Area: Minerals and Energy Resources

Goal : To promote the development of the mineral and energy resources of the North Carolina Coastal Zone for the maximum benefit of the State and Nation in a manner compatible with the environment and other uses.

PROBLEM	RECOMMENDATION
1. Lack of an adequate comprehensive inventory of the mineral and energy resources which is needed for research planning and commercial development in the coastal zone.	1. An appropriate State agency should be responsible for developing a coordinated inventory of mineral resources of the coastal zone through a compilation and assessment of existing data from State, Federal and commercial sources.
2. Lack of verification and appropriate policies for ownership of mineral resources by State and private sectors.	2. Develop a policy for allocation of State mineral resources in order to verify ownership. An appropriate State agency should be responsible for developing large scale maps depicting ownership.
3. Lack of an adequate method to evaluate the envrionmental impact of present and future development of mineral resources to meet growing public concern for the quality of the environment.	3. The State, in cooperation with academic and Federal government sectors, should develop a coordinated procedure for evaluating the environmental impact of present and future development of mineral resources. An appropriate State agency should be responsible for developing the data base upon which rational decisions can be made.

Minerals and Energy Resources (Con't.)

	PROBLEM		RECOMMENDATION
4.	Lack of information to properly manage ground water resources.	4.	Accelerate the ground water resource studies presently being conducted by the State.
5.	Lack of information on the market possibilities for coastal zone mineral resources.	5.	Studies should be undertaken to evaluate, identify and promote potential markets for coastal zone mineral resources.

CHAPTER 4

TRANSPORTATION

I. Introduction

Transportation and the sea have always been linked. The ease and economy of transportation by water have traditionally made the margin between land and sea a focus of commerce. That focus has been a stimulus to economic development so that earliest complex urban centers were associated with transportation and the sea.

In the more recent past, other transportation modes - railways, highways (including motor freight and passenger), airways and airports, pipelines, and multi-modal terminal and interchange facilities - also have had strong developmental influences. In fact, the pervasiveness of transportation in the day-to-day activities of North Carolinians necessitates investigation of the relationship of industry plans, research, programs, and projects to coastal development policy.

II. Goal

The overall transportation goal in North Carolina is to facilitate the transfer of people and goods so as to improve with minimal environmental impact the economic and social well being of the people.

III. Current Status

The newly created Department of Transportation and Highway Safety is the principal state agency concerned with transportation in North Carolina. Included at present within the department are the State Ports

Authority, the State Highway Commission, the Governor's Committee on Aviation, the Motor Vehicle Department, the Governor's Highway Safety Program, and several other minor transportation agencies.

A. Water Related Transportation

The Coastal Plains Region is endowed with deep water harbors and shallow-draft inland waterways whose ports provide a strong stimulus to the economy of the entire State. In 1970, seven rivers were utilized to handle 2.78 million tons of cargo; the Intracoastal Waterway, 2.95 million tons; and the five major harbors, 7.78 million tons. Thus, the rivers and Intracoastal Waterway accounted for about 20% each of the total water cargo carried, while about 60% of the total tonnage was handled through the harbors.

Waterborne passenger carriage in North Carolina, while virtually insignificant relative to total transportation movement, nonetheless played an important role in the tourism and recreation industries. In recent years (since completion of the bridge over Bogue Sound), ferry passenger volumes have averaged about one million per year (plus 275,000 vehicles), while 75,000 and 125,000 passengers (primarily sport fishermen on party boats) have utilized the waterways and harbor systems, respectively.

Five ports and harbors serve the shipping needs of the State. Three of these - Beaufort, Edenton, and Manteo Bay - are small, while Morehead City and Wilmington serve as the State's major ports. The following table shows total cargo movements at these ports for recent years.

TONS OF CARGO HANDLED (000)

	1960	1968	1969	1970
Beaufort	85	52	41	45
Edenton	50	117	89	Not available
Manteo Bay	21	41	38	49
Morehead City	679	984	1,241	1,364
Wilmington	5,168	5,001	4,971	6,317

Wilmington and Morehead City complement each other in the movement of waterborne cargo, and vigorously compete for certain types of goods with other Atlantic Seaboard ports. Since much of future general cargo is expected to move in containerized shipments, concern over North Carolina's competitive position relative to ports outside the State may be justifiable. (It is notable that regularly scheduled container service between Wilmington and Western Europe was initiated in February 1972.) Supplementing containerization, however, are recent demonstrated increases in break-bulk and unitized cargo operations at both ports.

The Wilmington harbor has a total of 43 wharves, piers, and docks, ranging in depth from 17 to 40 feet and having combined public and private berthing space of about 20,000 linear feet. Thirty-two are on the Cape Fear River and the remaining are on the Northeast (Cape Fear) River along the ship channel. The State Ports Authority at the Port of Wilmington can work 9 vessels simultaneously at its dray-cargo wharf of 6,000 feet. The depth alongside this wharf is 32-36 feet and the channel has been deepened to 38 feet. The State Ports Authority terminal handles general cargo in its dry-

storage, cold-storage, and open-storage areas. The remaining private terminals at the port handle petroleum products, liquid chemicals, iron and chrome ores, bulk fertilizer, fishmeal, pumice, and bulk building cement.

The Morehead City harbor has a total of 24 wharves, piers, and docks, with depths of about 35 feet, and a combined public and private berthing space of 12,080 linear feet. The State Ports Authority at Morehead City includes 1200 feet of barge dock and 4,850 feet of marginal wharves capable of berthing six cargo ships and one petroleum tanker. The State Ports Authority handles general cargo and petroleum products, while private terminals handle petroleum and asphalt products and liquid fertilizers.

The region's inland waterways provide a means for tying the commerce and economy of coastal cities to the interior of North Carolina. However, waterway traffic is narrowly specialized, consisting primarily of those bulk products that can be moved in mass quantities at slow speeds and at correspondingly low unit costs. There are several rivers which serve as major highways for inland water transportation in North Carolina east of the I-95 highway, as shown in the tables on the following pages. Nine of the twelve major cities with populations over 10,000 in the Coastal Region are served or are capable of being served by some form of waterborne shipping.

Under the Executive Organization Act of 1971, the State Ports Authority was transferred to the North Carolina Department of Transportation and Highway Safety. It is currently being proposed that a newly created Office of Ports

and Waterways within that Department will take on broadened marine transportation interests to include all navigable waterways and any other marine transport functions. (These functions will be separate and apart from the water quality responsibilities now housed in the Office of Water and Air Resources, Department of Natural and Economic Resources.) In view of the newness of the Department of Transportation and Highway Safety, areas of responsibility within the Department are not yet well-defined. However, legislation is being prepared for presentation to the 1973 General Assembly which will outline the recommended functional relationships for all elements of the Department.

TONS OF CARGO HAULED (000)

Navigable Rivers (Major)	1960	1968	1969	1970
Cape Fear-Above Wilmington	363	265	219	354
Cape Fear, Northeast	1	250	405	484
Chowan	116	164	134	164
Neuse	276	406	369	488
New	NA	125	130	85
Pamlico and Tar	60	567	673	718
Roanoke	419	522	521	485
Total Rivers	1,235	2,300	2,451	2,778

Intracoastal Waterway	1960	1968	1969	1970
Total (Virginia to S. C.)	1,891	2,752	2,778	2,948

TON MILES OF CARGO (000)

Navigable Rivers (Major)	1960	1968	1969	1970	Length in Miles
Cape Fear-Above Wilmington	27,335	18,464	14,747	22,971	115
Cape Fear, Northeast	28	4,423	5,559	7,826	27
Chowan	4,389	6,529	5,207	6,456	51
Neuse	2,757	13,810	9,764	13,253	43
New	-	-	-	-	21
Pamlico and Tar	835	14,514	17,351	18,588	38
Roanoke	8,587	11,367	11,717	13,253	79
Total Rivers	43,931	69,107	64,345	82,347	374

Intracoastal Waterway	1960	1968	1969	1970	Length in Miles
Total (Virginia to S. C.)	343,117	338,268	314,519	345,942	313

The State Ports Authority has the power to acquire, construct, equip, maintain, develop, and improve the harbor or seaports at Wilmington, Morehead City, and such other places as may be deemed feasible for a more expeditious and efficient handling of waterborne commerce within North Carolina and between North Carolina and other states and foreign countries. This includes the authority to rent, lease, buy, own, acquire, mortgage, and dispose of any property as may be deemed feasible for carrying out the broad objective of the State Ports Authority - namely, to develop to the utmost the port possibilities of the State of North Carolina.

The major North Carolina ports have initiated technological improvements in cargo handling and accommodations for the newer types of ships. For example, roll-on/roll-off facilities are in the design stages at both Morehead City and Wilmington. In addition, Wilmington presently handles LASH (Lighter Barges Aboard Ship), and is capable of servicing these barges as well as the mother ship. Morehead City has the capability of handling LASH, but does not presently do so. The State Ports Authority has been opposed to developing facilities for handling the new supertankers at State ports or at adjacent locations off the shore of North Carolina.

The State Ports Authority recently acquired property at Wanchese, with future plans of developing this area into a specialized fishing trawler harbor with fish processing and packaging facilities. The Authority also operates a marina at Southport, primarily for sport fishing and other recreational purposes.

B. Other Transportation

Eleven railroad companies operate in the Coastal Region, of which three - Seaboard Coast Line, Southern, and Norfolk Southern - are Class I railroads (annual revenues over $5,000,000). In addition, three of the eight major rail terminal areas and classification yards in the State (Morehead City, Wilmington, and Edenton) are found in the coastal area. Railroad freight service is available in all cities of at least 10,000 population as well as in many smaller towns. However, there are large geographic areas where no rail freight service is available at all.

Only Amtrak, the National Rail Passenger Service, carries passengers, and then only along a north-south corridor at the extreme western portion of the Coastal Region. Daily stops are made at Rocky Mount and Fayetteville with a conditional stop at Wilson. No east-west passenger service is available.

The highway network within the Coastal Plains Region is quite extensive. However, the problem is one of quality rather than quantity. For example, a very small percentage of the non-Interstate highway system in the Coastal Region is four-lane, while the remaining two-lane highways which predominate in the area are generally narrow highways with only fair alignment. With the exception of Interstate 95, no intercity freeways exist. For the future, two high-level primary highways are proposed to connect both Wilmington and Morehead City to major cities and other Interstate thoroughfares in the Piedmont Plateau. Several other U. S. highways are undergoing or are scheduled to undergo controlled access four-lane improvements.

Scheduled bus service is available from a number of communities within the Coastal Region. Travel time between communities is comparable with the automobile where non-stop service is provided, but most bus timetables indicate stops at many of the smaller communities en route. Bus service is used primarily for short trips, especially by military personnel traveling between a base and a nearby commercial airport or an adjacent community. North Carolina has nine major bus terminal areas where a significant number of passengers and goods are interchanged. Only one of these (New Bern) is in the Coastal Region.

Five major truck terminal areas are located within the Coastal Region - Rocky Mount, Wilson, Goldsboro, Fayetteville and Wilmington. Many trucking franchises exist in the smaller urban areas of the region, but service is rather infrequent due to a lack of demonstrated demand.

There are approximately forty-five significant airports in the Coastal Region ranging in size from small general aviation airfields with unpaved runways to commercial airfields capable of handling jet aircraft. A scheduled airline provides service at six airports (cities): Fayetteville, Goldsboro, Kinston, New Bern, Rocky Mount, and Wilmington. The Fayetteville Airport, which ranks fifth largest in the State in the number of operations, has both the greatest aircraft activity and the largest number of enplaned passengers of any airfield in the Coastal Region. There is very little passenger interchange between cities within the region, and service to and from the region on either east-west or north-south routes is poor.

Pipelines have become significant for the long distance transport of natural gas. In the Coastal Region all cities with a population of 10,000 or more, except Elizabeth City, have gas service. However, four counties - Camden, Currituck, Tyrrell and Dare - have no service at all. Natural gas lines terminate at Wilmington, New Bern, and Washington; lines have been recently proposed for extension to Williamston and Elizabeth City. The only petroleum product pipeline serving the region enters from Apex near Raleigh with one branch ending at Selma and the other at Fayetteville.

Two major multimode facilities exist in the State; these are at the ports of Wilmington and Morehead City. Railcars, trucks, barges, and ships interchange freight at both locations. In addition, Wilmington has a major truck-train piggyback operation. Two other cities in the Coastal Region, Fayetteville and Edenton, have certain multimode terminal facilities but do not have the complete range of facilities needed to accommodate complete intermodal transfer of goods and passengers.

IV. Current Problems

The following problem areas are considered to be the most significant relating to transportation in the Coastal Region.

A. Water-Related Transportation

1. There is a conflict between the necessity for continuing channel (river, harbor, inlet) maintenance and the environmental impact resulting from the dredging operations and disposal of dredged material. Uncertainties still exist at the State level over the interpretation of the National Environmental Policy Act, resulting in the possibility that maintenance dredging may be interrupted and delayed with serious loss in jobs and excessive financial losses to the industry.

2. No acceptable policy exists for the establishment of regional harbors or for the selection of barrier island inlets to be stabilized in connection therewith, including the choice of proper inlet configuration. The U. S. Army Corps of Engineers has received little guidance from State or regional sources concerning which inlets (out of 23 candidates) might have the highest priority.

3. There is an unknown economic impact upon the North Carolina ports by the possible construction of offshore, deep-water terminals on the East and Gulf Coasts. At present, studies are being conducted at the national and regional levels to determine the economic and technical feasibility of constructing deep-water multipurpose terminals on the East and Gulf Coasts to accommodate the required drafts of supertankers and very large solid-bulk carriers. It is anticipated that if such port facilities are constructed, the resultant changes in the nature and pattern of traffic will have some impact on the economics of North Carolina ports. The extent of this impact is unknown.

B. Other Transportation

1. The Coastal Region of the State lacks highway facilities of Interstate quality:

a. For services

(1) To move goods from ports to the Piedmont and Midwest United States, especially important because of increased national emphasis on containerized cargo shipments

(2) To provide easy, safe, and rapid access to the North Carolina coast for recreation and tourism

b. For economic growth of the region. (It is recognized that highway construction is a necessary, through not a sufficient, growth stimulant; it is only one of many factors which influence economic development.)

An inherent conflict exists between the need for additional highways and thoroughfares to accommodate seasonal tourist and recreational interests and the possible over-development and detrimental effects brought about by the increased use of the area, possibly leading to the destruction of coastal resources.

2. Commercial air service is extremely fragmented and widely dispersed among several coastal airports, resulting in

a. Poor east-west connections and

b. Almost no north-south connections intra-state or otherwise.

3. The Coastal Region suffers from not having a coordinated state planning effort directed to transportation matters. Development of State policy and issuance of a basic set of guidelines is the first need. Also of importance is the lack of sufficient and current planning base data for all modes of transportation. Other matters which urgently need to be given thorough examination include:

a. Rural and urban mass transportation

b. Problems of port development relating to labor, use laws, inventory taxes, etc.

c. Rail passenger and freight service

d. Rail and motor carrier rates and regulations

e. Oil spills, waste disposal from ships, and other pollution problems

f. Product pipeline service

g. Consolidation of transfer points (terminals).

V. Recommendations

The following recommendations apply to the specific problem areas mentioned in the preceeding section.

A. Water-Related Transportation

1. It is recommended that a State policy be adopted in coordination with Federal, State, regional and local interests, concerning all future maintenance operations of navigable waters. It is suggested that legislative action is needed to better define responsibilities and legal requirements for both environmental protection and continuation of activities vital to the State's economy. Specifically, we should assure that the study by the U. S. Army Corps of Engineers on the environmental impact of maintenance dredging be completed on time (now scheduled for December 1973). Until that time maintenance dredging on navigational projects essential to North Carolina should not be terminated or delayed, provided the established coordination procedures for selecting disposal areas have been followed.

2. The State and appropriate regional agencies must prepare a re-vitalized plan enumerating priority ranking for the inlet stabilization program. (The Commercial Fishing chapter also addresses this subject.)

3. The State should initiate a comprehensive evaluation of the economic impact on North Carolina of the creation of super-ports at likely points on the Atlantic and Gulf Coasts.

B. Other Transportation

1. In support of the Statewide Development Policy concerning a jobs-people-services balance and the encouragement of economic development in the coastal region, it is recommended that highway construction - specifically four-lane, limited access facilities - be given a place of top priority in the highway program and that existing construction programs on routes such as US-70, US-17, and US-74, as well as the proposed corridor from Raleigh to Wilmington be accelerated by all possible means. In addition, it is recommended that a careful and thorough study be prepared on tourism and recreational access, addressing particular attention to detrimental use trade-offs.

2. Concerning air service, it is recommended that Coastal Region interests provide substantial input to the North Carolina State Airport System planning effort just underway, and that ultimately the State be brought to task to improve commercial air access to the region.

3. A high-level, responsive, multimodal transportation planning effort should be established in the North Carolina Department of Transportation and Highway Safety, and this

planning function should be charged with the responsibility for coordination of transportation development in the Coastal Region.

Program Area: Transportation

Goal : To facilitate the transfer of people and freight so as to improve with minimal environmental impact the economic and social well being of the people. In carrying out these programs, the principal modes of transportation - air, highways, rail, and water - should be coordinated to the maximum extent possible.

PROBLEMS	RECOMMENDATIONS
1. The conflict between the necessity to maintain channels by dredging and the environmental impact of dredging operations.	1. Develop a state policy in coordination with federal, regional, and local interests that will better define responsibilities and legal requirements for both environmental protection and continuation of maintenance dredging vital to the State's economy.
2. Inadequate policy for the selection of barrier island inlets to be stabilized.	2. Prepare a re-vitalized plan enumerating priority ranking for the inlet stabilization program.
3. The unknown economic impact upon the North Carolina ports by the possible construction of off-shore deep-water terminals on the East and Gulf Coasts.	3. The State should initiate a comprehensive evaluation of the economic impact on North Carolina of the creation of super-ports in locations outside of the State.
4. The lack of highway facilities of Interstate quality for service and for economic growth of the region.	4. Certain existing highway construction programs in the Coastal Region should be accelerated by all possible means. In addition, a thorough study is recommended to relate highway access problems in the Coastal Region with plans for developmental, recreational, conservational, and other uses of the region.

Transportation (Con't.)

PROBLEMS	RECOMMENDATIONS
5. Inadequate air service in the Coastal zone.	5. Encourage responsible Coastal area agencies to provide substantial input to the North Carolina State Airport System planning effort just underway.
6. Lack of a coordinated state planning effort directed to transportation matters in the Coastal Region.	6. A high-level multimodal transportation planning effort should be established in the North Carolina Department of Transportation and Highway Safety, and this planning function should be charged with the responsibility for coordination of Coastal Region transportation development.

CHAPTER 5

RECREATION AND TOURISM

I. Introduction

The coastal area of North Carolina contains more than 3375 miles of unique and beautiful tidal shoreline, 3 million acres of water in numerous bays and sounds, and an excellent climate. These factors combine to provide the potential for a wide variety of coastal recreational opportunities sought by people.

Coastal resources make up one of the State's most valuable natural assets for recreation. Projected increases in population coupled with more leisure time indicate that the demands placed on these resources will be greatly increased in the future. In addition, it is anticipated that the range in recreation preferences will be much wider than existing recreational facilities can meet.

At present, a State Comprehensive Outdoor Recreation Plan (SCORP) is being prepared (scheduled for completion in early 1973). SCORP will measure the demand for recreation as well as the resources available to supply it, on a continuing basis. With both demand and supply to be measured, it should be possible to establish user standards and appropriate management criteria for the recreation resource base - the natural environment.

II. Goals

1. To provide a system of well-managed and serviced outdoor recreation areas which are balanced with respect to geographic, demographic, and environmental considerations.

2. To provide high quality "commercial" recreation consistent with preserving the natural resource base to meet the demand of the touring

public and to meet the needs for economic development of Eastern North Carolina.

3. To encourage conservation and development of fish and wildlife resources for recreation purposes consistent with other demands on these resources

Recreation in the coastal environment encompasses a broad spectrum of individual desires ranging from the person who wants to see the existing environment remain in its natural state for the use of fishermen, hunters, and naturalists to those persons who like coastal recreation primarily for the commercial attractions available. These varied desires all must be considered, analyzed, and made to work together insofar as possible in a compatible manner if a good overall recreation program is to be achieved. Finally, we must encourage the participation of private enterprise in expanding the State's recreational enterprises on a commercial scale.

III. Recreational Uses: Current Status, Problems, and Recommendations

A. Commercial Tourism

The attraction of tourists to recreational activities in Eastern North Carolina has great potential for economic development. Since 1960 the value of all tourist expenditures throughout the State (by both out-of-state and in-state visitors) has more than doubled, rising to a total of $850 million.[1/] Forecasts indicate that the value of this industry will rise to $1.5 billion by 1980. Tourism is now the second largest industry in the state; agriculture is the first. The Copeland reference also indicates that the value of these tourist expenditures in the 26 county coastal zone region presently exceeds $98 million.[2/] If the predicted trends for this

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1/ Copeland, L. & L. "North Carolina Travel Survey, 1971."

2/ The 26 counties are the ones bordering the Atlantic Ocean, estuaries, and the lower reaches of the major rivers. See Chapter 1 for a listing of the counties.

zone follow those of the State in general, then the value of tourist expenditures should almost double by 1980 (Copeland report). In view of the economic lag in the coastal zone, and potential improvement through increased tourism, the aspect of recreation must be given proper attention. There are several areas of concern, however, that need attention if the full potentials for tourism and the attendant economic benefits are to be realized.

1. Accommodations and Service Facilities:

To attract tourists, accommodations must cover a variety of individual needs ranging from motel, hotel, and rental cottages to second home accommodations.

Numerous hotels, motels, rental cottages and private camp grounds are now located along the coast and have a broad range of prices generally within the acceptance of most people. As demands increase, more of these accommodations will be built. There exists, at the present time, no methods of determining the number of second homes being used in the State, but it is known that the demand is high. Despite rising land and building costs, new second homes with water access will sell at increasing rates.

Sport fishermen use motel, hotel, and camping accommodations to a considerable extent. Generally, services and facilities for this user group is lacking. Needed are fish cleaning facilities, cold storage, equipment racks, bait, and up-to-date information about fishing activity and good maps. Businesses offering accommodations to the public should be encouraged to provide better facilities and services for the sport fishermen; particularly since good fishing extends well beyond the short summer season.

Many restaurants, gift shops, and recreational equipment stores operate in the coastal areas. Most of these, as well as many hotels and

motels, are open only during the summer season. Because of the seasonality of coastal tourism, it is often difficult to attract substantial investments in high quality facilities. As a result, many of the developments tend to be of marginal or sub-marginal quality. Promotional efforts should be directed toward developing additional tourist traffic in the coastal areas during the off-season months as well as convincing the owners of the necessary service facilities that there would be a sufficient off-season market to warrant keeping their business open.

2. Entertainment Facilities:

Some people choose to spend their leisure time in the coastal area because there are entertainment facilities available along with the natural resources. The spectrum of entertainment facilities ranges from miniature golf courses and boardwalk and amusement park developments to pavilions and hotels offering live entertainment in a night club atmosphere. Again, because of local zoning, regulations and the seasonality of the beach-oriented tourist, some of these entertainment facilities tend to be sub-marginal. In considering the development of such facilities in the the future, the State should adopt a rigorous set of requirements which would result in quality attractions and perhaps consider inviting concessions, such as unusual transportation systems (hydrofoils, monorails, etc.) which would not only help alleviate traffic congestion in the most popular areas, but would also be novel enough to attract tourists to the area. These transportation systems could be coupled with areas developed as theme parks, emphasizing past historical events of the North Carolina coast or other similarly interesting subjects.

3. Hospitality Training:

A very important factor in maintaining a high level of tourist flow in any area is the hospitality and services extended to a visitor

during his stay. At present, service people in the hospitality industry are too often poorly trained in their jobs and unskilled in the techniques of accommodating the tourist, including sport fishermen. The North Carolina System of Technical Institutes and Community Colleges is actively engaged in training programs for both tourism and recreation in the State. Four institutions conduct instruction for degrees in Hotel-Motel Management, Hotel-Restaurant Management, or Culinary Technology. A series of short extension courses to train employees in basic occupational skills directed toward how to serve the traveling public better is offered through the Hospitality Education Program. More interest in such programs is needed and community colleges and technical institutes within the coastal area of North Carolina should add these programs to their curriculums.

4. Insect Pest Management:

Biting flies and mosquitoes in season are not only a serious pest, but also can transmit diseases and cause serious economic loss, particularly by the developing tourist industry. Outdoor recreation participation suffers serious declines during outbreaks of such biting insects. For example, some golf courses have revenue reduction of several hundred dollars per day, and further development is discouraged. Needed is a comprehensive insect pest management program oriented toward tourism usage and residents alike which is based on sound ecological principles. Fortunately, a study leading toward such a management program has been undertaken at North Carolina State University with Sea Grant support.

B. Parks

The U. S. Department of the Interior operates the Cape Hatteras and Cape Lookout National Seashore areas while the U. S. Department of Agriculture operates the Croatan National Forest. These Federal facilities

are extremely popular, attracting several million out-of-state visitors yearly.

The North Carolina Division of State Parks presently maintains six parks and one nature preserve in the eastern part of the State. In addition, it has jurisdiction over eight of the large Carolina coastal lakes.

The need for additional state parks has been documented in the 1969 report of the State Parks and State Forests Study Commission. Current plans call for expansion of the State Parks System, with several outstanding sites in the coastal region identified for future acquisition including Masonboro Island and Jockey Ridge. The Division of State Parks in the Department of Natural and Economic Resources intends to develop areas for intensive outdoor recreation as well as new state parks of the traditional type. The Division also is formulating a program for the protection and preservation of natural areas for educational and scientific use. At present, the State relies heavily on the already overused Federal park facilities for its recreational needs. The State should assume responsibility for acquiring more recreational coastal parkland for use by its citizens.

The Land and Water Conservation Fund, administered by the Department of Interior, provides a major source of funding assistance for planning, acquisition, and development of recreation areas. So far, 12.9 thousand acres, costing $6.2 million has been acquired in North Carolina through the fund.

C. Hunting

A variety of game attracts hunters to North Carolina's coastal areas. During the winter months, the coast abounds with many species of migratory game birds. In 1970 over a half a million hunters paid over two million dollars in license fees. However, only a small portion of these

hunters, just over 8,000, were from out-of-state. This seems to indicate that more publicity is needed to attract sportsmen to this off-season recreational resource. Should hunting pressure increase, however, additional management programs would be necessary to sustain the numbers of wildlife which would be needed.

The Wildlife Resources Commission conducts its activities under several major categories. These include deer, turkey, waterfowl, and small game management, as well as a program for the management of public hunting areas. Its budget provides mainly for habitat development and some research. The Commission also provides an outdoor education program for hunters, fishermen, and boat operators.

D. Sport Fishing

Two main areas of concern that confront State-Federal planners are conservation and development of recreational fishing resources. By conservation, we mean the wise management of the resource to insure continuation of adequate stocks that are now providing anglers with excellent fishing. The most important problem in this area is obtaining adequate assessments of both the resource and the user activity.

Information concerning many important gamefish stocks is limited. The NOAA/NMFS Lab at Beaufort, North Carolina is investigating existing stocks of important game fish and potential ways of increasing standing crops through such means as the construction of artificial habitats. The North Carolina Division of Commercial and Sports Fisheries at Morehead City is conducting an inventory of estuarine resources which will provide useful information on stocks of estuarine gamefish.

Sport fishery statistics are needed to evaluate both the demand on the resource and the present and potential economic value of sport

fishing to the State. Additional studies similar to the recent report prepared for the Coastal Plains Regional Commission by the Coastal Zone Resources Corporation but expanded to include the angler's catch per unit of effort and the composition of his catch could provide much needed information. Other important problem areas which affect stocks of gamefish and forage fish are: (1) loss of estuarine nursery areas through pollution, dredge-and-fill, alteration of tidal currents by channalization, and diversion of fresh water, (2) heavy metal and pesticide uptake in tissues and organs which might seriously hamper use of certain species, and (3) destruction of juvenile fishes.

The problem of developing the gamefish resources requires an assessment of what is available and where and when. Along most of the North Carolina coastline, the continental shelf is relatively broad with very little irregular, hard substrate close to shore. This lack of favorable habitat required by many important gamefish restricts the sports fishing activities of salt water anglers who own small boats. Artificial reefs have great potential as management tools that can be used effectively to imporve fishing close to access points. This would be particularly useful to small boat fishermen. The North Carolina Division of Commercial and Sports Fisheries now has a bill before the General Assembly to provide appropriations for the construction of reefs. State-Federal cooperation has already resulted in the selection of 14 new reef sites along the coast and in the estuaries.

E. Boating

Boating is one of the most popular recreational forms in the coastal areas. There are now more than 90,000 motorboats of over 10 horse power registered in North Carolina plus numerous small craft and sailboats. This number is expected to increase steadily in the future. The State has

built 108 "free-of-charge" boating access areas and there are 239 commercial marinas along the coast.

Two major problems confront recreational boating. One is lack of adequate access areas to the water, though the State is presently constructing many new launching areas for boatmen. The other problem is that of boating safety. Despite boating safety programs conducted on the Federal, State and local levels, the number of drownings and personal injuries resulting from boating accidents increase. To combat the accident increase, the Wildlife Resources Commission is vigorously intensifying its boating safety programs. The number of boating accidents may eventually require licensing of all boat operators. To enhance boating safety and marine recreational activities, the National Weather Service provides marine weather forecasts which are broadcast continuously over two VHF/FM radio stations, at Wilmington and New Bern. A third station is planned to be installed in the near future in the northern coastal area.

A possible future problem could develop if fixed bridge spans across navigable waters are not high enough to accommodate large sail boats. As the area develops, sailing undoubtedly will become much more popular.

IV. General Problems

There are two major problem areas that do not relate to any specific type of resources. These include public access and general environmental considerations.

A. Public Access

Presently, the coastal area of North Carolina lacks good quality highways which would provide easy, safe and rapid access into the region. Commercial air service is infrequent with poor connections from

inland cities to the coast. If people are to use the resources of an area, there must be adequate access whether by private vehicle or public and commercial transportation. In addition to the need for a good road system, adequate parking facilities must exist at the centers of tourist attraction.

North Carolina has within its boundaries some of the most beautiful beaches along the Atlantic coast. However, below Onslow County, there are virtually no beaches set aside for public use. More public access to this portion of the shoreline needs to be provided. Such access requirements encompass proper roads, parking areas, and walkways through the dunes.

In North Carolina public ownership of the coastal beaches fronting private property is limited to the area below the mean high water line. This could severely limit public use of the beaches as property values rise and intensity of private use grows. Oregon and Florida legislation offers some useful guidance in this regard. The Oregon approach is more all-inclusive and has met with initial success in the courts. It states that the public rights along the ocean shore are vested in the state to be held and administered as state recreation areas and for related purposes. This includes all land lying between extreme low tide and the line of vegetation. The constitutionality of the Oregon law has been upheld by the Oregon Supreme Court with the finding that the state on behalf of the public had acquired a prescriptive easement for recreational purposes in the dry sand area. It also held that the dry sand area "has been used by the public as public recreational land according to an unbroken custom recurring back in time as long as the land has been inhabited."

The strong language of the Oregon statute gives substantial support to its courts in reaching favorable decisions "to preserve and protect scenic and recreational use of Oregon's ocean shore." North Carolina

General Statute Section 113-14.1 does not afford such support. Section 2 of the proposed North Carolina Coastal Zone Management Act of 1973 is much more useful in this respect and could be strengthened by incorporating therein some of the Oregon language.

In analyzing the North Carolina situation in light of the Oregon experience, it is recommended that consideration be given toward defining public ownership up to the mean high water or vegetative line, whichever is greater.

In the interior coastal area of North Carolina, additional parklands or scenic easements need to be acquired along waterways and shores of the larger natural lakes and estuaries to protect and preserve scenic quality and recreational value. Local governments do not appear to be in a financial position to respond to this need. The State must take the initiative.

B. Environmental Factors

As more and more people use the recreational facilities of coastal North Carolina, the effects of degradation and overcrowding of these facilities are felt. Some of the more popular facilities, such as those on the Outer Banks, are already being overused in the peak summer season and to alleviate overcrowding, the National Park Service in recent years has been obliged to turn away campers. The state parks at Fort Macon and Cliffs of the Neuse have already reached their maximum visitor capacity. To cope with this problem, it may be necessary to set user capacity limits on certain parks and other outdoor recreation areas to avoid over-intensive use and destruction of their fragile natural features.

Increasing use of recreational facilities has magnified problems of solid and liquid waste disposal. Immediate steps should be

taken to develop new legislation where necessary and to enforce existing laws and regulations to control pollution both on land and from vessels, as indicated in the Environmental Quality chapter.

A major factor which now exists in North Carolina regarding the construction of all types of recreational housing accommodations is the lack of any state zoning regulations. Presently, individual counties have the authority to exercise control over land usage, but, unfortunately, most have not exercised this authority. The result is the wrong type of development in certain areas, such as mobile home parks on ocean front property. A compounding problem that leads to inadequate construction is that frequently insurance in such storm vulnerable areas is very difficult to obtain or its cost is prohibitive. There is a definite need to plan recreational facilities in the coastal areas for all economic levels, but care must be taken to obtain optimum use of an area. For economic reasons, certain areas need to have high density development such as hotels and condominiums, but such developments should be in zoned clusters. In this way, additional areas, paid for by the taxes arising from the high density development can be made available to serve other recreation interests. State regulations governing subdivision builders are necessary to assure quality development.

Coastal beaches are subject to constant, and at times, catastrophic erosion, leading to serious economic and human consequences. The balance between beach erosion and deposition is delicate with changes occurring continuously at various rates. Substantial loss of a normal beach profile results in decreased property values, a decreased tax base, and ultimately a loss of tourism. Careful advance planning is necessary for a good beach management program including the use of newly developed and proven engineering techniques and a continuous reassessment of conditions. Adequate funds need to be provided for the application of existing knowledge and the generation of new

knowledge to help resolve the problems of erosion.

Summary of Major Problems and Recommendations

A. Problems

In summarizing the problems discussed earlier, the following areas were considered to be the most important related to recreation in coastal North Carolina:

1. Insufficient public access to recreation areas. This includes lack of good highways and airline transportation into coastal regions, virtually no publicly owned beaches below Onslow County, and limited public access points to estuaries, rivers and lakes.

2. Degradation of recreational facilities arising from the effects of pollution and overcrowding.

3. Seasonality of recreational demand, especially in the northeastern coastal area.

4. Insufficient public park lands.

5. The need for meaningful conservation and development or recreational fishery resources. This includes lack of adequate assessments of resources; lack of data on present and potential use of the resource, lack of favorable habitat near access areas, loss of nursery areas, destruction of juvenile fishes and inadequate management of resources.

6. Lack of adequate controls on land use for development.

7. Inadequate insect pest management programs.

B. Recommendations

1. To provide for adequate public access:

a. Initiate a study which would result in an adopted state and regional policy concerning the development of highway and air access both into and within the coastal region in consonance with plans for recreational, conservational and other uses.

b. Take steps to insure public access to beach areas with legislation enacted to assure public access to and usage of beach areas. Study of the Oregon approach should be undertaken in this connection.

c. Utilize information in the SCORP plan to identify specific localities where additional public access is needed.

2. To reduce degradation of recreation facilities:

a. Immediate steps can be taken to develop new legislation and enforce existing laws and regulations related to sewage treatment facilities, solid waste disposal and liquid and solid waste disposal from vessels. This is discussed in greater detail in the chapter on Environmental Qaulity.

b. Avoid unnecessary intensive and destructive use of fragile natural areas by setting user capacity limits on public and private facilities where necessary.

3. To reduce seasonality of recreation demand:

a. Publicize and promote year-round outdoor recreational activities.

b. Promote use of existing conference facilities to attract groups during the off season.

c. Develop and publicize package tours to create additional tourism traffic during slack months.

d. Develop high quality theme parks and other facilities having year-round appeal.

e. Develop a program to evaluate present and potential recreational demands.

f. Encourage participation in training programs for service people in the hospitality industry.

g. Emphasize such fish and wildlife activities as bird watching and sport fishing, both of which extend into the off-seasons.

4. In order to acquire more public recreation areas:

a. Undertake an aggressive park land acquisition and development program.

5. To properly manage recreation fishing resources and develop and improve recreation fishing:

a. Coordinate stock assessment by State, Federal and university researchers.

b. Initiate complete study of recreational fishing to include angler success and present and potential economic impact.

c. Continue research on effective use of artificial reefs to increase stock sizes of some important gamefish species and to develop fishing groups in areas accessible to small boat fishermen (estuary and nearshore reefs) and to construct artificial reefs both offshore and in estuaries.

d. Through cooperative efforts and planning sessions with State, Federal and university researchers, gather information on importance of estuarine nursery areas and recommend protection.

e. Through State, Federal and university research in North Carolina, and liaison with other states and Federal agencies develop and implement meaningful management practices and legislation.

f. Provide necessary zoning to control interactions of vehicles and sportsmen and commercial interests.

6. To reduce and prevent uncontrolled land and water use and development:

a. Take immediate steps to initiate strict, uniform state and local zoning regulations to insure orderly planning and development

of coastal areas. Subdivision developers should be made to follow specific regulations so that quality developments are assured and irresponsible developers not allowed to operate within the state.

7. To provide for an adequate program of insect pest management:

a. Continue the study by North Carolina State University to develop programs, based on ecologically sound principles of insect pest management for control of biting flies and mosquitoes in the coastal zone.

b. Implement, as appropriate, pest management programs as they are developed to control biting flies and mosquitoes through mix of appropriate cultural, chemical, and biological methods.

Program Area: Recreation and Tourism

Goals:

1. To provide a system of well-managed and serviced outdoor recreation areas which are balanced with respect to geographic, demographic, and environmental considerations.
2. To provide high quality "commercial" recreation consistent with preserving the natural resource base to meet the demand of the touring public and to meet the needs for economic development of eastern North Carolina.
3. To encourage conservation and development of fish and wildlife resources for recreation purposes.

PROBLEM	RECOMMENDATION
1. Lack of adequate public access to recreation areas:	1.
a. Lack of good highways a d airline transportation into the coastal region.	a. Initiate a study which would result in a policy for the adequate development of highway and air access into and within the coastal region in consonance with plans for recreational, conservational and other uses.
b. Inadequate publicly owned beaches and limited public access points to estuaries, rivers, and lakes.	b. Take steps to insure that adequate public beaches and public access points to estuaries, rivers, lakes and beaches are acquired.
2. Degradation of recreational facilities	2.
a. Overcrowding.	a. Avoid unnecessary intensive and destructive use of fragile natural areas by setting user capacity limits on public and private facilities where necessary.

PROBLEM	RECOMMENDATION
b. Pollution.	b. Take steps to develop new legislation and enforce existing laws and regulations relating to solid and liquid waste disposal.
3. Seasonality of recreation demand, especially in the northeastern coastal area.	3. Develop a program which would result in the maximum use of facilities and recreational areas on a year-round basis taking into account present and potential recreational demands and the need for additional parks and facilities having year-round appeal.
4. Insufficient public park lands.	4. Undertake an aggressive park land acquisition and development program.
5. Need for meaningful conservation and development of recreational fishery resources.	5.
a. Inadequate assessment of the resources, their use and habitat near access areas.	a. Coordinated assessment by State, Federal, and university researchers of stocks, their use and habitats taking into account present and potential economic impact, and the need to increase stock sizes by the construction of artificial reefs both offshore and in estuaries.
b. Destruction of juvenile fishes in nursery areas.	b. Continue and expand cooperative efforts and planning sessions with State, Federal, and university researchers gathering information on estuarine nursery areas and recommend protection.
c. Quality of fishing experience.	c. Implement the necessary zoning and regulation to control interactions of vehicles and sportsmen and commercial interests.
6. Inadequate land use controls accelerating demand for second homes with water fronts, mobile home parks on ocean front property, etc.	6. Immediate steps should be taken to initiate strict, uniform state and local zoning regulations to insure proper planning and orderly development of coastal areas.

PROBLEM	RECOMMENDATION
7. Inadequate insect pest management programs.	7. Continue the study by North Carolina State University to develop a program of insect pest management and implement as appropriate a program to control biting flies and mosquitoes.

CHAPTER 6

COMMERCIAL FISHERIES

I. Introduction

Since the first colonists settled on Carolina shores, fishing has been a reliable, useful, and profitable enterprise. For more than three hundred years, most, but not all, wild native stocks have kept pace with the harvest. With the impact of man-made influences on the environment and pressures on the stocks and lack of adaptation of modern technology to the fishing industry, especially in the processing segment, the industry may soon lose its rightful place as a significant contributor to the economy of the State of North Carolina.

II. Goal

The overall goal is to increase income from commercial fishing through improved efficiency in catching, processing and marketing, and to preserve the long-range viability of the industry through efforts to maintain stocks and reduce environmental hazards.

In accomplishing this goal, several areas are in need of attention. The most important of these are: (1) environment and stocks, (2) processing and marketing, (3) statistics, and (4) advisory services, including socio-economic and legal affairs.

Attention to the first area might be considered the most essential, for without the proper environment and an adequate supply of fish stocks,

there cannot be a viable fishing industry -- commercial or sport. However, the second and third areas can hardly be assigned lesser status. Processing and marketing capability is critical if North Carolina is to escape its present "colonial" status of exporting most all of its raw fishery products while importing processed fishery products for consumption. This area must have assistance for meeting the demand of stricter sanitary requirements and operating efficiency.

An adequate statistics program is also essential to a realistic evaluation of the industry, to assessing the impact of commercial and sport catches on certain stocks, and to developing rational management methods -- including resource allocation. *

An advisory/extension-education program is essential because the people who are the backbone of the industry need to learn about new industrial and technical advancements in order to use fishery technology methods advantageously. Fishermen also need assistance with socio-economic and legal matters of importance to them. They must also have the opportunity to feed back information concerning their real needs and how well the services provided for them are functioning.

III. Current Status

About 50 species of finfish and shellfish are harvested commercially from North Carolina coastal waters. It is generally unknown whether species

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*Marine sport fishing is included in greated detail in the chapter on "Recreation and Tourism."

are under- or over-harvested by present harvest techniques, except that menhaden are definitely overfished and striped bass are probably under-harvested. Most North Carolina fisheries are seasonal and largely dependent on the migratory habits and reproductive cycles of the species. For the most part, North Carolina commercial fishermen seek high quality, high value food species such as shrimp, oysters, and flounders.

Presented in Table 1 are the North Carolina landings data for selected high value, high volume species for the period 1965-1971. Presented also are the total annual landings and value for all species harvested, including industrial fish such as menhaden. Presented in Table 2 are the annual North Carolina menhaden landings and value for the same time period.

The commercial landings fluctuate widely with average total landings for the seven-year period being 207.5 million pounds annually value at almost $10 million. Only ten edible food fish species exceed annual average landings of one million pounds. The 1970 landings represent about 3.5 percent of the nation's total catch and 1.5 percent of the United States total dockside value. Only about 58.3 million pounds of edible finfish and shellfish were harvested in North Carolina during 1970, most of which was shipped out-of-state unprocessed.

The estuarine, coastal, and nearshore waters of North Carolina provide fishery resources for a commercial and sport fishery industry value at nearly $100 million annually (Heatherly, 1971). Commercial

Table 1 - North Carolina Landings Data for Selected Species, 1965 - 1971 (Thousands of Pounds and Thousands of Dollars)

Year	Croaker	Spot	Whiting	Mullet	Sea Bass	Sea Trouts	Blue Fish	Flounders	Striped Bass	Crabs	Shrimp	Scallops	Total Landings All Species	Total Value (Dockside) All Species
1965	1,753	913	1,337	1,260	1,090	2,134	704	4,721	484	22,571	5,416	1,342	225,859	$ 9,160
1966	1,267	1,091	766	1,445	1,266	2,012	821	4,017	653	19,040	5,697	2,256	245,485	9,544
1967	1,283	3,048	839	1,063	1,994	1,892	888	4,391	1,817	14,358	4,919	1,776	219,589	8,301
1968	1,201	1,575	635	1,172	1,193	2,383	872	2,602	1,912	19,253	4,612	680	228,583	9,688
1969	1,369	1,488	843	1,090	1,047	1,728	871	2,766	1,568	22,253	7,854	625	217,790	12,520
1970	807	1,529	563	1,123	1,178	2,846	495	3,163	2,318	20,940	5,054	1,704	171,693	9,356
1971	948	1,190	764	713	748	3,983	578	4,011	1,449	14,525	7,615	1,345	143,475	11,227
Ave.	1,233	1,548	821	1,124	1,217	2,425	747	3,667	1,456	18,991	5,881	1,390	207,496	9,971

Source: National Marine Fisheries Service Annual Summaries

Table 2 - North Carolina Menhaden Landings Data, 1965 - 1971

YEAR	POUNDS	VALUE (dollars)
1965	160,595,000	2,072,000
1966	182,289,000	2,538,000
1967	150,480,000	1,694,000
1968	167,189,000	1,958,000
1969	145,235,000	2,228,000
1970	108,235,000	1,570,000
1971	79,488,000	1,116,000

Source: National Marine Fisheries Service Annual Summaries

fishing boat license sales data presented in Table 3 for 1966 and 1971 show a substantial increase in most categories. These data include sales of boat licenses for "sport" or "recreational" fishing when using commercial gear. It is interesting that the greatest increase is in the small boat category (class "C" and "B1" for boats to 26 feet) and apparently indicates an increase in occasional and/or recreational commercial fishing activities.

Data relative to the apparent commercial fleet and fishermen involved on boats and shore (haul seine for example) activities are presented in Tables 4 and 5. These data indicate no significant change in the number of commercial vessels overfive tons between 1960 and 1970, whereas, a general increase has occurred in the category of less than five tons. There has been a general decrease in the number of fishermen for the same period (Table 5).

The number of wholesale and processing establishments and persons engaged in these activities has changed very little during the ten-year period ending 1971 (Table 6). Seventy-nine establishments, which are currently active, processed primarily crabs, oysters, and scallops (in 1971).

It is estimated that less than one-half dozen establishments are processing edible finfish and then only in a very limited way. It would appear that with annual landings of over one million pounds each for seven edible species (Table 1), the potential for processing would be far greater than actually occurs.

Table 3 - Comparison of Commercial Fishing Boat Licenses Sold in North Carolina During 1966 and 1971

	1966	1971	Percentage Increase
Class "C" licenses	6,040	8,498	41
Class "B1" licenses	893	1,276	43
Class "B" licenses	673	840	25
Other licenses	840	606	-28
Total	8,446	11,220	33

Note:

Class "C" licenses - for boats to 18 feet

Class "B1" licenses - for boats 18 to 26 feet

Class "B" licenses - for boats over 26 feet

"Other" licenses - for Menhaden boats and boats without motors

Source: State Division of Commercial and Sport Fisheries Records

Table 4 - Data on Vessels and Persons Employed During the Period 1960 - 1970; North Carolina

YEAR	Over 5 Tons Net (No. of Vessels)	Less Than 5 Tons (No. of Boats)		Over 5 Tons Net (No. of Fishermen On Vessels)
		Motor	& Other	
1970	475	2,311	86	1,682
1969	372	2,472	88	1,470
1968	398	2,516	102	1,642
1967	446	2,506	111	1,775
1966	431	2,533	101	1,659
1965	471	2,038	376	1,839
1964	481	2,194	601	2,027
1963	475	2,267	708	1,898
1962	458	2,157	894	1,886
1961	496	2,099	816	2,172
1960	447	1,968	889	1,863

Source: National Marine Fisheries Service

Table 5 - Data on Numbers of Regular and Casual Fishermen in North Carolina

Year	No. Fishermen on Boats & Shore (Regular & Casual)	Total Fishermen
1970	2,432	4,114
1969	2,665	4,135
1968	2,703	4,345
1967	2,683	4,458
1966	2,737	4,396
1965	3,081	4,920
1964	3,524	5,551
1963	3,904	5,802
1962	4,076	5,962
1961	3,983	6,155
1960	4,411	6,274

Source: National Marine Fisheries Service. Regular fishermen earn over one-half of income from commercial fishing, while casual fishermen earn less than one-half.

Table 6 - Data on Numbers of Wholesale and Processing Establishments; North Carolina

Year	No. Wholesale & Processing Establishments	No. of Establishments Producing Processed Products	Persons Engaged	
			Avg. Season	Avg. Year
1971	178	(79)	2,670	1,584
1970	175	(70)	2,625	1,558
1969	164	(71)	2,462	1,463
1968	165	(69)	2,741	1,509
1967	170	(70)	2,783	1,671
1966	165		2,620	1,397
1965	158		2,430	1,412
1964	161		2,582	1,242
1963	165		2,664	974
1962	176		2,593	973
1961	181		2,514	996
1960	185		2,541	978

*Frozen Products
Shucked Products
Fish Meal
Canned Products
Fresh Packed Crab Meat, etc.

Source: National Marine Fisheries Service

Except for the automated, and possibly underutilized menhaden industry, most fisheries use little fishing machinery other than that required for boat propulsion or for retrieving a trawl. For example, catches are sorted by hand, unloaded by hand, and packed by hand. Minor improvements of recent years include: a transition to the use of nylon for net materials, increased use of radar and electronic aids on larger vessels, and the replacement of wooden fish boxes with coated paperboard boxes for shipping.

The processors in North Carolina are relatively small and have limited capital for expansion of facilities and the development of new products and market outlets, so there is a limited amount of technology currently being applied. There has been very little effort to develop product identity in the marketplace. In North Carolina the particularly wide variety of species and seasonality of the catch has impeded the growth of the industry. There is a limited amount of product storage space available so the processor cannot market his product at the most opportune time. Underlying these factors is a deterioration in the quality of fishery products as a result of poor handling practices. Constant handling with little apparent concern for proper refrigeration and sanitary conditions often result in quality degradation.

IV. Current Programs

Several federal and state programs are underway for each of the important areas of concern. Several of the more significant ones are briefly described in this section.

A. Environment and Stocks

1. Federal Programs. Major federal agency programs are conducted by the National Marine Fisheries Service's Atlantic Estuarine Fisheries Center located at Beaufort. Two major divisions of work are recognized: (a) research objectives of the Division of Fisheries are to obtain biological and statistical information about commercial and recreational fishes of the coastal zone. These studies emphasize the collection and analysis of data which describe the status of exploited and latent stocks. They are used to sustain and, where possible, to increase the yield of seafood and the recreation derived from fishing. Specific work includes: (1) annual estimation of stock sizes, fluctuations in abundance and fishing rates in Atlantic and Gulf of Mexico menhaden fisheries; (2) determination of the relation of species distribution, migration and reproduction to environmental conditions on the South Atlantic coast in the nearshore zone; and (3) assessment of effectiveness of natural and artificial fishing reefs in providing recreation and seafood. And (b) the longer term mission of the Center's Division of Ecology is to study ecosystem structure and function in the coastal plain salt marsh estuaries typical of the mid-Atlantic and South Atlantic regions of the United States and to evaluate the effects of man's activities on this ecosystem type. Included in this study are: (1) assessment of species structure, biomass composition and trophic energy of the ecosystem; (2) determination of major pathways and rates of flux for contaminants

of human origin, especially heavy metals, radionuclides and pesticides within the ecosystem; and (3) determination of organism responses to important contaminative additions, alone and in combinations, over the entire range of environmental variation to which the organisms are normally exposed.

2. State Programs. Several state agencies are engaged in surveying estuaries and offshore waters from South Carolina to Virginia borders. These are the State Division of Commercial and Sport Fisheries, University of North Carolina and North Carolina State University with assistance from Sea Grant, State Office of Water and Air Resources, and the Sanitation Division of the State Board of Health. These surveys involve sampling several hundred stations monthly. They are also designed to better define nursery areas and the relative and seasonal abundance of young shrimp, crabs and finfish. Scallop surveys have been conducted in Carteret and New Hanover Counties as well as offshore. Environmental data including water temperature, salinity, and selected chemical (nutrient) measurements, depth, and bottom type are taken along with the biological specimens. In general, the sampling methods, instrumentation, and equipment used for these projects are comparable. Some of the hydrological and climatic data are processed for computer storage and manipulation. These are available for retrieval from HISARS. Some of the water quality data also has been incorporated in EPA's STORET system.

The Commercial Fisheries Study Commission, established by the 1971 General Assembly, is developing recommendations for the growth and development of the fishing industry and for improvements in its administration at state level.

B. Processing and Marketing

There has been considerable interest in developing and expanding the processing and marketing activities of commercial fisheries during the past several years. This interest has resulted in the initiation and current operation of the following programs by State and federal agencies:

1. Industrial Extension Service, North Carolina State University, Engineering Systems

2. Department of Food Science, North Carolina State University, Seafood Processing, Preservation and Storage System

3. Department of Economics, North Carolina State University, Fisheries Economics Program

4. Division of Commerce and Industry, North Carolina Department of Natural and Economic Resources, Fisheries Marketing Program

5. Division of Continuing Education, East Carolina University, Fisheries Cooperative Program (Sound and Sea Fishermen's Association)

The above State programs, in many cases, are being supported in part by federal funds from the NOAA Sea Grant Program, Coastal Plains Regional Commission, Public Law 88-309, administered by NOAA's National Marine Fisheries Service, and the U. S. Department of Agriculture. These

agencies are actively working with the fisheries industry in seafood processing and marketing. Although there is not an integrated effort among the agencies to solve common problems in a complete follow through from harvesting to marketing.

C. Statistics

In North Carolina, many dealers voluntarily provide catch and value data on a monthly basis to the National Marine Fisheries Service. Some statistical information can be derived from the state tax records paid by dealers on shellfish; however, it is believed that much of the shellfish catch is not recorded or taxed. Inaccurate information sometimes results when one develops catch data from tax figures. A more rigorous reporting program is needed if meaningful analyses of the fishery resources is to be obtained.

D. Advisory Services

Several small advisory extension programs have been started at separate coastal locations but there is little or no coordination between the.

The Sound and Sea Fishermen's Association has been established in the Albemarle Sound-Outer Banks area. This program has been developed with the assistance of the Sea Grant Advisory Services Program at East Carolina University and currently, NOAA's new advisory service is providing assistance.

The Food Science and Industrial Extension facilities at North Carolina State University are providing Sea Grant advisory services to the industry. Newsletters and workshop-conferences offer additional opportunities for communication and dissemination of information to the industry.

The State Division of Commercial and Sport Fisheries provides advisory services to oystermen to help maximize production of lease holdings. Also, the Division issues a monthly newsletter and occasional technical bulletins. A recently released pamphlet has been provided for grade school students; it describes the coastal area, its environment and the importance of fisheries.

NOAA has recently organized a marine advisory service to provide information and assistance for all kinds of coastal activities, including development, utilization and management of marine resources and coastal zone management. As noted above, the program in North Carolina is providing assistance to the Sound and Sea Fishermen's Association.

E. Trade Organizations

There are several fishery related organizations working toward the improvement of commercial fisheries in North Carolina. Some of these organizations are: North Carolina Fisheries Association, Inc.; National Fishmeal and Oil Association; Southeastern Fisheries Association; National Fisheries Institute; National Shellfisheries Institute

(Oyster Institute of North America); Tri-State Crab Processors Association; Carteret County Oyster Farmers and Fishermen; Southeastern North Carolina Fisheries Association; Sound and Sea Fishermen's Association; Atlantic Offshore Fish and Lobster Association; and North Carolina Catfish Growers and Producers.

V. Problems and Recommendations

A. Environment and Stocks

1. Nursery Areas:

Problem: Inadequate protection of nursery areas during critical stages of species juvenile development.

Explanation: Identification and location of nursery areas of major estuarine species is complete in the southern half of the State. Projects designed to yield this information in other parts of the State are underway in the Neuse River, Southern and western Pamlico Sound, and Albemarle Sound areas. Funds and personnel to obtain this information in northern and eastern Pamlico Sound and the Pamlico and Pungo River areas are not available. Management of high value species such as shrimp is not possible without protection of nursery areas.

Shrimp nursery areas offer a good example of this problem area. Prior to the 1971 shimping season, all coastal waters in the southern areas, including what we now know to be shrimp nursery areas, were traditionally opened to all shrimping activities with no consideration for critical states of post-larval and juvenile development. The shrimp nursery

areas were identified in 1970 and were protected beginning in 1971. This management action probably had much to do with the record shrimp landings in the counties comprising the Southern District (Onslow, Pender, New Hanover, and Brunswick Counties) in 1971. Landings for 1972 through September again are at record level.

Natural environmental factors, which cannot be controlled by man, play a major role in the recruitment of post-larval shrimp to estuarine areas. Identification and protection of these areas containing critical states of development is necessary for maximum production of natural recruitment. Protection of nursery areas against habitat degradation through development alteration and pollution is also a major consideration for management of these areas.

Recommendation: Accelerate the completion of surveys designed to identify nursery areas so that recently developed management methods to protect juvenile stocks can be employed in the remaining areas of the coast.

2. Foreign Fishing:

Problem: The intrusion of foreign fishing upon traditional fishing stocks of the North Carolina fishing industry presents a potential problem.

Explanation: According to the National Marine Fisheries Service Enforcement and Surveillance Division, foreign fishing off the Atlantic Coast has increased. In 1971, there were 229 vessels of the

Soviet Block fishing off North Carolina and their catch amounted to 91.1 million pounds worth 3.6 million dollars at landed value (ex-vessel). Eighty-five percent of the catch consisted of sea herring and Atlantic mackeral. River herring constituted ten percent of the catch and the remaining five percent included hake, flounder, scup, and sharks. The principal season of foreign fishing was January through March.

In April 1972, five Spanish side trawlers were observed fishing inside of the 100-fathom contour approximately 45 nautical miles east of Kitty Hawk, North Carolina. The vessels had moderate catches of squid, butterfish, and sea robins on deck, and it is possible that they were taking northern lobsters in bottom drags.

In the same month, a Japanese longliner was observed fishing for tuna from 35 to 65 nautical miles offshore between Oregon Inlet and Currituck Beach. Catches were probably albacore and bluefin tuna.

The State cannot regulate fisheries beyond three nautical miles off the coast, although North Carolina fishermen have traditionally fished upon these offshore grounds and for some of the species that are now being exploited by foreign fleets. It is in the interest of the State to take all reasonable and appropriate steps to ensure against depletion of valuable stocks.

Recommendation: Provide North Carolina fishery information and other forms of assistance to State compacts and appropriate federal agencies

to facilitate establishment of the controls necessary for protection of those species traditionally fished by the North Carolina industry.

3. Management Controls:

Problem: There are insufficient management controls for major fish stocks.

Explanation: Of all the selected species listed in Table 1, not one is under a full scale management program. Only crustaceans and molluscs are considered non-migratory for the purposes of management. The oyster is the only species under substantial management in North Carolina. Shrimp are being managed only in the southern counties. Of all remaining species, mostly finfish, information sufficient for development of a realistic management plan is available only for menhaden. However, the species is migratory and cannot be managed by individual states without a regional management plan. Regional management plans, involving the affected states and the National Marine Fisheries Service, for all finfish listed Tables 1 and 2 are essential if meaningful management is to be accomplished.

Recommendation: Development state-federal management plans using existing data and conduct additional research where required. North Carolina would work with the National Marine Fisheries Service and other Atlantic coast states in developing and implementing the plans.

4. Estuarine Modification:

Problem: Detrimental impact of estuarine modification on fishery habitats.

Explanation: Environmental impact statements are now required by both the state and federal governments for proposed estuarine and coastal habitat alterations having significant effects on the environment. Most investigators, however, have time for only a superficial view of the problem without benefit of realistic research data on effects or potential effects of such estuarine modification. Research data on ecologically sensitive areas which can support impact statements for state and federal use are generally lacking. Lacking also are state-federal coastal management plans which will be required for realistic and meaningful management of the coastal estuarine area. Chapter 10 discusses this problem. Plans for coastal alterations also are reviewed under authority of the Fish and Wildlife Coordination Act cooperatively by the Fish and Wildlife Service, National Marine Fishery Service and appropriate state organizations. Recommendations to correct potential adverse effects are provided to the responsible construction agency. The problem of coastal alteration also is discussed in Chapter 8, Environmental Quality.

Recommendation: More rapid and thorough identification of particularly ecologically sensitive areas; implementation of state-federal coastal management plans; improvement of state-federal impact statements procedures; conduct research supportive of impact statements and other regulatory requirements for coastal alterations.

B. Processing and Marketing

1. Processing and Marketing Facilities:

Problem: North Carolina processing and marketing facilities have never accommodated the State's commercial catch to a satisfactory degree. The problem is to determine why and to correct if feasible.

Explanation: Although the attitude is by no means unique to North Carolina or to the fishing industry, there is a pervasive assumption behind the whole idea of achieving economic development that further development is, in fact, feasible. Implicit in this assumption is the idea that either private investors are unaware of the opportunity or that investors await the development of appropriate technology presently limiting commercial development. The fishermen themselves, community leaders, and technical research professionals servicing the industry have observed the development of fisheries in other regions through transition into more sophisticated processing and marketing operations. Frustration arises from the intuitive assumption that, since fish are presently caught in North Carolina waters and shipped elsewhere for processing and distribution, these same fish could be processed and marketed by firms operating within the State, to the benefit of the local industry, the Coastal Plains Region, and the State, in general.

The root of the problem lies in the disparity, with resulting frustration, that has arisen from the expectation of further economic development

on the one hand and the lack of private development activity on the other. Before spending large sums seeking answers to all of the technical problems confronting the industry, there is a need to analyze and clearly understand (1) whether or not further economic development in the form of more processing and marketing activity is economically feasible, and (2) what the first limiting constraints really are. Since the development of integrated catching -- processing -- distribution -- marketing operations are not unprecedented in other fisheries, one cannot assume that it is ignorance of lack of technology alone that has prevented private capital from developing the same kind of business in North Carolina. One must at least suspect that there may be social, political, or economic phenomena present in the North Carolina situation that do in fact make the formation of viable businesses risky or infeasible. Moreover, limited funds for research in the public sector prohibits exhaustive examination of all of the opportunities for technical improvement that may exist. It is imperative that first priority be given to the areas of processing technology that are discovered to be immediately limiting to investment by the private sector.

Recommendation: Sponsor a study from a business analysis viewpoint of the entire opportunity from catching through processing and marketing. The objectives of the study are to identify viable business opportunities in this area and to identify the reasons for the lack of commercial development in processing and marketing be they technical, business, or otherwise.

The problem created by the disparity between the current limited development of the fishery industry and the expectations and aspirations of the industry and region can be resolved by more clearly understanding the true nature of the business opportunity suspected to be latent in the fishery. It is proposed that a study of the industry be made from a business analysis point of view. The project manager would be directed to seek business opportunities potentially exploitable in the fishing industry and to consider all functional levels from catching, through processing and distribution, to marketing. The study will (1) look for ways to make function areas complimentary, hence, opportunity for increased efficiency from catch to retail marketing; (2) consider opportunities for collective activity among different geographical areas, demographic groups, types of fishing, etc., that could increase efficiency through economies of scale; (3) identify the technical, social, political, institutional, economic and other constraints that are currently limiting development and need to be overcome before private capital will be invested; and (4) require that the output from the study include a description of the economically optimum configurations of business units that are concluded to be economically feasible. It is important that one section of the output be in the form of a specified, investment prospectus for each business proposed.

In order to insure objectivity, new insight, and business oriented analytical methods and organizations, it is strongly recommended that the study be conducted by an agency with a wide range of business analysis

skills at its disposal, including, but not limited to, economics. The respectful contention of this thought is that a school of graduate business administration or a private management consulting firm of broad, recognized experience and competence would be far better equipped to perform this analysis than any single academic discipline such as an economic department or study team of State, university and federal professionals. The businessman's or investor's perspective is multi-disciplinary in nature and is seldom found inside the business schools within the university system. It involves a different pattern of organizing the problem, its analysis, and the format of the output, and, perhaps most important, speaks the business language so necessary if the study is to actually attract private capital.

2. Marketing Services:

Problem: Inadequate marketing services to meet industry needs.

Explanation: In 1967, the seafood industry of North Carolina, through its fishermen, wholesalers, and processors with sponsorship of the North Carolina Fisheries Association presented its need for assistance in marketing North Carolina seafood products to State government. The commercial fishing industry felt justified in requesting this assistance because: (1) increase in incomes would far surpass the small investment; (2) the industry had demonstrated its good faith by self-imposed additional taxes on seafood products; (3) similar, more extensive assistance had been provided to the agricultural industry for many years; and (4) no one firm or

group of companies is financially capable or professionally competent to engage in an overall seafood marketing development effort.

The 1971 General Assembly authorized the North Carolina Seafood Marketing Development Program and assigned its functions to the Department of Natural and Economic Resources. The $35 thousand appropriated for this program is to facilitate the movement of seafood products through the various channels of trade, by the sound application of busines, managerial, economic and technical aspects applicable to the seafood industry. This program is designed to be flexible enough to adjust to immediate industry needs, yet consistent in all four areas of basic seafood marketing: marketing assistance, marketing development, consumer acceptance and marketing coordination.

The program has been in operation for only 15 months, yet it has been effective in building marketing systems through a more unified marketing effort by soliciting working cooperation of all elements in the marketing chain. Special emphasis has been placed on consumer acceptance of North Carolina seafood utilizing news media and personal contact with consumer groups. The program is now prepared to become an effective development tool and render assistance to North Carolina's seafood industry that is not being provided by any other agency or department of local, state, or federal governments. However, the level of effort is low and needs to be expanded considerably if large scale accomplishments are to be realized.

Recommendation: Increase the capability of ongoing marketing services programs.

C. Statistics

1. Data Programs:

Problem: Lack of adequate statistical data required for the management of the State's fisheries, sport and commercial. (Catch effort data, age and size composition of catch, etc.)

Explanation: Except for data obtained on menhaden by the National Marine Fisheries Service in cooperation with the states, very little catch-effort, age or size composition data are available on commercial fish landings in North Carolina. A meaningful evaluation of stock composition, age classes, sizes, and catch-effort is a necessary part of any management plan.

The lack of reliable statistical data concerning North Carolina's commercial and sports fishing industry is a serious drawback. The needs for fuel, ice, and docking space are unknown. All these unknowns tend to discourage investment and development of the industry. There is no legal requirement in North Carolina for licensed commercial fishermen to supply such data and information to the management agency.

Catch-per-unit-effort, area of catch, year class composition of stocks and catch, fishing mortality, and other information on stocks are generally unknown. Intelligent management of the fisheries is impossible without such up-to-date information on a continuing basis.

In the absence of adequate data, any attempted evaluation of the potential effects of pollution and habitat alteration on the environment and stocks is very difficult.

Recommendation: Implement a comprehensive statistical program geared to acquire data needed for economic development and evaluation of stocks and legally require licensed commercial fishermen to provide such information as may be necessary for these purposes.

D. Advisory Services

1. Technology and Business:

Problem: Many of the people in the fishing and seafood industry do not have the ability to evaluate fully the results of research and make needed technological and business changes in harvesting, processing, and marketing practices. A comprehensive extension education program relating to all aspects of the fishing industry, including management training and market analysis must be planned and implemented; a good start has been made by the universities, the State and NOAA.

Explanation: The education and extension programs presently being conducted are not comprehensive enough to meet the needs of the fishing industry. More attention needs to be given to program design and implementation and socio-economic and legal needs. A feedback and evaluation component should be an integral part of the program. More attention needs to be given to techniques used successfully by other states.

Recommendation: A full-time professional unit with competence in business administration should be employed to advise members of the fishing industry in business and financial methods, availability of financial assistance and management of fishermen's resources. An overall coordination of existing advisory-extension programs and activities is recommended to improve the effectiveness of existing efforts.

Additional recommendations include the following: the addition of capabilities to the present Agricultural Extension Service at the local level to provide extension type assistance to the fishing industry. The expansion of the technical advisory services and assistance to further the use of technology in production, and to assist industry in making adjustments to higher environmental and product quality standards. Furthering the development of future leadership through high school vocational programs, post-high school short courses, and other programs.

E. Inlets

1. Fishing:

Problem: Unsure and unsafe accessibility to fishing grounds, or to refuge during inclimate weather, limits fishing time and increases the cost of fishing.

Explanation: Currently, 23 inlets connect North Carolina's estuarine system with the Atlantic Ocean, affording the salt water-fresh water interchange essential for maintaining the valuable ecosystems so important to North Carolina. The inlets also are a vital transportation

link between the fishing grounds in the Atlantic Ocean and the points of discharge of the products harvested in the ocean. Currently, only two (Beaufort Inlet and Cape Fear River) can be traversed with relative certainty and safety. The others vary from impassable to relatively good passage at selected times.

This uncertainty affects the fishing industry in several ways: (1) limiting the time a fishing vessel can stay on the grounds by delaying its entry into the ocean following unfavorable weather conditions, and requiring an early return to port and safety during marginal or worsening weather conditions; (2) increased damage to vessels by bumping bottom or running aground; (3) increasing insurance costs because of the higher risks involved and damage claims paid by the insurance companies; (4)loss of fishing time while repairing damage; (5) limiting the effective area a vessel can work because of the necessity to run further for safe harbor in the event a sudden or unexpected storm develops.

Recommendation: That selected inlets be maintained at higher standards including jettying and/or other suitable engineering methods and that regional harbors be developed at these locations.

That a study be made to determine which inlets are more important economically, which inlets are more important from a safety viewpoint, which are more readily stabilized from an engineering viewpoint, and which are more important from an ecological viewpoint.

Select inlets suitable for an adequate stabilization and improvement program, and accomplish the necessary improvements.

This issue is also addressed in the "Transportation" chapter.

Program Area: COMMERCIAL FISHERIES

Goals : To increase income from commercial fishing through improved efficiency in catching, processing and marketing, and to preserve the long-range viability of the industry through efforts to maintain stocks and reduce environmental hazards.

PROBLEM	RECOMMENDATION
Environment and Stocks	
1. Inadequate protection of nursery areas during critical stages of species juvenile development.	1. Accelerate the completion of surveys designed to identify nursery areas so that recently developed management methods to protect juvenile stocks can be employed in remaining areas of the coast.
2. The intrusion of foreign fishing upon traditional fishing stocks of state fishermen.	2. Increase efforts to work with pertinent federal agencies to facilitate establishment of the necessary controls for protection of those species traditionally fished by the North Carolina industry.
3. Insufficient management controls for major fish stocks.	3. Develop state-federal management plans using existing data and conduct additional research where required. North Carolina would work with the NMFS and other Atlantic coast states in developing and implementing the plans.

PROBLEM	RECOMMENDATION
Environment and Stocks (con't)	
4. Detrimental impact of estuarine modification on fish habitats.	4. More rapid and thorough identification of ecologically sensitive areas; implementation of state-federal coastal management plans; improvement of state-federal impact statement procedures; conduct research supportive of impact statements and other regulatory requirements for coastal alterations.
Processing and Marketing	
1. North Carolina market and processing facilities have never accommodated the State's commercial catch to a satisfactory degree. The problem is to determine why and to correct if feasible.	1. Sponsor a study from a business analysis viewpoint of the entire opportunity from catching through processing and marketing. The objectives of the study are to identify viable business opportunities in this area and to identify the reasons for the lack of commercial development in processing and marketing be they technical, financial, legal or otherwise.
2. There is a lack of adequate marketing services to meet industry needs.	2. Increase the capability of ongoing marketing service programs.
Statistics	
1. Lack of adequate statistical data required for the management of the State's fisheries, sport and commercial. (Catch-effort data, age and size composition of catch, etc.)	1. Implement comprehensive statistical program geared to acquire data needed for economic development and evaluation of stocks and legally require licensed commercial fishermen to provide needed data.

PROBLEM	RECOMMENDATION
Advisory Services	
1. Inability of much of the industry to evaluate fully the results of research and make needed technological and business changes. Advisory services are not adequate.	1. A full-time professional unit with competence in business administration should be employed to advise members of the fishing industry in business and financial methods, availability of financial assistance, management of fishermen's resources and socio-economic and legal problems.
Inlets	
1. Unsure and unsafe accessibility to fishing grounds, or to refuge limits fishing time and increases the cost of fishing.	1. Conduct a study to determine which inlets are most important from the view of economics, safety, ecology and engineering (for stabilizing). Select the appropriate inlets and accomplish the necessary improvements.

CHAPTER 7

AQUACULTURE

I. Introduction

Interest and activity in the controlled rearing of brackish and marine organisms of commercial importance has recently reached an unprecedented level in many parts of the world. This interest has been stimulated by the anticipation of significant economic yield from high unit value species which appear capable of being grown in large numbers in rich estuarine waters. Varying degrees of success in growing crustaceans, molluscs, and fishes in confined natural waters have been reported from several nations. In the United States, estuarine aquaculture to date has largely been of an experimental rather than commercial nature. Notable exceptions to this are the culture of oysters and the successful commercial pilot operations for pan-sized salmon in Puget Sound and penaeid shrimp in an enclosed bay near Panama City, Florida.

Extensive estuarine systems dominate the coastal geography of North Carolina indicating considerable potential for the development of aquaculture of selected brackish and marine organisms. Natural features such as land configuration, temperature and salinity regimes, and high natural fertility which provide favorable habitats for wild stocks should prove equally suitable for cultivated sto ks. The fact that North Carolina coastal waters are still relatively free of pollution in comparison to many other states further enhances many locations as potential aquaculture sites.

In contrast to the open culture system which would utilize enclosures in the natural waters described above are closed culture systems. Such closed systems could conveniently be located adjacent to water of good quality while avoiding many of the biological, legal, and technical problems of open systems. Further, closed systems could be constructed on high ground avoiding problems attendant to the development of ecologically important wetlands or estuarine nursery areas. Thus, it might be economically feasible to operate either open or closed aquaculture systems (or both) in North Carolina.

II. Goals

1. To promote and coordinate the orderly development of an economically viable aquaculture industry based on selected high unit value species for which sufficient basic technological information is available.
2. To continue development and refining of aquaculture systems by obtaining relevant biological, engineering, economic, and legal information regarding such selected species.
3. To investigate the feasibility of developing culture techniques and systems which utilize additional species.

III. Current Status: An Assessment of Resources

Even for the best known estuarine organism which has high potential for aquaculture, the oyster, there are definite gaps in our knowledge which impede or prevent the further development of culture systems. Because of

such gaps, the culture of marketable species is still largely in the experimental stage. A recent series of workshops conducted by the Mardella Corporation under the auspices of NOAA will soon result in a report designating many of these gaps.

Despite the existence of such gaps, numerous commercial-scale ventures have undertaken the culture of various crustaceans, molluscs, and fin-fish in the South Atlantic and Gulf regions of the country. Many of these ventures have failed or are experiencing financial difficulties because of the lack of knowledge regarding a variety of specific problems such as nutrition, brood stock maturation and spawning, diseases, operations, economics, and legal sanctity.

Whereas, aquacultural practices in the Far East have largely involved tidal transport of larvae into diked enclosures with subsequent growth depending on natural food production, recent emphasis has been placed on developing hatchery operations to provide larvae or post-larvae for pond stocking with supplemental feeding. In this country, initial studies of shrimp culture in South Carolina and Louisiana also depended on pond or enclosure stocking by tidal transport of larvae, but recent aquaculture efforts (not only on shrimp) have tended toward the use of the hatchery-to-enclosure mode of operation with supplemental feeding of the organism. The general trend is to rely less upon natural production of young animals and to provide a more controlled environment in which the production capabilities of the system may be manipulated.

Aquaculture in the United States presently involves development along three basic lines all of which employ hatchery production of young for stocking in grow-out enclosures. The variation in technique arises from the size or stage of life to which the organisms are maintained in the grow-out situation. In one case, the organisms are harvested while still relatively small for sale as bait to sport fishermen (i.e., shrimp, minnows, worms). In the second case, the organisms are released into the natural waters and harvested after they have grown to marketable or catchable size (i.e., clams, oysters, salmon, striped bass). In the third case, the organisms are maintained within the grow-out enclosure until they reach marketable size and are harvested (i.e., shrimp, trout, catfish) or are maintained for use in fishing ponds (i.e., trout, catfish).

In North Carolina, the farming of catfish and trout have been active and profitable operations for several years. A pilot clam hatchery is in operation at Peletier Creek in Carteret County, and promising studies on the propagation and rearing of dolphin are in progress in Pamlico Sound. Hatcheries for rearing young striped bass for release into natural waters have been maintained for a number of years. In the past, farming of the diamond-back terrapin was active and profitable; however, none have been marketed in recent years due to lack of consumer demand. Also, several attempts have been made in the controlled production of soft-shelled blue crabs although such business activities are not strictly aquaculture.

Because organisms occurring naturally in North Carolina coastal waters are also found along neighboring states, aquacultural activities in

Delaware, Maryland, Virginia, South Carolina, Georgia, Florida and the Gulf States may have application in North Carolina. Particular reference is made to oysters, clams, bay scallops, and penaeid shrimp. It should also be noted that organisms presently not found or not commonly found in North Carolina, i.e., lobsters, salmon, abalone, etc., may become candidate species should closed systems be developed for their culture.

Many problems remain to be solved before most brackish or marine aquaculture reaches a profitable level in the United States. Combinations of reliable sources of larvae, improving conditions for growth, control of diseases, legal aspects of ownership and/or use of coastal and estuarine waters, and economic factors involved in production and marketing to provide a reasonable profit are some of the existing problems.

IV. Problems

1. Marketing and production economics are important facets of any aquaculture venture. Feasibility studies and economic analyses for profit potentials are vital for encouraging the entry of new capital into this field. Incentives in the form of low-interest loans, pilot-plant demonstration facilities, or assistance through advisory services programs need consideration and implementation to stimulate activity by private and corporate interests.

2. Over the past 100 years, research on the biology and life history of many commercial marine and estuarine species has resulted in a voluminous accumulation of information. Yet, as demonstrated by the Mardella aquaculture workshops and preliminary report, many gaps exist in our

knowledge which are of vital importance to the development of an economically viable aquaculture industry. Examples of these are: (1) nutritional requirements of all life stages for nearly all organisms being considered, (2) diseases, (3) genetics, and (4) environmental requirements for all life stages. The accompanying table indicates the relative potentials of ten species selected for consideration as candidates for aquaculture in North Carolina. Also indicated in the table are some of the areas in which knowledge is lacking about a particular species. Much of this knowledge could be obtained from pilot-plant aquaculture demonstration projects similar to the existing agricultural experiment station system.

3. Tolerance limits and optimal conditions for growth and production must be determined. If aquaculture is to be developed, pollution problems must be solved. Of long-range potential is the use of selected pollutants, i.e., seafood processing wastes or domestic sewage, as sources of energy in culture systems. There is a need for a comprehensive survey of the estuaries to determine the most favorable areas in which particular species might be cultivated. Such a survey, however, must consider the potential conflict with other uses.

4. Of importance for many potential species is the inability to hold brood stock to maturity and induce spawning to provide "domestic seed" animals for growing and genetic study.

5. Legal analyses related to water and wetland use in the private development of aquaculture are needed to define the limits of ownership, leasing, and protection. Related problems of zoning for multiple or ex-

clusive use of estuarine and coastal areas need to be resolved; new legislation may be needed.

6. There are only a few species, such as oysters, hard clams, and bay scallops, which are present prime candidates for commercial aquaculture in North Carolina.

7. There is a lack of information regarding the effects of aquaculture on the environment. Further, it is evident that discharges of effluents from culture operations will have to meet Federal Water Quality Standards. The effects of such operations on the environment should be determined and corrective steps taken so that natural waters are not adversely affected by aquaculture.

8. There is a need for cooperative culture programs and improving communication between the researchers, governing agencies, and industrial participants. Public understanding of aquaculture should be improved, and a viable means of disseminating information to users needs to be developed. Joint industry-academia pilot operations could aid the development of an aquaculture industry in North Carolina.

V. Current Programs

At present, aquaculture in North Carolina is being carried out to a very limited degree. There are a few full-fledged culture operations, but most of the effort is limited to studies of selected aspects of the culture of certain species. The following is a brief summary of the existing culture activities in North Carolina with these being either aquaculture programs or projects related to aquaculture.*

*Those programs which are aquaculture will be designated (P) and those which are related to aquaculture (R).

1. Striped bass - Studies on the formulation and evaluation of diets for juveniles are being conducted at East Carolina University (R). Hatcheries are being operated by governmental agencies to produce young striped bass for stocking in natural rivers and estuaries (P).

2. Dolphin - Studies are underway at Hatteras and in Pamlico Sound (N. C. State University) with the objective of developing techniques for spawning, rearing, and maintaining dolphin year-round (P). Initial growth studies have shown the dolphin to be a rapidly growing fish which adapts well to captivity. Eggs have been obtained and hatched but all larvae died within nine days. The study is funded by Sea Grant.

3. Hard clams - The Coastal Zone Resources Corporation has successfully reared hard clams to seed size in large numbers (P) at Peletier Creek in Carteret County. Since June 1972, this company has produced 41 million clam larvae, 14 million post-larvae, 4 million small seed clams, and planted 400,000 large seed clams on natural estuarine bottoms. Present programs are designed to delineate markets and assess the potential for marketing seed clams. The program is funded by private capital and the Coastal Plains Regional Commission.

4. Oysters - The Coastal Zone Resources Corporation has planted more than 10,000 tire-bead configurations for off-bottom culture of oysters in which natural spat production is being utilized (R) in Rose Bay in Hyde County. The State of North Carolina is conducting an oyster rehabilitation program in which includes planting of oyster cultch upon which natural spat may set and grow. The program receives funding through PL 88 - 309 (R), administered by NOAA's National Marine Fisheries Service.

5. Crabs - Studies of larval development and rearing of blue crabs and other crustaceans have been and are being conducted at the Duke University Marine Laboratory (R).

6. Shrimp and Minnows - Under a Sea Grant project, initial studies were conducted by the University of North Carolina's Institute of Marine Science on the utilization of treated domestic sewage in brackish-water ponds for the cultivation of shrimp. Studies are planned for a system in which (1) shrimp and oysters are grown together under controlled conditions to produce food products, (2) minnows are grown in plankton culture ponds for sale as fishing bait and for use as food for cultured fin-fish, and (3) grass shrimp are grown for use as food for cultured fin-fish (R).

7. Other bivalve molluscs - At the University of North Carolina Institute of Marine Science, initial studies have been conducted on the use of suspensions of algal cells and other potential food materials in the culture of hard clams and bay scallops. Studies are planned to investigate the culture of calico scallops (R).

8. Other fin-fish - Programs at the National Marine Fisheries Laboratory, Beaufort, make use of larval and juvenile stages of menhaden and other species of fin-fish which are reared for experimental purposes (R).

9. A summary of the aquaculture potential of 10 selected species based on each of 10 criteria is shown in the following table.

VI. Recommendations

1. Establish joint industry-academia pilot-scale aquacultural operations to help solve several of the problems noted above this would provide

A summary of the aquaculture potential of 10 selected species. Species were scored on an all-or-none for each of 10 criteria. Higher total scores indicate those species with the highest potential at present. Note that these species were selected for consideration on the basis of an initial subjective judgement that they possessed higher potentials than species not being included, i.e. squid, stone crab, sea trout, etc. (Note further that most of the criteria refer to the technical feasibility of growing these species, not to the economic feasibility of commercial operations.)

	Controlled Spawning 1/	Simple Larval Development 1/	Fast Growth Rate	High Conversion Efficiency	Satisfactory Feeds Known	Commercial Feeds Avail.	High Priced Product	Hardy	Native to North Carolina	Density Potential	Total Score
MOLLUSCS											
Oyster+	1	1	0	0	1	0	1	1	1	1	7
Hard Clam+	1	1	0	0	1	0	1	1	1	1	7
Bay Scallop+	1	1	1	1	1	0	1	1	1	1	9
Calico Scallop+	1	1	1	0	0	0	1	1	1	1	7
CRUSTACEANS											
Penaeid Shrimp+-	0	1	1	1	0	0	1	0	1	1	6
FISHES											
Striped Bass+	1	1	1	1	1	1	1	1	1	0	9
Dolphin+	0	0	1	1	0	0	1	1	1	0	5
Flounders+	1	1	0	0	0	0	1	1	1	0	5
Mummichog-	1	1	1	1	1	1	1	1	1	1	10
WORMS											
Blood Worm-	1	1	1	0	0	0	1	1	1	1	7

+=Food Product -=Bait Product 1=advantage 0=disadvantage or largely unknown.

1/ Controlled spawning and larval development are essential so selected species noted (0) are not good prospects for culture at this time.

the demonstration facilities which would encourage the investment of additional capital and would provide the facilities for gathering information to fill in the blanks which now exist in our knowledge. This would also serve to improve communications.

2. Emphasis in the current programs should be directed toward expanding research on biology, economics, and engineering pertaining to prime candidate species with particular reference to needs as pointed out by the Mardella report.

3. Implement small-scale, controlled aquaculture studies in order to be possible to delineate those estuarine areas which are favorable for specific types of aquaculture. Thus, it would be possible to determine the potential for utilizing a portion of the many miles of mosquito control drainage ditches and other impoundments in coastal North Carolina for various culture operations.

4. As technology permits, establish long-term programs of selective breeding and genetic manipulation. If aquaculture is to progress toward the level of sophistication which has been achieved by agriculture, the genetic make-up of the stocks employed must be improved.

5. Ascertain the need for legislation dealing with the concepts of multiple and exclusive use of estuarine areas as well as with other legal-institutional constraints which preclude or impede the development of aquaculture in public waters.

6. Recognize and investigate the potential for culturing other native and exotic species. While this document has indicated favorable potential for

10 selected species, it should be realized that investigations being conducted in other parts of the country may reveal other species which have considerable potential for culturing in North Carolina. This will be particularly true should highly controlled closed systems be developed.

7. The effects of aquaculture activities upon the environment should be determined, including the characteristics of all effluents discharged so that water quality standards may be met. The intensive culturing of any organism may result in considerable amounts of waste products being discharged into the environment.

8. Utilize a central agency, such as the Coastal Plains Center for Marine Development Services in Wilmington, working in conjunction with State and Federal information facilities, to provide a clearinghouse for information on culture techniques, field developments, and up-to-date biological information. The three laboratories of the Marine Resources Center which are to be constructed in coastal North Carolina in the near future would then act as local points of information dissemination to potential users. (See Chapter 2.)

Program Area: Aquaculture

Goals :

1. To promote and coordinate the orderly development of an economically viable aquaculture industry based on selected species for which sufficient basic technological information is available.

2. To continue development refining of aquaculture systems by obtaining relevant biological, engineering, economic, and legal information regarding such selected species.

3. To investigate the feasibility of developing culture techniques and systems which utilize additional species.

PROBLEM	RECOMMENDATION
1. Aquaculture development in North Carolina for those species which appear among the most promising, such as oysters, hard clams, and bay scallops, has not progressed past the research and bench-scale process level.	1. Effect a linkage between research and projection through both joint industry-academia pilot-plant operations and State-Federal advisory services programs.
2. Gaps exist in the biological, engineering, and economic information with respect to the candidate species which prevent efficient and profitable aquaculture operations.	2. Institute specific research and development projects to fill in the knowledge gaps known to exist or identified by pilot-plant operations.
3. The culture potential of specific estuarine areas of North Carolina is unknown.	3. Based on small-scale controlled culture operations, identify estuarine areas of potential value for specific organisms and culture processes.
4. There are no genetically improved brood stocks available to potential culturists.	4. As technology permits, conduct a long-term program of selective breeding to develop such superior brood stocks.

Aquaculture (Con't.)

PROBLEM	RECOMMENDATION
5. Legal-institutional constraints preclude or at least impede the development of aquaculture in public waters or in systems drawing upon public waters.	5. Investigate and identify the nature and significance of this legal-institutional problem and enact suitable legislation if needed. Such legislation should be drafted to optimize multiple use of areas with aquaculture potential wherever possible.
6. There are only a few species, such as oysters, hard clams, and bay scallops, which are immediate candidates for aquaculture in North Carolina.	6. Continue to investigate the potential of other species, both those native to North Carolina and those found in other areas, for use in aquaculture.
7. There is a lack of information on the impact of aquaculture operations (either open or closed systems) upon the environment, particularly with reference to meeting water quality standards.	7. Determine the effects of culture operations on the environment including the characteristics of all effluents discharged from such such systems.
8. An information clearinghouse is needed for up-to-date information on culture techniques, field developments, and biological breakthroughs.	8. Establish a clearinghouse for up-to-date information on aquaculture developments.

CHAPTER 8

ENVIRONMENTAL QUALITY

I. Introduction

Although all aspects of environmental quality ultimately must be considered, this chapter deals essentially with problems of water quality and secondarily with problems resulting from alteration of estuaries, wetlands, and dunes.*

The major planning effort for water quality in the coastal region is the North Carolina Water Plan, currently under preparation by the Office of Air and Water Resources in the Department of Natural and Economic Resources. This plan is to encompass the entire State; and at present the plan is about 15 percent complete. The first draft effort to emerge as a part of the plan is directed at the coastal region and covers the Cape Fear River Basin. The plan, if adequately supported, should enable the State to fulfill its responsibility for water resources conservation and development by providing for the orderly and progressive use of water resources. Plans will be developed for up to 50 years in the future on a continuing basis and will include consideration of every major condition wherein the presence, absence, use and effects of water as a resource touch upon the activities of man.

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*Problems dealing with alteration of estuaries, wetlands and dunes will be treated in much greater detail in the final comprehensive report. Chapters on Oceanographic Research and Coastal Zone Management also address this subject.

A significant amount of data pertaining to the present and past quantity and quality of coastal water resources has been obtained including measurements of the magnitude and direction of flow. Basic data are obtained on a routine basis by the Division of Commercial and Sport Fisheries, the Office of Water and Air Resources, the Board of Health, and the U.S. Geological Survey, and on a non-routine basis by the National Ocean Survey. Additional data have been collected by various smaller groups conducting independent studies. An example is the measurement of nutrients in the Albemarle, Pamlico, Neuse, and Cape Fear estuaries by North Carolina State University Professors Copeland and Hobbie.

North Carolina hydrologic and climatologic data have been processed for computer storage and manipulation; these are available for retrieval from the Hydrologic Information Storage and Retrieval System (HISARS). Some water quality data are also being incorporated into the Environmental Protection Agency's STORET system.

Data on public water supplies are routinely reported to the State Board of Health. This organization also monitors the bacteriologic quality of shellfish waters.

Data from all of these sources are extensive but in order to maximize their availability and use, they should be more conveniently assembled and they should be supplemented by field study as gaps and shortcomings are identified. A contralized repository and a data management system are needed.

The General Statutes of North Carolina have long considered the problems of waste disposal into the waters of the State. These include the following: Chapter 130, Public Health, Article 13; Chapter 113A, Pollution and Environment,

Articles 1 and 3; Chapter 143, Article 21 Department of Water and Air Resources, Article 38 Department of Water Resources; Chapter 153, Article 25, Metropolitan Sewerage Districts; Chapter 159A, Pollution Abatement and Industrial Facilities Financing Act; and Chapter 160A, Article 8, Emission of Pollutants; and Chapter 162A, Water and Sewer Systems.

The recently enacted new Federal water quality and waste disposal laws in October 1972 ultimately will call for far reaching actions by North Carolina. Standards will have to be upgraded, industrial and municipal wastes treated better, regulations better enforced, and more long range planning initiated. These new laws will be a vehicle through which it will be possible to obtain additional funding and provide impetus to upgrade water quality programs. The continued close partnership between the State and Federal governments for marine resources planning should do much to assure that future water quality programs in the coastal areas can be developed and implemented with maximum efficiency. Further, the recently enacted national Coastal Zone Management Act of 1972 should result in strengthened land and water use planning and zoning which will complement water quality objectives.

Present water usage in the coastal zone is varied and includes public and industrial water supply, swimming, boating, commercial and sport fishing, municipal and industrial waste disposal, transportation, and agriculture. Rough estimates of present water usage for public and industrial water supply and waste disposal can be made from data obtained by the Office of Air and Water Resources. More sophisticated water demand studies are underway.

Evaluations of future water requirements for other uses might be made by the appropriate advisory committee(s) to the Marine Science Council (e.g., commercial fishing, mineral and energy resources, etc.)

Under statutory authority, the Board of Water and Air Resources has classified the surface waters of North Carolina, including tidal salt waters, for the best usage and has set quality standards to assure that such uses are protected.

Three levels of classification are recognized for tidal salt waters. The best usage of Class SA waters (the highest class) is shellfishing for market purposes and any other usage requiring waters of lower quality. The best usage of Class SB waters is bathing and any other usage except shellfishing for market purposes. The best usage of Class SC waters is fishing and any other usage except bathing and shellfishing for market purposes.

It is significant that North Carolina would like to classify most if not all of its 2.0 million acres of potential shellfish growing areas for the highest usage (Class SA) - - shellfishing for market purposes. Unfortunately, about one-fourth or 500 thousand estuarine acres cannot meet the necessary stringent quality standards at this time, due primarily to excessive coliform bacteria counts which indicate that the waters are contaminated with sewage.

II. Goals

1. Assure non-degradation of existing water quality,
2. Reclaim low quality (polluted) waters by raising to higher classifications, through the institution of appropriate remedial measures, and

3. Prevent the physical destruction and adverse alterations of estuaries, marshes, and dunes.

III. Considerations of Environmental Quality

Adverse effects on the coastal environment can be summarized as (a) those resulting from pollution, and (b) those resulting from man's deliberate modification of his environment. Inadvertent or accidental modifications and the effects due to major natural events such as storms are not included.

A. EFFECT DUE TO POLLUTION

1. Human, Animal and Industrial Waste

a. Current Status

The total population of the 25 coastal county region analysed by Riley* is about 600,000 persons. Only 200,000 of these live in areas with waste collection and treatment systems. Thus, two-thirds (400,000 thousand) of these people use some other type of waste disposal system such as septic tanks or privies. Although the area is not heavily industrialized, increasing numbers of waste-producing industries are being located in the coastal area. These are concentrated at several locations.

Nutrient enrichment, at present, is an emerging water quality problem in the State's estuarine waters. Severe eutrophication has occurred in the Chowan River during the past summer and evidence suggests that conditions

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*As defined in the report, "Waste Disposal and Water Quality in the Estuarines of North Carolina", by Charles D. Riley. (Except in this chapter and wherever else specifically noted, the coastal zone region being discussed in this report refers to a 26-county region as defined in Chapter 1).

are appropriate for major algae blooms in several other rivers. Inadequately treated municipal and industrial wastes and wastes from septic tanks, animals and urban runoff are major sources of the nutrients responsible for this enrichment. It is important to note that even secondary treatment will not remove significant amounts of nutrients.

Municipal wastes. At present there are 29 municipal waste sources in the coastal counties with a total "population equivalent" in terms of biological oxygen demand (BOD), before treatment of 200,000 people. Treatment reduces this by almost three-fourths to approximately 56,000. Some municipalities, such as Hertford, Wrightsville Beach, and Columbia provide treatment up to 90 percent but most are much less efficient. As a class, Federal government military and civilian facilities provide the poorest level of treatment. The largest Federal facility is at Camp Lejeune with a population equivalent of 25,000 after 50 percent treatment. The President, by executive order, has instructed all Federal organizations to implement the necessary pollution and abatement control programs in order to comply with State and Federal water quality requirements. The necessary programs are being planned and implemented.

Septic Tanks and Privies. Use of privies has declined greatly in the last few years, 835 permits being approved in 1964 and only 324 in 1970. At the same time, however, the use of septic tanks has increased. About 4,500 were approved in 1964 while more than 5,300 were approved in 1970. Although data for septic tank approvals is not complete, the number might even be greater in 1972. The bulk of new residential building units on the coast utilize septic tanks as most are in sparsely settled areas not having central waste collection and treatment systems.

Boating Wastes. Boat and ship activity adds several types of pollution to coastal waters. Sanitary wastes are often pumped overboard, solid wastes are thrown overboard, while gas and oil from engines leak into the water. It is difficult to determine the size of this problem or its effects, but Riley estimates that wastes equivalent to a population of 18,000 people are generated annually from boats and ships in North Carolina. The extensive use of marine sewage treatment devices and holding tanks may significantly reduce the problem. Although the North Carolina Wildlife Resources Commission requires that all boats equipped with a marine toilet must also have a treatment device or holding tank, limited shore pump - out facilities still cause many people to flush wastes overboard untreated. It is not possible to assess the quantity of solid wastes disposed of overboard. In addition to State requirements, the Federal Water Quality Improvement Act of 1970 will eventually require vessels and boats to have marine sanitary devices to handle human wastes.

Industrial Wastes. There are 87 industrial waste discharge permits in the coastal counties. Thirty-three are located in or near the Cape Fear River in Brunswick and New Hanover Counties while the others are widely scattered. The total population equivalent based on BOD of these industrial discharges is 1.6 million before treatment and about 290,000 after treatment. Although the general level of industrial treatment is considered to be good, several notable exceptions occur. Three pulp and paper mills contribute almost 200,000 of the 290,000 population equivalent BOD.

Animal Waste. Animal wastes are substances of major concern. A rough estimate of animal wastes produced in the Coastal Plains Region developed by

Riley suggests that swine contribute as much waste as the equivalent wastes from 1.9 million people. Similar figures for cattle, chickens, and turkeys may be expressed as 7,12, and 1 million people respectively. These raw animal wastes at the point of origin in the Coastal Plains Region are equivalent to the waste from 21 million people, and much of these wastes are not treated or biodegraded before reaching estuarine waters.

Urban Run-Off. Recent studies suggest that statewide, stormwater run-off from urban areas may be a significant source of pollution. Research in the Piedmont Region has shown that BOD contributed by storm run-off may equal that of sanitary wastewater effluent from secondary sewage treatment. Riley calculated that total BOD from urban storm run-off amounts to over 2 million pounds per year for the entire coastal zone. Although these figures may not be entirely accurate, they do suggest that urban run-off is a major problem that must be dealt with effectively.

b. Problems

Municipal Wastes. It is evident that there is considerable opportunity for improvement in municipal waste treatment programs on the North Carolina coast. In many areas, facilities are not providing an adequate level of treatment. This may be due to poorly designed treatment facilities or to poorly trained and inefficient operators. A full program at the State level is needed to upgrade existing waste treatment facilities and to provide additional training for operators. Expansion of existing facilities and planning for new municipal collection systems and treatment facilities is also a vital requirement. Funds are available at the State level to plan regional waste collection and treatment facilities. Such planning must

immediately be intensified in the coastal zone. This is the only way that the massive pollution problems caused by high density settlements with no treatment other than septic tanks can be alleviated.

Septic Tanks and Privies. Several problems attend the rapid increase in numbers of septic tanks. Although many are in areas where soil porosity is appropriate, the sheer density of such installations can render ground water unfit for domestic use. Many other installations are in areas having permanent or periodically high water tables so that proper tank performance cannot be achieved and partially treated wastes seep into estuarine waters. Large numbers of tanks have also been installed in areas where fill has been placed over impermeable layers so that the effluents flow laterally into adjacent waters thereby contaminating them. Although regulations at the State and local levels govern installations of septic tanks, they are often ignored or are weakly enforced. The problem of privies is obvious; they are dangerous to use and always present a pollution threat.

Boating Wastes. Limited shore pump-out facilities lead to the discharges of untreated human wastes into coastal waters and many vessels and boats do not yet have proper sanitary facilities for handling human wastes.

Industrial Wastes. Many industries provide adequate treatment of their wastes; several, however, do not. A State-wide program is needed to identify those industries having inadequate waste treatment facilities. In addition, effluent standards, as required by the Federal Water Pollution Control Act Amendments of 1972, should be established as soon as possible, particularly for polluting pulp and paper mills. The present concentration of heavy industry in the Wilmington area should be examined to determine its impact on water quality and marine resources of the lower Cape Fear River.

Animal Wastes. The major problem associated with animal wastes is inadequate treatment or degradation prior to discharge into rivers and streams. In many areas, farmers run streams through animal holding areas to remove wastes and in others, where treatment is utilized, overflows and inadequately treated materials reach waters virtually undegraded. Animal access to drainage sites on dry pastures can also impose substantial waste loads to streams. Clearly some system for regulating such wastes is needed. At present, legislation on this subject has been prepared and will be presented to the 1973 Legislature. The draft bill calls for a system of permits to be administered by the Office of Water and Air Resources.

Urban Runoff. At present, urban runoff wastes receive only limited treatment. Contents of nutrients, hydrocarbons, and heavy metals of these wastes generally are of sufficient concern to receive attention. The effect of urban runoff on coastal waters needs to be determined so that necessary steps can be taken, to harmonize land and related water uses. Classification of coastal waters without regard to land uses and urban runoff will lead to increasing conflict which no reasonable investment in waste treatment can resolve. Characterization of urban runoff problems also is important when setting priorities for controlling point source discharge of wastes.

c. Recommendations

Municipal Wastes.

1. Upgrade existing waste treatment facilities so that they provide at least secondary treatment with disinfection as necessary to protect shellfish growing and bathing waters.

2. Institute a coast-wide program of long range planning for development of regional waste collection and treatment facilities in areas where

no such facilities exist at present.

3. Develop a program at the state level to provide better training and incentives for waste treatment plant operators.

4. Increase the frequency of state inspection of waste treatment plants to insure compliance with terms of the operating permits.

5. Develop a strategy for water quality monitoring which will better characterize sources of pollution and pollution effects on shellfish growing and bathing waters. (Note: This recommendation is applicable to all kinds of pollution and waters.)

Septic Tanks and Privies.

1. In all areas other than of low population density, central waste collection and treatment systems should be installed and septic tanks phased out.

2. In presently underdeveloped areas septic tanks should not be permitted for high density developments.

3. Septic tanks should be permitted only for low density development where soil conditions and ground water levels clearly are suitable and then only under the strict supervision of a qualified state official.

4. Prohibit the use of privies except where they are absolutely essential.

Boating Wastes.

1. Require that pump-out facilities be constructed at all new marinas and that they be constructed at existing marinas as soon as feasible, and that vessels and boats have marine sanitation devises as required by State and Federal law.

Industrial Wastes.

1. Implement the existing state law that requires periodic reporting of industrial waste discharges.

2. A full monitoring program for every industrial discharge in the coastal zone should be instituted immediately.

3. Effluent standards should be set for major industries on an individual basis.

4. Industries with wastes that are inadequately treated should be required to update their facilities at the earliest possible date.

5. Studies should be initiated to determine the long rage effects of concentrated industries in areas such as Wilmington and of any special pollution abatement needs that may develop therefrom.

Animal Wastes.

1. Institute a system of permits for regulating discharges from animal rearing and processing facilities.

2. Continue research on animal waste management.

Urban Runoff.

1. Initiate action to integrate land use controls with water use classifications so that land runoff will be comparable with the quality of receiving waters.

2. Heavy Minerals.

Current Status. Although heavy metals are a part of industrial wastes, they are discussed separately because of their importance. Unfortunately, however, very little is known about the occurrence of toxic metals in the State's coastal waters. Limited studies have been carried out by the Office of Water and

Air Resources of the Department of Natural and Economic Resources and the U.S. Geological Survey and the Environmental Protection Agency. The most intensive study was made on mercury in fish, birds, and raccoons in the Cape Fear River basin. These studies certified that local populations of raccoons and fish showed relatively high mercury levels in the fall of 1970 but that these had uniformly declined by the fall of 1971. The highest levels of mercury were found in raccoons taken near Acme-Delco on the Cape Fear River above Wilmington. These levels were related to discharges from an alkali-chlorine manufacturing plant in the area. The results from this study were similar to many other world-wide studies in that low levels of mercury, slightly in excess of the FDA standard of 0.5 ppm, were found to be widespread in naturally occurring fish and wildlife species. Clapper rails from Southport were the only true estuarine species sampled and mercury levels above 0.5 ppm were found. Studies presently are underway to determine heavy metal contents in estuarine fish and shellfish, but too few results have been obtained to permit any generalizations.

Problems. Information on the extent of heavy metals in coastal waters is so limited that is is difficult to develop a program to cope with them. The first step therefore is to define the magnitude of the problem. Obviously an intensive program to monitor industrial effluents and natural waters and biota is necessary. This should be accompanied by a strong state program to bring all discharges of dangerous substances down to an acceptable level.

Recommendations.

1. Because of their potentially hazardous nature, discharge of heavy metals should be reduced immediately to the minimum levels attainable by

present technology.

2. Sources of toxic heavy metal contaminents should be identified by surveys, and their concentrations in coastal waters, sediments and biota should be monitored so discharge criteria can be developed. Zero discharge should be the desired goal.

3. Discharge criteria should be refined as new technology permits and as monitoring dictates.

3. Oil Pollution.

Current Status. Pollution from oil is not the remote problem it is thought to be by many North Carolinians. Large quantities of oil are shipped into and through North Carolina. In the coastal zone the problem of oil spills generally is greatest near major shipping lanes off the coast at the approaches and ports of Wilmington and Morehead City, and on the Intracoastal Waterway. Although no producing oil wells have ever been found in the State, exploration continues. It is the considered opinion of geologists that subsurface conditions are suitable for the discovery of gas or oil.

Problems. Recent testimony before the Legislative Research Commission points up North Carolina's exposure to the risk of major oil spills. U.S. Coast Guard data indicate that 1.4 billion barrels of oil per year are transported by vessel past Cape Hatteras. The State's recent experience with coastal and inland spills is far from reassuring. During the first quarter of 1972, for example, one-third of the significant oil spills in the United States occurred in the eight states comprising the Southeastern Region of the Environmental Protection Agency.

North Carolina has the legal framework for protection against spills from oil wells drilled in the State, in the form of legislation enacted in 1971. However, similar proposals for oil spill cleanup procedures and permit controls over terminal facilities and pipelines were not included in the 1971 Act. Legislation to correct this problem has been prepared and will be submitted to the 1973 Legislature. Federal legislation, Public Law 91-224, enacted in April, 1970 deals with control of pollution by oil.

Recommendations.

1. New legislation relating to a comprehensive State program of oil spill control and surveillance over siting, and construction of major facilities for producing, transporting, storing, processing and refining oil and gas. Such legislation has been prepared by the Legislative Research Commission.

2. The State's enforcement capability to deal with all problems of oil pollution should be improved.

4. Agricultural Runoff - Pesticides and Fertilizers.

Status. There is little agreement as to the magnitude of fertilizer runoff and its effects on coastal waters. Research at North Carolina State University suggests that fertilizer runoff is not a major problem in the state. However, large releases of nitrogen can be anticipated under some conditions, leading to localized "hot shots", particularly when excessive fertilizer is used and high rainfall occurs.

Research on pesticide transport indicates that harmful quantities can reach surface waters through rain runoff and surface erosion. Accidental

discharges and careless use, however, are probably the most frequent causes of hazardous episodes.

It is difficult to assess the amount of pesticides washed into surface waters. Although estimates are available of quantities used in each of the State's river basins, many factors, such as characteristics of the pesticide, properties of soils, vegetation, topography, and sediment influence the quantities entering estuarine waters.

Preliminary studies have been made of levels of pesticides in North Carolina waters. These show that levels are higher in sediments than in water and that fine sediments contain higher levels that do coarse. This supports the contention that pesticides are transferred in water largely as molecules absorbed on fine particles. It was concluded that DDT, TDE, dieldrin, and toxaphene should be monitored. It would be most desirable to develop a system to monitor these pesticides in the tissue of estuarine plants and animals.

North Carolina passed a Pesticide Control Act in 1971. At present, the use and sale of pesticides in the State is regulated by the Pesticide Board.

Problems. There clearly is a need to further investigate the specifics of fertilizer and pesticide runoff. Detailed studies of fertilizer and pesticide use, and their interaction with soils and biota must be continued so criteria and regulations can be developed to assure that problem agricultural runoffs are held to the lowest levels consistent with good agricultural practices.

The Pesticide Board at present has no staff an therefore cannot monitor pesticide concentration in the environment, or changes in concentration which might occur as use patterns change. A major problem thus exists

because State regulatory programs do not operate with an adequate understanding of the status of pesticide concentration and movements in natural systems.

Recommendations.

1. Assess fully the implications of pesticide and fertilizer use in the coastal zone and institute cooperative programs with farmers to minimize unnecessary discharges into coastal waters.

2. Encourage the use of soil conservation practices for control of agricultural runoff pollution associated with sediment transport (erosion).

3. Expand programs of pesticide monitoring to include all major pesticides used in North Carolina to determine their concentrations in sediments, and biota.

4. Provide the administrative machinery to incorporate the results of monitoring in the regulatory programs of the Pesticide Board by expanding the capacity of the Board.

5. Thermal Effects.

Current Status. At present, only two electric power generating facilities are located in the coastal counties, one of which is nuclear. Both are on Cape Fear River and belong to Carolina Power and Light Company. One, the Sutton Steam plant has an installed capacity of 225 megawatts and the other, the Brunswick Nuclear plant has an ultimate capacity of over 1,600 megawatts. Future generating facilities in the coastal zone have not been clearly identified but Carolina Power and Light is known to be considering the need for facilities in the Northeastern Coastal Plain and in the southeastern Coastal Plain.

Problems. The streams of the coastal region are too small for once-through cooling of large steam-electric generating plants. Artificial cooling devices such as ponds, towers or spray modules appear to offer the only environmentally feasible alternatives. The use of shallow estuaries for cooling presents additional problems. The entrainment of small animals on intake screens, their destruction as they pass through the cooling system, and the resulting thermal and chemical additions to estuarine waters could cause considerable damage to estuarine biota and violate established water quality standards. Each case for cooling, however, would have to be assessed individually to arrive at the most acceptable method. The impact of estuary withdrawal for cooling and its discharge near Brunswick have not yet been determined.

Recommendation.

1. Intensively study each request to use coastal waters for cooling to assess potential impact and develop and recommend the most suitable site for such development and the most environmentally acceptable means of cooling.

2. Develop a power plant siting policy.

6. Natural Sources of Pollution

Status. Many rivers draining into North Carolina's estuaries have their origin in areas of high natural organic debris accumulation such as swamps and pocosins. These impose natural BOD loadings on streams and estuaries and cause highly colored waters, low pH, and depressed oxygen levels. Wastes from concentrations of wild animals and birds also may add substantial organic matter as well as enteric (intestinal) bacteria to coastal waters.

Problems. The magnitude of natural sources of pollution is very difficult to measure and evaluate. Limited evidence suggests that there may be substantial "natural background" organic matter and enteric bacteria from natural environments and from wild life resources. The significance of this contribution has not been determined.

Recommendations.

1. Assess the magnitude of natural pollution, identify sources, and determine its effect on water quality and biota. If found to be needed and if practical, develop control programs.

B. EFFECT DUE TO DELIBERATE ALTERATIONS

Water quality may be seriously impaired by a number of man's deliberate alterations of the environment. In addition to impact on water quality, deliberate alterations such as from development or excessive use also can destroy or seriously damage the physical environment, particularly of estuaries, marshes, and dunes, and sometimes even beaches. The effects of these deliberate actions must be assessed so that steps can be taken to eliminate or minimize their adverse environmental impacts.

1. DREDGING AND DREDGED MATERIAL DISPOSAL.

a. Status and Problems.

Dredging causes an increase, often temporary, in turbidity of the waters so that there is a decrease in light penetration, which in turn causes a reduction in photosynthesis and primary productivity. Tidal circulation may increase along with increased salinity intrusion so that pollutants might be flushed from an area faster. The opposite, however, can also happen. Increases in water depth by dredging might improve fishing,

but benthic organisms could be destroyed. Creating dead end channels can result in reduced reaeration and waste assimilative capacity so that a stagnant condition (devoid of most life), results.

Disposal of dredged material in estuaries and high quality salt marshes can reduce populations of wildlife, fish and shellfish through loss of food producing areas and habitats. Often productive shallow estuaries and high quality salt marshes could be irretrievably lost when used for disposal areas. Increased water turbidity, reduced tidal exchange, decreased dissolved oxygen, and introduction of toxic materials to nearby waters frequently accompany improper disposal.

Dredging can physically alter estuaries by deepening, and destroy marshes by removing them. Improper deposition can destroy water and marsh areas by filling or reduce water depths so that bay bottoms would be altered, benthic organisms destroyed, and water volumes reduced along with their assimilative capacity for wastes.

It is extremely difficult to assess the full range of direct and indirect costs and benefits which result from dredging and disposal of dredged material. The problems posed by such activities, however, are amenable to solution, but frequently not to everyone's satisfaction. At present there are Federal and State regulatory programs for controlling dredging and the resultant disposal of dredged material in coastal waters for new projects and for regulating maintenance dredging of existing navigation channels. Both the State and Federal governments require permits for dredging and deposition of dredged materials in navigable waters, estuaries, marshes, and other coastal waters below the mean high watermark. It is now very difficult for a private developer to obtain the necessary permits to dredge and

dispose of materials in such navigable waters. Unfortunately, the legitimate projects needed usually are approached in a piece-meal basis. Long range planning to determine needs for navigation channels, port facilities, disposal areas and future maintenance must be properly addressed, by the Federal, State and Regional Planning Commissions. Further, the possible commercial use of dredged materials has not been adequately studied; however, disposal areas now can be stabilized when it is necessary to do so and provided adequate funds are available. In Public Law 91-611, 31 December 1970, Congress requested the U.S. Army Corps of Engineers to develop a comprehensive program of research, study and experimentation relating to dredged material.

Recommendations.

1. Long range planning for dredging and deposition of dredged materials should be developed by State and Federal agencies. Such planning should identify high value ecologically sensitive areas, develop criteria to prevent their destruction and damage, and implement the necessary controls to assure their protection.

2. In the interim, dredged channels should be limited to sites which serve major public interest activities and which do not cause ecological imbalances or environmental degradation. The benefits to be derived from the dredging should always be scrutinized in relation with long-term environmental costs.

3. Wherever possible, dredged materials should be contained within diked ponding areas on uplands. When unavoidably deposited in estuaries, the material should be stabilized.

4. Productive uses of dredged material should be determined and plans developed for their utilization.

2. Stream Channelization.*

Status and Problems. Extensive stream channelization programs have been carried out by the Soil Conservation Service and by the U. S. Army Corps of Engineers. Although it is generally accepted that channelization accomplishes its primary purpose of reducing flood damages in urban and agricultural areas, there is considerable debate as to its side effects. It has been contended that increased rate of runoff from fields and through communities has resulted in added quantities of sediment, nutrients, and pesticides being introduced into the lower reaches of receiving waters. Land treatment programs, often accompanying channelization, are designed to minimize this effect. However, such programs require strict enforcement to insure that they are carried out and treatments are continued.

At present, two studies of the effects of channelization are underway. One deals with water quality and fish and wildlife resources. The other study is concerned with effects on surface and ground water quantity and quality. In both cases, these before and after studies are of long duration.

Recommendation.

1. Continue the ongoing studies of channelization and its effects. Insure that all project plans involving channelization, not now under construction, are reviewed and that project plans are brought into conformity with the study results.

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*Channelization is an improvement of the hydraulic characteristics of a channel in order to increase its flow capacity to reduce destructive flooding; common channel improvements are cut off, pilot channel, clearing and snagging, enlargement, and channel lining.

3. Canals

Status and Problems. Canal construction, in conjunction with coastal recreational housing and mosquito ditching has accelerated rapidly in the last few years. Evaluation of the effects of mosquito ditching in North Carolina is being obtained through the Water Resources Research Institute of the University of North Carolina. Studies in Florida indicate that coastal recreational housing canals can become serious environmental hazards especially when they are accompanied by poorly constructed and environmentally unsound septic tanks and waste disposal facilities. The Florida studies have shown that very high rates of pollution often occur in canals and that, in some cases, the water in the canal is entirely devoid of oxygen.

Recommendations.

1. Study the effects of canals constructed in association with recreational housing. Until this study can be completed, permits for such construction should not be issued unless clear evidence is established that there will be no degradations of environmental quality. Ongoing studies of mosquito ditching should be continued.

2. Develop criteria for canal construction based on the above studies so that environmental impact can be acceptably controlled.

4. Dune Development

Status and Problems. The development of dune areas for recreational use is a critical problem. Recreational development requires consumption of fresh ground water and disposal of waste water. Waste water disposal with septic tanks maintains the quantity of the ground water

resource but can reduce its quality. A sewer system and a sewage treatment plant are necessary if development is to be concentrated. The collection and point of discharge of waste water can deplete the level or the quality of ground water which is critical for the maintenance of the vegetation needed to stabilize the dunes. Thus, the degree of development that should be permitted in a dune area may depend upon the rate at which fresh water is resupplied to the ground by natural or other means. Further, construction on dunes or excessive traffic (vehicle and pedestrian) often destroys the stabilization vegetation and/or the dune proper.

Recommendations.

1. The development of dune areas should be restricted to density levels that will allow for adequate high quality ground water to sustain vegetation which, in turn, serves to stabilize the dunes.

2. The use of septic tanks in densely developed dune areas should be terminated; sewers and sewage treatment plants should be required.

3. Criteria for levels of use and development for all dune areas should be established. Development and uses which would destroy the dune proper or its stabilizing vegetation should be prohibited.

4. Damaged dunes should be rehabilitated to the maximum extent possible.

Program Area: Environmental Quality

Goal : To assure non-degradation of existing water quality and reclamation of low-quality waters to higher classification by instituting appropriate remedial measures, and to prevent the physical destruction and adverse alterations of estuaries, marshes, and dunes.

PROBLEM	RECOMMENDATION
1. Inadequate treatment and/or control of human, animal and industrial wastes and urban runoff discharging into coastal waters.	1. To provide proper treatment and control of waste: (1) upgrade all treatment facilities to provide for at least secondary treatment and develop regional waste collection and treatment facilities where they are lacking; (2) prohibit the use of septic tanks for high density development, phase them out in areas of moderate density and where used, stringently control them; (3) monitor industrial discharges, set effluent standards for major industries and require adequate treatment; (4) develop a control and treatment program for urban runoff; (5) institute a program of permits to regulate discharges from animal rearing and processing facilities; and (6) require sewage pump-out facilities for boats at all marinas and that all vessels and boats have marine sanitation devices.
2. Insufficient information about and/or control of toxic heavy metals, pesticides, oil pollution, thermal effects and natural sources of pollution.	2. To control pollution of coastal waters by toxic and noxious materials and other sources: (1) identify sources of toxic heavy metals and reduce their discharges to minimum levels

PROBLEM	RECOMMENDATION
	attainable by present technology; (2) expand pesticide monitoring and improve regulatory programs; (3) enact new legislation to provide regulatory control over all phases of oil exploration development, production, transport and processing; (4) study the environmental impact caused by thermal pollution, take the proper actions to reduce unacceptable adverse effects to nonsignificant levels; develop power plant siting policy; and (5) assess the magnitude of natural pollution and its effect on water quality and biota for the purpose of developing control programs if needed and if feasible.
3. Deliberate destruction and adverse alterations of estuaries, marshes, and dunes by dredging, dredged material deposition, stream channelization and by inadequately controlled recreation and residential development.	3. In order to control the impact of deliberately destroying or altering the environment: (1) develop long-range plans for dredging and deposition of dredged material (2) limit dredged channels to sites which serve a major public interest and do not cause ecological imbalances; (3) require dredged material to be contained in diked ponding areas on uplands; when deposition in water areas cannot be avoided, it should be stabilized; (4) develop productive uses for dredged materials; (5) carefully assess on-going channelization and canal dredging projects until appropriate studies can be

PROBLEM	RECOMMENDATION
	completed and criteria developed to regulate such construction; (6) in dune areas restrict development to density levels and uses which will continue to provide for adequate high quality ground water for vegetation and which will not physically destroy the dune proper; and (7) identify all high value, ecologically sensitive areas, establish criteria for use and development which will prevent their destruction and damage, and implement the necessary controls to assure their protection.
4. An insufficient data base and data organization to assure maximum water quality program effectiveness.	4. Assemble all relevant water quality data for easy review and retrieval, introduce into appropriate data management system, identify data gaps and shortcomings, and initiate or intensify field data collection and monitoring programs. Cooperate with NOAA's Environmental Data Service.

CHAPTER 9

OCEANOGRAPHIC RESEARCH

I. Introduction

Detailed knowledge of the complex natural systems of the coastal zone is essential for management of the State's marine resources. This chapter deals essentially with basic research requirements, while most applied research requirements are discussed in other pertinent chapters, such as Commercial Fisheries, Environmental Quality and Aquaculture. This chapter also discusses research policy needs for applied research as well as basic research.

II. Goal

Identify and provide via a balanced research program the scientific information necessary for the management of the State's marine resources. To achieve this goal, an oceanographic research plan should be developed to take maximum advantage of existing State, Federal, academic, and private capabilities and facilities. The plan should also be designed to promote a flow of information back and forth between basic research levels, applied programs, and eventual users.

III. Current Status, Problems, and Recommendations

There is a surprisingly diverse group of institutions (Federal, State, interstate, academic, and commercial) with programs in various aspects of basic research in the estuaries of North Carolina and on the continental shelf. These will be described under Current Programs in this chapter. Work is also being conducted in the deep ocean, both off North Carolina and other parts of

of the Atlantic Coast, as well as in the Great Lakes.

Currently, there is no up-to-date compilation of marine research in progress in North Carolina. The Coastal Plains Center for Marine Development Services is now involved in preparing a complete and up-to-date list of the State's governmental, educational, commercial and basic research units which undertake or are concerned with marine science research.

Furthermore, no planning is underway to determine specific present and future needs for ship time and to assure its availability. Duke University's "Eastward" and Cape Fear Technical Institute's "Advance II" are both large instrumented ships which have commitments, for the most part, to deep water programs. The "Eastward" serves as a national facility and often operates in areas far from the North Carolina coast. "Advance II" has the primary mission of training oceanographic technicians; it supports and assists in activities of a number of research institutions along the Atlantic Coast and for most of 1972 has been operating in Lake Ontario. The commitment of both vessels to ongoing programs allows little leeway for scheduling of oceanographic research related to North Carolina estuaries, bays, and coastal waters. The Division of Commercial and Sports Fisheries in the N. C. Department of Natural and Economic Resources operates an 85-foot research vessel, the "Dan Moore," as well as three smaller vessels. In addition, the "Cape Fear II," a 45-foot National Marine Fisheries Service (NMFS) research ship, operates out of the Atlantic Estuarine Fisheries Center at Beaufort, North Carolina.

A. Physical Oceanography:

As a consequence of the work of Stefansson, Bumpus, Miller and others, the gross outline of the circulation pattern of the waters overlying

the North Carolina shelf is known. However, much more work must be done before details are established. Although North Carolina State University currently is conducting research in estuarine circulation, there is almost no published information on the circulation patterns of the vast complex of estuaries and lagoons landward of the Carolina Outer Banks. A detailed knowledge of the water of both the estuaries and the shelf, as well as information on water mixing in these areas, is basic scientific data required in almost every phase of coastal zone management. At present decisions are made without this information simply because it doesn't exist. For example, the movement and distribution of sediment, contaminants, nutrients, population of fish, of shellfish, their eggs and larvae are necessary inputs to decisions concerning fisheries management and are all on the circulation and water mixing patterns of coastal waters, yet this basic data is largely unavailable.

In addition to the gross annual circulation patterns of coastal waters and information on water mixing, general baseline studies on temperature and salinity are required for effective coastal zone management, particularly in the areas of fish conservation and pollution. A numerical model for water movements associated with autumn hurricanes and winter storms in the estuarine system and on the shelf would assist materially in understanding their effect on sea floor configuration and shifts in the shoreline. Seafloor configuration plays a role in the distribution of benthic organisms and the stability of such structures as navigational aids. It also affects the natural rate at which sand is supplied to the beach as well as the availability of sand for artificial replenishment purposes and thus affects shifts in the shoreline.

A specialized hydraulic model would also be valuable for predicting from the pattern of wave trains, the resultant distribution of wave energy on the sea floor, and the resultant system of wave-driven littoral currents. Information to help clarify sand movement on the sea floor and also show what portion of the shoreline might be expected to erode away, could be generated by this model. Significant work along this line is presently being done by North Carolina State University, the Wilmington District of the U. S. Army Corps of Engineers, U. S. Army Corps of Engineer's Coastal Engineering Research Center (CERC), and NCAA's Atlantic Oceanographic and Meteorological Laboratories. CERC is presently planning to construct a research pier and attendant facilities at Duck, North Carolina on the Atlantic Ocean.

B. Chemical Oceanography:

The primary aim of chemical oceanography research is understanding of the consequences of the chemical nature of seawater on biological, geological, and physical processes in the marine environment. Thus understanding is critical if we are to deal with such problems as pollution and coastal water fertility in the coastal zone. Almost no information is available concerning kinds, concentrations, and disposal paths of nutrients and chemical contaminants in the estuarine system or on the shelf, although the University of North Carolina through Sea Grant support, is studying the concentrations and transport rates of nutrients in Albemarle Sound and the Neuse River estuary. Furthermore, research should be conducted on improved analytical methods for the determination of specific pollutants that are most toxic and long lasting in the environment.

C. Geological Oceanography:

A sizeable body of literature is available on geological aspects of the North Carolina Coastal Zone. The gross outlines of bottom sediment distribution in most of the estuaries has been established by the University of North Carolina, and on the shelf by Duke University, Old Dominion University in Virginia, and the U. S. Geological Survey. However, the details of shelf sediment distribution must be determined. This additional information will give important clues to the distribution of benthic organisms (surf clams, for instance, live primarily in the fine to very fine sands on the flanks of sand ridges) and also to the regional sediment transport pattern.

A study of the sediment budget 1/ of the North Carolina Coastal Zone was completed in 1970 by North Carolina State University (Langfelder, Stafford, Amein). This sediment budget affects aspects of coastal zone management as diverse as shoreline erosion control, channel and harbor maintenance, environmental impact of dredging and dumping, the distribution of aggregate (sand) and placer minerals, the dispersal of dredged material and sewage sludge, and the amount of absorption of nutrients and contaminants by suspended fine sediment.

Geological baseline studies in addition to those already undertaken are needed for a thorough understanding of shoreline processes, mineral resource assessment, and pollution problems.

1/ The term "sediment budget" refers to an assessment of storage volumes (cubic yards of sediment) in such sediment reservoirs as the beach sand prism, shelf floor sand blanket, etc., and the rates of sediment transport (cubic yards per year) between these reservoirs.

D. Biological Ocenaography:

Despite the relatively long history of fisheries-oriented research in North Carolina, a great deal of basic work remains to be done. The density and distribution of faunal communities is poorly known, and a detailed faunal census is a prime requisite for an understanding of fisheries and coastal water fertility. Although life history data has been gathered on a number of species, it is not adequate for suitable management with the exception of menhaden.

Rational management of fishery organisms exploited by man will depend ultimately on man's understanding of the dynamics of ecosystem function and the responses of individual species and of the other man-induced stresses. NOAA's Marine Resource Monitoring and Assessment Program (MARMAP) will be important in assessing fish stock offshore. In addition, NOAA's Atlantic Estuarine Fisheries Center, located at Beaufort, North Carolina is fulfilling a critical need in two major fields of investigation:

1. Basic ecological studies to describe and understand natural principles underlying the complex dynamics of estuarine ecosystems which includes the coastal wetlands (marshes), so that the State and Federal Government can develop sound policies for the management of estuaries and for the control of estuarine pollution; and

2. Life history and population studies of coastal recreational and commercial fishes to describe the status of exploited and latent stocks and to insure their wise use.

E. Coastal Engineering:

There is a need for a large engineering data base of reliable data on

surface waves, wastes and pollution, sea/shore interactions, and seabed conditions for solutions to many of the problems in the coastal zone. For example, North Carolina State University and the Wilmington District of the U.S. Army Corps of Engineers have identified the major problems of coastal erosion and inlet and harbor maintenance, and a start has been made in obtaining the necessary information for specific trouble areas. Work on the data base, however, must be expanded if we are to cope with the myriad problems in the coastal zone. The CERC research pier mentioned earlier should assist in the study of coastal processes.

IV. Current Programs and Plans

North Carolina Marine Science Council - This organization which is presently responsible for guiding the growth of marine science in North Carolina is sponsoring a survey of public and private marine institutions and organizations in the State, with a view toward determining the disciplinary aspect, scope, and degree of completion of marine research projects, as well as examining possible relationships between such projects.

North Carolina Board of Science and Technology - This Board, comprised of representatives from business, State government, the universities and professions, sponsors a number of marine-related programs, some of which are identified as "seed projects" designed to initiate research and better understanding of the management needs and requirements for regulating use of the State's marine resources. Since 1964, the Board has awarded 34 grants for research which can be classified as oceanographic. Although these grants cover both the geosciences and life sciences, they have not been

coordinated or directed toward solving the specific applied marine problems of critical interest to North Carolina

Nevertheless, the data and information derived from research funded by the Board of Science and Technology will be of use in such areas as developing pollution control systems or marine aquacultural farms.

North Carolina State University, Raleigh, N. C. - The marine sciences program provides for graduate education, research and extension services. The graduate enrollment currently includes students pursuing courses of study with concentration on physical, geological, biological oceanography, marine meteorology, and coastal engineering. Many graduate students find it convenient to conduct their research at the Atlantic Estuarine Fisheries Center, Beaufort, N. C. Research aspects of this program are funded by Sea Grant, private industry, and the State. Current research includes analyses of coastal erosion, and estuarine circulations. Extensive use of the photographs of the Earth Resources Technology Satellite (ERTS) will be used in this research. Marine resource projects in the extension service provided by the University have focused on providing assistance to the seafood industry in developing new techniques for harvesting and processing.

University of North Carolina, Chapel Hill, N. C. - A full graduate curriculum in the marine sciences, with primary emphasis on the biological, chemical, and physical aspects of oceanography is offered by UNC-Chapel Hill. Most of the research activities as well as instruction and service covering areas of coastal management, marine resources, estuarine studies, and oceanography are performed at the Institute of Marine Sciences, Morehead

City, N. C. The program is receiving Sea Grant funding. The primary mission of the Institute, a branch of UNC-CH, is ecological research of estuaries and the near-shore ocean environment. While particular attention is given to obtaining basic knowledge of organisms and their life functions, changing environmental and socio-economic conditions and their effect on various organisms are also under investigation. Two faculty members of the UNC Law School are engaged in studies of legal problems related to ocean and estuarine development.

Duke University, Durham, N. C. - Duke University offers a full range of courses in the oceanographic aspects of the life sciences, the physical sciences, and engineeing both at the graduate and undergraduate levels. The program of instruction is complemented by a strong program of research at the Duke University Marine Laboratory, Beaufort, N. C. The laboratory is funded by governmental and private sources. It offers seminars and short courses, maintains an excellent library of journals and other marine science reference materials, maintains a museum, and operates the 117-foot oceanographic research vessel, "Eastward."

East Carolina University, Greenville, N. C. - At East Carolina University, undergraduate and graduate programs in marine sciences are available through the Departments of Biology and Geology. Both graduate and undergraduate students participate in a "quarter-in-residence" research program at the ECU Marine Science Center at Roanoke Island. This is a broadly based, interdisciplinary study of the coastal environment with a strong emphasis on the interaction between natural processes and man. Additionally, a program of continuing education for commercial fishermen is actively

functioning under Sea Grant funding.

University of North Carolina, Wilmington, N. C. - The program of instruction and research at UNC-W emphasizes the biological and physiological aspects of oceanography. The major efforts are in the areas of ecological studies and coastal zone management. Basic research in high-pressure physiology and biology is conducted at the Wrightsville Marine Bio-Medical Laboratory, now affiliated with UNC-W. The University recently awarded a contract to construct a new Marine Science building on the campus to be completed in 1974.

Cape Fear Technical Institute, Wilmington, N. C. - Under the North Carolina Board of Education CFTI conducts two programs for training marine science technicians. The program in marine technology teaches the skills required for duties in physical, biological, and geophysical survey operations and basic fishing techniques. The program in marine laboratory technology is oriented toward near-shore and estuarine problems with emphasis on pollution and ecological studies. A third program is being developed to fill the demand for electronics and instrumentation technicians in the marine industry. The research vessel "Advance II" allows the students an opportunity for "hands-on" applications of the skills learned in the classroom.

Atlantic Estuarine Fisheries Center, NMFS, NOAA, Beaufort, N. C.* - This Federal facility sponsors research on estuarine ecosystems and commercial and sports fish populations. The estuarine research, supported under a cooperative agreement between the National Marine Fisheries Service and the Atomic Energy Commission is directed at understanding the natural functioning

* The research of this Center is described in more detail in Chapter 6, "Commercial Fisheries."

of the ecosystems as they relate to the distribution and cycling of radionuclides and the effects of thermal addition and radiation on estuarine organisms and ecosystems.

Research on coastal fisheries is directed to monitoring the status of commercial stock resources, investigating the causes of fluctuations in abundance, and relating changes in stock resources to environmental changes and to the fishing industry.

Additional institutions and a sampling of their programs are briefly described below:

National Climatic Center, NOAA, Asheville, N. C. - Conducts marine climatic studies.

Cape Hatteras National Seashore, National Park Service, U. S. Department of the Interior, Manteo, N. C.: Conducts experiments in the prevention of beach erosion at Cape Hatteras.

Atlantic Oceanographic and Meteorological Laboratories, NOAA, Miami, Florida: A pilot program of sedimentation and geochemistry on the North Carolina continental shelf has been initiated.

National Ocean Survey, NOAA: Conducts bathymetric and other geophysical surveys which are described in Chapter 3, "Mineral and Energy Resources." It also has ongoing programs in coastal mapping (photogrammetry), and physical oceanography, which include tide and current observations and analyses and estuarine modeling.

U. S. Army Corps of Engineers, The Coastal Engineering Research Center (CERC): An experimental (instrumented) pier in the ocean and field

facility at Duck, North Carolina is being planned. CERC also has an ongoing program for establishing aritificial marshes on the disposal sites in the vicinity of Drum Inlet, North Carolina.

U. S. Army Corps of Engineers, Wilmington District, N. C. - Supports coastal engineering research for CERC and for authorized Federal water resources projects, conducts an environmental reconnaissance inventory of items of environmental concern in the State of North Carolina.

Coastal Plains Regional Commission - The Commission is in the process of sponsoring technology transfer projects and studies of the marine environment which will help provide base line data relevant to effective management of marine resources.

U. S. Coast Guard - Affords opportunities and support for data collection in both coastal and offshore waters.

U. S. Geological Survey - Maintains a groundwater office in Greenville, N. C. which is concerned with the problem of salt water intrusion.

Westinghouse Ocean Research Laboratory, Annapolis, Maryland - Planning a comprehensive study of sedimentation on the North Carolina shelf.

Coastal Zone Resources Corporation, Wilmington, N. C. - Provides ecological evaluation of the impact of commercial development on marine resource systems for users, decision-makers and citizen groups. This company is also involved in developing production techniques for the intensive culture of shellfish.

International Nickel Corporation, Wrightsville Beach, N. C. - The Francis LaQue Laboratory is engaged in the study of the effects of salt water on metals.

V. Summary of Major Problems and Recommendations

1. Problems

a. Presently there is a lack of clearly defined needs as determined by the decision-makers and users for oceanographic research programs for the management of marine resources. This has hindered orderly planning; as a result certain programs required for the solution of critical problems have not received sufficient support.

b. There is an insufficient scientific and engineering data base in physical, chemical, geological, and biological oceanography, and coastal engineering to solve the State's more pressing problems. In addition, there is a lack of knowledge by the State's users and decision-makers of already existing estuarine and coastal research data and information.

c. The availability of suitably equipped vessels for research work in estuarine waters and on the continental shelf is largely unknown. This inhibits proper planning for the acquisition of required scientific information and in the past has prevented the determination of the existence of a possible vessel shortage for work in certain areas. For example, the early commitment of both the "Eastward" and "Advance II," vessels capable of working offshore, to ongoing programs has allowed little leeway for the scheduling of oceanographic research related to the North Carolina continental shelf. Scheduling of these vessels could be better optimized with across the board information on other available ships.

d. Research investigators, users, and decision-makers lack adequate knowledge of current research programs. The dissemination of information concerning ongoing programs and their findings has been inadequate.

2. Recommendations

a. Criteria should be developed for establishing research support priorities. These priorities should be set on an annual basis taking into account long term planning for the effective management of the State's marine resources. Such priorities cannot be established until a thorough inventory is made not only of existing coastal zone scientific data and information but of on-going and planned research programs. (This problem is also addressed in the Coastal Zone Management Chapter.)

b. Scientific areas and geographical locations where important data gaps exist should be clearly identified. Appropriate programs to fill these gaps should be developed, such as those indicated earlier in this chapter. In addition, the State should ensure that all available data banks and information sources be made readily available to researchers and users. For research planning purposes the State should also make maximum use of federal data banks such as those maintained by U. S. Geological Survey, Environmental Protection Agency, and NOAA's Environmental Data Services.

c. An up-to-date inventory of the annual use of all academic, State and federal vessels suitably equipped for various types of research activities in estuarine waters and on the continental shelf should be compiled. Such an inventory will make possible effective planning for research programs and will result in the optimum use of existing research vessels. Examination of the inventory should reveal if sufficient vessels are available to carry out any research programs that are determined necessary to implement the State's marine programs.

d. A description of research programs, their findings, and future plans should be periodically disseminated to the research community, appropriate State and federal agencies and be available for end users.

Program Areas: Oceanographic Research

Goal: Identify and provide via a balanced research program the scientific information necessary for the management of the State's marine resources.

	PROBLEMS		RECOMMENDATIONS
1.	Lack of clearly defined needs as determined by the decision-makers and users for basic and applied research has impaired effective management of marine resources.	1.	Criteria for establishing research support priorities should be developed. These priorities should be set on an annual basis taking into account long term planning for the effective management of the State's marine resources.
2.	Inadequate scientific information and in many cases, lack of knowledge by the user and decision-maker of already existing information has impeded the solution of resource management problems.	2.	Scientific areas and geographical locations where data gaps exist should be closely identified and appropriate programs developed to fill these gaps. In addition the State should ensure that all available data banks and information sources be made readily available to researchers and users.
3.	Lack of knowledge of availability of suitably equipped vessels has retarded planning for the acquisition of required scientific information and has prevented the determination of the existence of a possible vessel shortage.	3.	An inventory of the current annual use of all vessels suitably equipped for various types of research activities should be compiled by some agency that could assist in scheduling available ships in a manner consistent with established priorities for research in North Carolina.

PROBLEMS	RECOMMENDATIONS
4. Inadequate knowledge of current research programs by other investigators and users.	4. A description of research programs, their findings and future plans should be disseminated to the research community, and appropriate state and federal agencies.

CHAPTER 10

COASTAL ZONE MANAGEMENT

I. Goal

The goal of a coastal zone management program is the establishment of an effective system to insure that the resources of the coastal zone are used and conserved for the economic and social well being of the people of North Carolina and the nation. The following are objectives consistent with this goal:

a. To preserve and manage those natural ecological conditions of the estuarine system so as to protect, perpetuate, and enhance its natural productivity, and its biological, economic and esthetic value;

b. To insure that the development or preservation of the land and water resources of the coastal zone proceeds in a manner consistent with the capability of the land and water for development, use, or preservation based on ecological considerations, and in a manner such that the uses are compatible with each other.

c. To establish clear-cut objectives, policies, guidelines, and standards for all public and private uses of lands and waters in the coastal zone; and

d. To develop institutional arrangements to accomplish the above objectives so as to focus responsibility, provide viable means for implementation and review, and assure response to public will and purpose.

II. Current Status

Although North Carolina is seeking to achieve the goal stated above, it is apparent that all of the efforts of the past few years have not prevented heavy developmental pressures from causing serious damage to the marine environment. The people of the State are still concerned about the possible exploitation and disruption of its marine resource base in spite of an intensive effort within the past few years to develop effective research, education, and regulatory programs.

The key Federal and State agencies with missions and programs related to coastal zone management are listed below:

A. Federal Agencies

The federal government exerts considerable influence over the use of the lands and waters in North Carolina's coastal zone through its own activity and by regulating the activity of others. The Department of Defense owns large areas in coastal North Carolina. A major DOD agency, the U. S. Army Corps of Engineers, probably has a greater effect on use of coastal lands and waters than does any other state or federal agency. Its actions result from administration of Section 10 of the River and Harbors Act of 1899, relating to permits for dredging, filling and structures in the navigable waters of the United States, the Flood Plain Management Services Program, and its water resource development public works programs. The Environmental Protection Agency administers several water quality programs and together with the states enforces major federal anti-pollution legislation. Activities of several agencies of the Department of the Interior influence uses on the coastal zone. These include Interior's role in the Fish and Wildlife Coordination Act, carried out by the Fish and Wildlife Service, the cooperative programs of the Geological Survey and the Bureau

of Sport Fisheries and Wildlife, and the Bureau of Outdoor Recreation's coordination of federal recreation programs. In addition, the National Park Service administers the Cape Hatteras and Cape Lookout National Seashores. The U. S. Department of Agriculture's small watershed program, administered by the Soil Conservation Service, may have a profound influence on coastal resources in the coastal zone. The Department of Housing and Urban Development provides financial assistance for planning and administers the National Flood Insurance program.

The research and advisory services of the National Oceanographic and Atmospheric Administration (NOAA), in the Department of Commerce, provide major research, development and advisory programs for coastal zone management through their Office of Sea Grant, National Marine Fisheries Service, National Ocean Survey, Environmental Research Laboratories, Environmental Data Service, and National Weather Service. NOAA also has a role in the implementation of the Fish and Wildlife Coordination Act. The Commerce Department's Maritime Administration and the Economic Development Administration are also prime participants in coastal zone activities.

B. State Organizations

Among State agencies, the Department of Natural and Economic Resources (NER) has the major role for management of the State's coastal zone. Consisting at present of an administrative combination of several previously independent agencies, the Department has as its major functions promoting the conservation and development of the State's natural resources (including marine), the protection of its air and salt and fresh water resources, and planning assistance to local governments. Major agencies involved in these programs are the Divisions of Commercial and Sports Fisheries, Commerce and Industry, Travel and Promotion, State Parks,

Mineral Resources, Mining, Geodetic Survey, Community Services, Recreation, the North Carolina Forest Service, and the Office of Water and Air Resources.

In the Department of Transportation and Highway Safety, the State Highway Commission formulates policies and enacts rules and regulations necessary to govern construction, improvement and maintenance of roads and highways throughout the State. In addition, it operates a number of coastal ferries. The State Ports Authority, also in the same Department , develops and promotes the harbors and seaports of the State. The State Board of Health is vested with broad powers to protect public health, including jurisdiction over drinking water supplies, shellfish sanitation, mosquito control, and solid wast disposal. The Wildlife Resources Commission manages and regulates the wildlife resources of the State exclusive of marine fish.

The Department of Administration regulates the control and disposition of state property, including the management of all vacant and unappropriated lands, swamp land, and submerged land. In addition, the State Planning Division is authorized to coordinate and review all planning activities relative to federal requirements for statewide or regional planning and to maintain a comprehensive development plan for the State.

The Marine Science Council which operates within the Department of Administration, has broad responsibility for planning and helping to coordinate State, interstate, and federal programs involving marine affairs within the State. This organization is supposed to provide an overview of all of the programs of the State relating to marine affairs. Chapter 1 discusses the nature of the Marine Science Council in greater detail.

C. Interstate Organizations

The Coastal Plains Regional Commission, has as its major

goal improvement of the economic status of the region. Marine Resource development is one of its six target areas. The Interstate Environmental Compact provides a machinery for cooperative programs between the states relating to environmental protection. The Atlantic States Marine Fisheries Commission resolves problems dealing with interstate fishing and regional fisheries resource management.

D. Relevant Major State Legislation and Regulatory Policies

Although North Carolina as yet has no comprehensive program for coastal zone management, several recent pieces of legislation, administered by various State agencies, deal with some of these problems. Chapter 8 describes the environmental quality problems in greater detail.

1. Dredge and fill

Dredge and fill work in estuarine waters and coastal marshes is controlled under the terms of General Statute (G.S.) 113-229, passed in 1969 and strengthened in 1971. Before carrying out dredging or filling in any estuarine waters, tidelands or marshlands, an individual must obtain a permit from the Department of Conservation and Development in the Department of Natural and Economic Resources. Permits may be approved, with or without conditions, or denied on grounds of detrimental effects on navigation, on use of the water by the public, on public water supplies and public health, on fish and wildlife, and on public safety. In addition, all dredges working in coastal waters must register with the Office of Water and Air Resources as specified in G.S. 146-6.1.

2. Wetlands Protection

A Wetlands Protection Act (G.S. 113-230), passed in 1971, permits the Department of Conservation and Development in the Department of Natural

and Economic Resources to adopt rules and regulations to protect coastal marshes and contiguous lands. Such rules may be adopted only after hearings and publication of maps. As yet, this act has not been implemented.

3. Sand Dunes, Modification to

Modifications to sand dunes are regulated by G.S. 104B-3. This act specifies the important role that sand dunes have in protecting the coast and specifies that each county shall have the power to regulate proposed modifications through a system of permits. These are obtained from the sand dune protection officer designated by the county. Problems have been encountered in administering this act, particularly in the area of the expertise necessary at the county level to judge the effects of a proposed modification.

4. State Environmental Policy

The State Environmental Policy Act (G.S. 113A, Article 1) passed in 1971 requires that an environmental impact statement be prepared for any project involving state funds and having a significant effect on the environment. This Act, as a supplement to the National Environmental Policy Act, insures that no public construction programs will be carried out in North Carolina without an assessment of their environmental impact.

5. Permits for Air & Water Pollutants

As indicated in the chapter on "Environmental Quality," discharges of pollutants into air and water are regulated through permits issued by the Board of Water and Air Resources in the Depart-

ment of Natural and Economic Resources and in accordance with Federal laws. In addition, in order to manage ground water resources, the Board may identify and establish a series of capacity use areas. Limits may then be set, and permits issued, specifying the size of withdrawals from ground water reserves in each area.

E. Coastal Zone Management Federal Legislation

In October 1972 the President signed into law the Coastal Zone Management Act of 1972 (S.3507 - Public Law 92-583). In so doing he stated the following:

> "S.3507 recognized the need for carefully planned, comprehensive management programs to ensure the most rational and beneficial use of the coastal zones. This bill also recognizes that the States can usually be the most effective regulators of such a planning process. I will instruct the Secretary of Commerce to carry out this statute in a way which focuses Federal efforts on the adequacy of State processes rather than to become involved in the merits of particular land use decisions."

The Acting Director of the newly created Office of the Coastal Zone in the National Oceanic and Atmospheric Administration (NOAA) stated that, "The Coastal Zone Management Act of 1972 provides the essential need that Federal legislation had to meet: incentive and encouragement to the states to develop and operate programs to manage rationally their coastal resources and zones."

He further pointed out three key roles of the Federal Government,

> " - Provision of guidelines for states to use in developing their management programs.
>
> - Provision of financial assistance to help states in developing and operating programs under Federal guidance.

- Assistance to the states in acquiring the technical information, the data and the understanding necessary as input to any rational management process."

More specifically, Section #305 of the Act specifies that the Coastal Zone management program developed by the states shall include the following:

- Identification of Coastal Zone boundaries.
- Definition of which permissable uses have direct and significant impact on coastal waters.
- Designation of areas of particular concern.
- Identification of means by which states propose to exert control over use (such as through constitutional provisions, legislative enactments, regulations, and judicial decisions).
- Broad guidelines on priority of uses in particular areas.
- A description of the organizational structure proposed to implement the program, including inter-governmental and interagency arrangements.

Prior to granting approval of a management program, the Secretary of Commerce shall find that the State has authority for management. Such authority shall include power to:

(1) Administer use regulations, control development, resolve competing use conflicts.

(2) Acquire fee simple and less than fee simple.

Prior to granting approval, the Secretary shall also find that the program provides:

(1) For any one or a combination of following general techniques for control of use:

- State established criteria and standards for local implementation.
- Direct state land and water use planning and regulation.
- State administrative review for consistency with management program of all development plans, use regulations... with power to approve or disapprove after public notice and an opportunity for hearings.

(2) For a method of assuring that local use regulations do not unreasonably restrict or exclude uses of regional benefit.

NOAA, at the present time, is drawing up the necessary plans and arrangements for implementing the Coastal Zone Management Act.

F. Other States

Numerous States have enacted or are contemplating enacting either limited provisions regarding coastal zone management (such as a temporary moratorium on certain types of commercial development) or permanent legislation dealing with coastal zone management as an entire package. Several of the States which have already enacted wetlands legislation include Massachusetts, Connecticut, New Jersey and Maryland. In these states the preservation of coastal wetlands has been declared a public policy and any proposed alteration to them is either prohibited or regulated by permit to prevent damage to the wetland environment. Delaware's approach was to issue a temporary moratorium in early 1970, followed by the enactment of special legislation concerning industrial development in the Coastal Zone. While the Delaware legislation includes the wetlands, approximately half of the Coastal Zone encompasses dry or "fast" lands.

State controls of large-scale development have also been established recently during the past two years in Maine and Vermont; laws to control development of shorelands are in effect in Wisconsin, Minnesota and California.

Florida's actions in preparing for Coastal Zone Management in the State represents one of the more advanced plans in the Nation. In the November 1972 elections, its voters approved a bond issue of $240 million to buy endangered lands and outdoor recreation sites. The Florida Coastal Coordinating Council, which was created by the 1970 Florida Legislature, unites in one body the directors of the three-state departments with primary concern for the coastal environment. The Council which has its own staff, has four primary assignments:

- To develop a comprehensive coastal zone management plan for Florida.
- To coordinate state coastal zone research.
- To help assure the coordination of activities sponsored by Federal, State and local agencies with responsibilities in the coastal zone.
- To act as a clearinghouse for coastal zone information.

The Council selected two counties in western Florida as a pilot study area in which to work out the format and methodology to be followed in developing a coastal zone management plan for the entire Florida coastal zone.

Mindful of the legislative charge to develop a coastal management plan allowing for both preservation and development, the Coastal Coordinating Council has developed three basic zoning categories for land and water use.

- Preservation - no development.

- Conservation - limited development.

- Development - intensive development.

In arriving at these conclusions, the Council staff conducted and exhaustive study of many parameters, including but not limited to soils, vegetation, topography, beach erosion, ground water conditions, shoreline land use, recreational resources, and marine ecology, Criteria and recommended policy for each zoning category follows:

(1) Preservation (No Development)

Preservation areas are recommended to be protected from any further development except in extreme cases of overriding public interest authorized by the Cabinet of the Legislature. The preservation concept includes considerations of ecologically sensitive flora and fauna as well as fragile topographic features such as beaches, marshes, and dunes. Included are historical and archaeological sites and any unique, environmental features peculiar to the region such as selected springs, caves, waterfalls, and reefs.

(2) Conservation (Limited Development)

Conservation (or limited development) areas are recommended to be used for extensive land uses as opposed to intensive uses. The conservation concept is applicable to lands inherently unsuited to high density, intensive development because of physical limitations of the soil and/or high flooding probability. They are not considered critical to ecological balance but do provide buffer zones for preser-

vation areas and represent a retention of use options for future generations. The lands with soil limitations could in the future be used for development but based on present technology and engineering, would require a considerable expenditure of capital if that were done.

(3) Development (Intensive Development)

Development zoning includes: (a) lands already developed; (b) undeveloped lands now vacant or used for other purposes, including forestry and agriculture, which are intrinsically suitable for intensive development; and (c) undeveloped lands with some physical limitations--drainage problems, poor permeability, salt water intrusion--which can be corrected by drainage techniques, central sewage systems, or central water supplies. In general, these lands are not considered to be environmentally fragile. Although detailed zoning in development areas is recommended to be left primarily to local and county authorities, "key facilities" and shoreline use zoning would be subject to criteria established by the Coastal Coordinating Council.

III. Current Problems

1. Need for Effective Coastal Zone Management Organization

There is no dearth of regulatory authority or individual agency management programs in the North Carolina coastal zone. However, at this time there is a lack of effective coordination of all of the various management programs of the many State and Federal agencies with jurisdiction in the area, lack of overall planning, and lack of responsiveness of coastal zone research programs to State needs.

This problem has many facets. First, there is the necessity for a coordinated, comprehensive program for planning the wise use of the land, water, and resources of the area. The present pattern of administration leads to "piece meal" decisions which operate to the detriment both of programs for public resource protection and efforts at private development. If this fragmented pattern continues, it is likely that many of the State's marine resources will soon be seriously depleted.

The programs of university and government research and education are not sufficiently coordinated nor is there a recognized system for setting priorities to insure that they respond adequately to the needs of management programs. Such coordination is urgently needed and without it we will never achieve efficient expenditure of funds for marine resource protection and development. Various attempts have been made to devise the kind of machinery needed to coordinate all of these programs including the creation of the North Carolina Marine Science Council. Related to this are research policy recommendations found in the chapter on "Oceanographic Research."

2. Need for Land and Water Use Classification System

A second problem clearly related to the deficiencies in effective management is the lack of information concerning which portions of the coastal zone are most appropriate for existing and future uses. There are few good maps of the coastal zone of North Carolina showing the present status of man's activities, the distribution of the various natural resources on which man depends and the extent to which these resources are being developed, and the natural features suitable for diverse development and use.

These information gaps must be filled before a sound coastal zone management program can be designed and implemented.

3. Need for Funds to Purchase Lands Required for Preservation

In some cases it will prove necessary to acquire by direct purchase, areas that are deemed necessary for preservation. In addition, restrictions imposed on the use of private property may prove so severe as to constitute a taking without compensation. In such cases, prudence dictates that the State be able to purchase such lands. Although the 1969 General Assembly appropriated $500,000 for acquisition of estuarine lands, much larger sums will be required. It may be necessary to seek approval of a bond issue specifically for the purpose of acquiring coastal lands.

IV. Current Programs

Several actions have been taken in the last few years to help resolve these problems. These include:

1. The creation of the North Carolina Marine Science Council. The activities of this group were referred to earlier in this chapter and in Chapter 1.

2. The creation of a State/Federal Planning Committee to assist in comprehensive planning for the accomplishment of local, State, and Federal goals relating to marine affairs. This Committee has been working with the State Marine Science Council in order to help insure that there is an optimal relationship between State and Federal efforts. The nature of this Committee is described in greater detail in Chapter 1.

3. The Estuarine Study requested by the 1969 General Assembly. The Commissioner of Commercial and Sports Fisheries was asked to prepare a comprehensive and enforceable plan for management of the coastal zone. This plan is to be presented to the General Assembly in 1973.

4. The Commercial Fisheries Study Commission, established by the 1971 General Assembly, is developing recommendations for the growth and development of the fishing industry and for improvements in its administration at the State level.

5. Several local planning efforts are underway. For example, Currituck County has declared a moratorium on development to allow time for preparation of an overall plan for land and water use and resource management in the county. The town of Holden Beach in Brunswick County is requiring environmental impact studies for any future residential and commercial development. A pilot plan for coastal land management has been prepared by the State for New Hanover County.

6. The Federal Coastal Zone Management Act of 1972 has recently been enacted by Congress, as discussed earlier in this chapter.

V. Recommendations

A. Functions Required for Effective Coastal Zone Management

As stated earlier, the Commissioner of Commercial and Sports Fisheries is preparing a plan to be submitted to the General Assembly in early 1973. It is expected that this plan will recommend an overall governmental structure for Coastal Zone Management that is best able to fulfill the needs of the State. Such a structure should be responsible for the following functions:

1. Insure continued development of a comprehensive coastal zone management plan and its subsequent administration. The plan should provide for the following:

- Optimum development of selected areas, preservation of areas of public concern, and limited development for the balance of the coastal zone.
- Reclamation of degraded areas.

- Machinery for resolution of coastal zone multiple use conflicts through such processes as regulations, permits, zoning, and land acquisition.
- Establishment of institutional arrangements to focus responsibility, provide means for administration, and assure opportunity for public participation.

2. Provide for adequate representation of the State in reconciling its interests with those of local communities, the private sector, and other states, existing interstate organizations, and the Federal government in order to take advantage of the recently enacted Federal Coastal Zone Management Act of 1972. The new State Coastal Zone Management structure should also provide for the coordination of existing State government regulatory programs.

3. Determine the priorities of research necessary to accomodate the needs of the State Coastal Zone Management System and insure that such research is accomplished utilizing, whenever possible, existing competence in the government, academic and private communities.

These recommendations in this chapter deal with the desired functions of a coastal zone management structure for the State. The Council and State/Federal Planning Committee, however, have concluded that the question of the exact form of this organizational structure should not be addressed in this report. This decision was made because a parallel effort, being conducted by the State Commissioner of Sport and Commercial Fisheries, at the request of the 1969 General Assembly, is expected to recommend legislation early next year concerning the desired form of the management structure.

B. A Land and Water Use Classification System

The State should immediately begin to compile an inventory to be continually updated, of coastal zone lands and waters. This inventory should specify existing patterns and forecasts of uses on a comprehensive scale. This will also involve establishment of a classification system for land and water use in which the identifying characteristics are well agreed upon and clearly defined.

Criteria relating to the extent to which coastal lands and waters can tolerate developmental activities must be included. Eventually, a full inventory of resources should be conducted leading to maps of the natural systems including use patterns and other relevant information relating to the full spectrum of man's activities in the coastal zone. Areas of public concern, including ecologically sensitive areas requiring preservation and management, should be identified, as well as those areas found to be suitable for intensive development.

C. Funds for Purchase of Lands needed for Preservation

A study should be initiated to determine the extent to which State funds will be needed to purchase lands in the coastal zone. Consideration should be given to direct appropriations and to the use of bonds, plus other alternative means (other than fee simple).

* * * * *

The recent passage of the Federal Coastal Zone Management Act of 1972 will do much to assure that North Carolina will be able to satisfactorily implement the recommendations cited above. In addition, the receipt of Federal financial and technical aid and planning guidance under the terms of this Act should help expedite achievement of the goals stated earlier.

A comprehensive coastal zone planning effort is now underway. Although the direction of the effort to date is consistent with the findings in this chapter, no final draft Coastal Zone Management legislation is yet available.

In seeking to develop an effective Coastal Zone plan, the State of North Carolina must insure that its marine resource base not be impaired or destroyed. History has taught that special attention must be given to proper management of resources lest pursuit of short-term gain result in the destruction of resources and jeopardize the very foundation upon which wise development depends. The extent to which the State adopts and adheres to a prescribed timetable and implements a comprehensive plan for its coastal zone will determine the success to which one can match uses and capacities of the resources and retain use options for future generations.

Program Area: Coastal Zone Management

Goal: The overall goal of a coastal zone management program in North Carolina is the establishment of a system that will insure that resources of the coastal zone are used and conserved for the economic and social well being of the people.

PROBLEMS	RECOMMENDATIONS
1. Lack of coordination of the various State and Federal management programs, lack of overall planning, and lack of responsiveness of coastal zone research programs to State needs.	1. A governmental structure for coastal zone management should be responsible for the following functions: (1) continued development of a comprehensive plan for the coastal zone and its subsequent administration, (2) provision for interagency and intergovernmental coordinating arrangements, (3) setting of priorities of the State's most important coastal zone research needs, (4) assured involvement of interested segments of the public.
2. Inadequate information concerning which portions of the coastal zone are most appropriate for existing and future use.	2. Criteria and classification system should be established for land and water use which will delineate various categories ranging from ecologically sensitive areas to those suitable for intensive development.
3. Inadequate funds to buy endangered lands and outdoor recreation sites.	3. Undertake study to determine extent of funds needed; consider alternative means for acquiring lands other than fee simple.