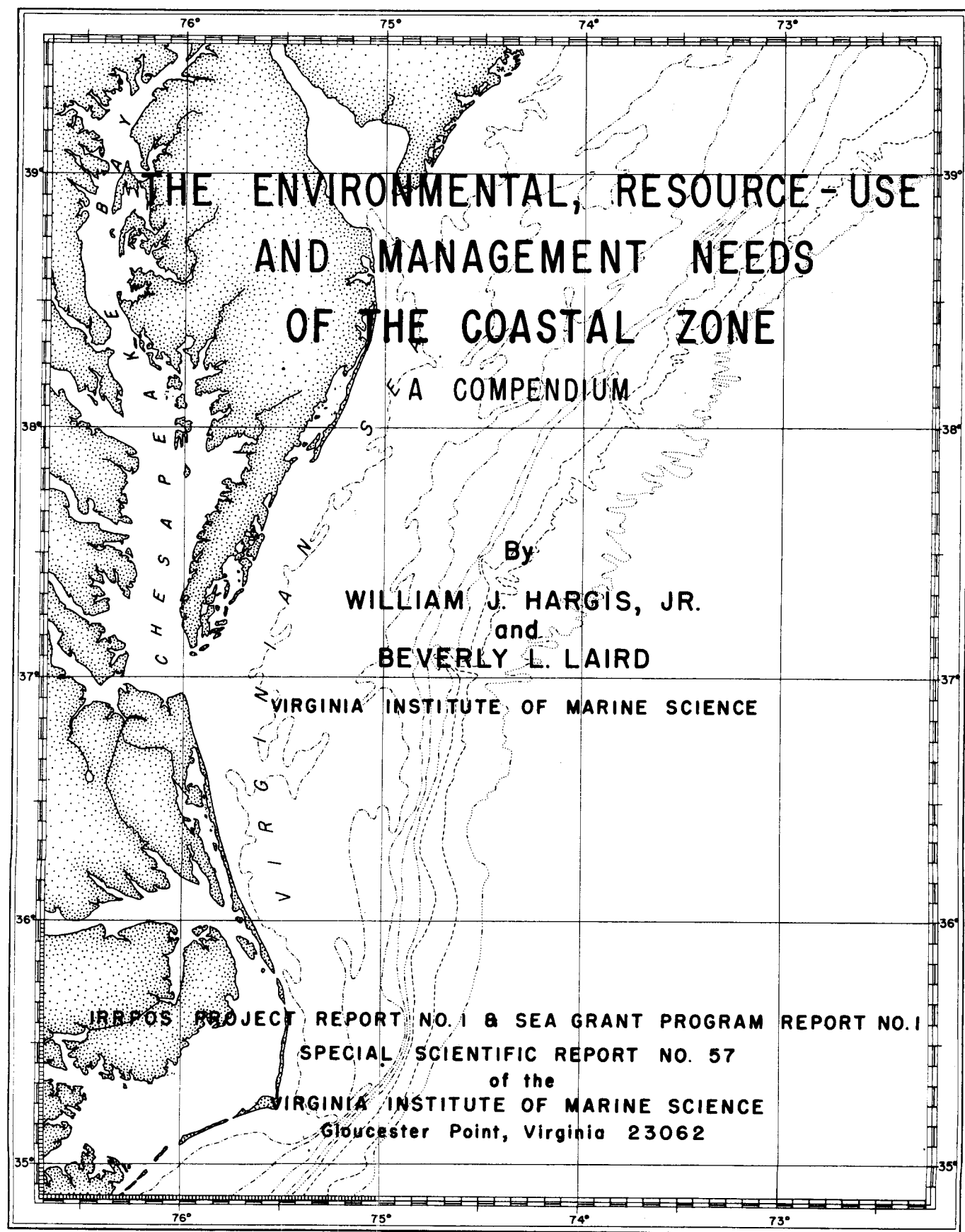


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THE ENVIRONMENTAL, RESOURCE-USE AND MANAGEMENT
NEEDS OF THE COASTAL ZONE,
A COMPENDIUM

by

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TABLE OF CONTENTS

	Page
Acknowledgments	ii
Table of Contentsiii
Introduction	v
ENVIRONMENTAL PROBLEMS AND INFORMATION AND TECHNICAL NEEDS	1
Outline	2
Water Quality	4
Air-Sea Interactions	14
Land-Sea Interactions	14
Hydrography and Fluid Dynamics	16
RESOURCE-USE PROBLEMS AND INFORMATION AND TECHNICAL NEEDS	19
Outline	20
Recreational Resources	22
Water (Hydrological) Resources	23
Biological Resources	25
Geological Resources	30
Bordering Areas	31
MANAGEMENT PROBLEMS AND NEEDS	34
Outline	35
Legislation	37
Decision-Making	40
Coordination	42

	Page No.
Technological and Economic Improvements	44
Education	45
BIBLIOGRAPHY	47

INTRODUCTION

As part of an extensive effort to develop a better understanding and evaluation of the problems imposed upon the Chesapeake Bay System by the activities of man and the management and informational needs related to their solution, we decided to examine a number of documents of ranging authorship and origin. The reports, papers, and manuscripts, comprising the resource materials utilized, range from the massive study entitled National Estuary Study -- recently completed by the United States Fish and Wildlife Service of the U. S. Department of the Interior, to internal study manuscripts of the Institute, itself. Included were studies aimed at environments and resources of Virginia's coastal zone, including the Chesapeake Bay, those of other states, as well as nation-wide or federal interests.

In all, some 53 separate items involving approximately 6800 pages were reviewed for relevant statements or data (see Bibliography, pp. 47 to 51). During the review, notes consisting of quoted or paraphrased materials were accumulated for later selection, sorting, and arrangement. Organization was developed in accordance with three categories:

- (a) Environmental Problems and Information and
Technical Needs,

(b) Resource-Use Problems and Information and
Technical Needs, and

(c) Management Problems and Needs.

The resultant draft lists were examined by the authors and several specialists, Dr. Robert J. Byrne, Dr. Edwin B. Joseph, Dr. Marvin L. Wass, and Mr. John J. Norcross, with appropriate eliminations, modifications, and reordering.

Due to the varied dates of production of the source materials, it is obvious that some of the items cited are of less urgency due to progress since the source documents were prepared. Indeed, we are aware of much progress in several of the problem areas mentioned. No great effort has been made to indicate priority.

The list should be of utility in developing appropriate planning and management programs for the Chesapeake Bay and mid-Atlantic region since it does provide a compilation of problems and needs statements from studies involving many thousands of man-hours by people of competence, experience, and responsibility. Many of the sources were quite extensive and exhaustive. With this variety of sources and their generally authoritative nature, our listing should serve as a basis for developing more selective lists of problems and needs in each category; lists to which priorities can be attached and from which action decisions can be made. In addition, along with other data, we at VIMS expect to be able to design more meaningful and timely research programs

to obtain the scientific information and engineering capabilities necessary to more efficient planning and management of the Bay and coastal environments and resources.

ENVIRONMENTAL PROBLEMS AND INFORMATION
AND TECHNICAL NEEDS

Outline
ENVIRONMENTAL PROBLEMS AND INFORMATION
AND TECHNICAL NEEDS

I. WATER QUALITY

A. Determining Factors

1. Industrial wastes

a. Chemical

- (1) Heavy metals
- (2) Nutrients
- (3) Other compounds

b. Thermal

c. Radioactive

d. Animal and vegetable processing

2. Agricultural and silvicultural

a. Biocides

- (1) Herbicides
- (2) Pesticides

b. Fertilizers and waste materials

c. Erosion

3. Domestic wastes

4. Miscellaneous

a. Oil and other hazardous materials spills

b. Eutrophication

c. Storm drainage

d. Ocean disposal

e. Alteration of normal freshwater inputs

- B. Modeling, Monitoring, and Methodology
 - 1. Equipment, instruments, and facilities
 - 2. Mapping

II. AIR-SEA INTERACTIONS

III. LAND-SEA INTERACTIONS

- A. Naturally-Occurring
 - 1. Erosion and sedimentation
 - 2. Beach processes
 - 3. Storms
 - 4. Miscellaneous
- B. Man-Influenced
 - 1. Dredging and mining (including channels, canals, and bottoms)
 - 2. a. Siltation and sedimentation
 - b. Spoil disposal
 - 2. Draining and filling
 - 3. Shoreline protection

IV. HYDROGRAPHY AND FLUID DYNAMICS

- A. Currents
- B. Estuarine Flow
- C. Mixing
- D. River Flows

ENVIRONMENTAL PROBLEMS AND INFORMATION
AND TECHNICAL NEEDS

I. WATER QUALITY

Establishment of:

--Standards for water quality.

A. Determining Factors

1. Industrial wastes

Studies of or development of:

- Methods of treatment of municipal and industrial wastes.
- The adequacy of present treatment systems.
- Possibility of in-river treatment of wastes and spills.
- Post-treatment residue disposal techniques.
- Refractory waste disposal problems.
- Methods to determine assimilative capacity of rivers and other environments for industrial wastes.
- Synergistic effects of effluent mixtures.
- Pollution of groundwater supply.
- Methods to select industrial sites for most efficiency and least environmental damage.
- Maximum utilization of existing facilities, manpower, and knowledge in solution of industrial waste problems.

a. Chemical

(1) Heavy metals

Research on or development of:

- Residence times of heavy metals in salt water and bottom sediments.
- Physiological effects of heavy metals on shellfish and other aquatic life.

- Methods to control and recover heavy metals.
- Methods to determine present production and consumption of heavy metals by society.

(2) Nutrients

Studies of or development of:

- Effects of nitrates, phosphates, and similar compounds on aquatic life.
- Methods to reclaim and recycle nitrates, phosphates, and other trace elements.

(3) Other compounds

Studies of or development of:

- Effects of PCB and compounds used in the plastics industry on marine organisms.
- Methods of controlling discharge or of treating these wastes.

b. Thermal

Research on or development of:

- Biological effects of thermal effluents, specifically behavioral and physiological effects.
- Techniques for the use of waste heat for aquaculture and related uses.
- Chemical consequences of thermal effluents.
- Effect of thermal effluents on normal stable characteristics of a water body, i.e. transport and behavior of heat energy in water.
- Methods for dispersion of thermal effluents.
- Seasonal variation in capabilities of specific bodies of water to assimilate waste heat.
- Methods to determine the best places for effluent discharge points for least environmental effect.
- Establishment of suitable temperature prediction and quality criteria.
- Possibilities of non-thermal power generation.

c. Radioactive

Research on or development of techniques for:

- Damaging effects of exposure to radioactive wastes to sensitive stages of aquatic organisms.
- Determination of levels of radioactivity in the environment which are harmful to aquatic biota.
- Determination of levels of radioactive wastes which produce concentrations in aquatic organisms which render them unsuitable for food.
- Determination of long-range effects of low level doses of radiation.
- Regulation of release of radiation to the environment.
- Effects of circulation in concentrating radionuclides.

d. Animal and vegetable processing

Studies on or determination of:

- Significance of BOD loading on tidal waters produced by food processing plants.
- Material other than organic wastes introduced into marine environments and food webs from food processing plants.
- Methods to dispose and/or utilize solids or solutes which result from processing animals and vegetables.

2. Agricultural and silvicultural

a. Biocides

(1) Herbicides

Studies of or development of:

- Effects of weed control on ecological quality of estuaries.
- More economical and desirable methods of prevention and control of weeds.

(2) Pesticides

Research on or development of:

- Role of pesticides in determining levels of reproduction of aquatic organisms.
- Effects of pesticides on species survival.
- Methods to limit effects of pesticides to target species.

- Present level of pesticide concentrations in the system.
- Pesticides which are more readily biodegradable and less toxic to aquatic life and other wildlife.
- Chemical reactions between pesticides and soil and water.
- Methods to decontaminate soil and water containing pesticides.
- Biological control of insects.
- Effects of DDT on marine environments.
- Damage of DDT to human health.
- Methods to dispose of empty pesticide containers and unused pesticides.

b. Fertilizers and waste materials

Studies of or development of:

- The behavior and fate of nutrients applied to land and water.
- Nutrients present and utilized in Chesapeake Bay.
- Methods to control nutrient content of receiving waters.
- Methods to comprehensively study eutrophication.
- Contribution of fertilizers and animal wastes to nitrate and phosphate content in water.
- Analytical procedures to determine phosphates.
- Contribution of chemically adsorbed phosphates.
- Animal waste management and disposal.
- Utilization and disposal of forest residues.

c. Erosion

Research on or development of:

- Areas of high natural rates of erosion and deposition.
- Effects of bathymetric, shoreline, and river flow alterations on patterns of erosion and sedimentation.
- Suitable techniques for measuring and monitoring turbidity and sedimentation.
- Effects of turbidity on marine systems.
- Techniques and criteria for managing color and turbidity of public waters.
- More effective techniques to control shore erosion caused by water and wind.
- Utilization of improved soil erosion prevention schemes and sediment traps.

3. Domestic wastes

Research on or development of:

- Complete treatment of domestic wastes.
- Methods to remove more of the nutrients from domestic wastes.
- Methods for solid waste reduction, disposal, and/or utilization.
- Design of aeration systems to prevent odor production from septic wastes and to promote aerobic digestion.

4. Miscellaneous

a. Oil and other hazardous materials spills

Studies of or development of:

- Techniques to determine toxic levels of different petroleum fractions to sensitive marine organisms (clams, oysters, scallops, etc.), and to the larval stages of other invertebrates and fishes.
- Physiological effects of oil on aquatic life.
- Survival of all life stages of selected species in different concentrations of various grades of oil.
- Effects of oil accumulation on the gas exchange of gill-breathing organisms.
- Previous spills to determine effects.
- Possibility of recycling used oil.
- Chemical composition of oil slicks at the point of origin and at increasing distances from it.
- Accumulation of water soluble toxic compounds in oil-polluted water.
- Rate of degradation of oil under controlled laboratory conditions and in the natural environment.
- Gas formation in oil sludges.
- Effects of surface films on evaporation rate, wave generation, and oxygen exchange rate.
- Better methods of removing oil from large accidental spills.

- More economical and easily used techniques, not involving the discharge of oil residues in the sea, for cleaning the bilges and fuel tanks of merchant ships.
- Degradation and utilization of oil and other hazardous materials by bacteria and fungi.
- Effects of explosions and vibrations from oil exploration on aquatic life.

b. Eutrophication

Studies of or development of:

- Magnitude of seriousness of eutrophication on domestic water supplies.
- Important nitrate sources in public water supplies.
- The effect of minimized nitrate concentrations on nuisance algal populations.
- Methods of harvesting and utilizing algae.
- Oxygen production and consumption of algae.
- Feasible methods to minimize phosphorus concentrations in wastewater effluents.
- The possibility of substituting harmless substances for phosphates in detergents.
- Methods to determine the effectiveness of better sludge management on receiving water quality.
- Ultraviolet remote sensing of sewage in marine areas.
- Better methods to control agriculture run-off.
- Nutrient budgets.

c. Storm drainage

Development of methods to:

- Determine pollutional effects of storm drainage overflow on the receiving stream including suspended solids, total and fecal coliform bacteria, BOD, COD, and oil.

d. Ocean disposal

Research on or development of:

- Alternatives to ocean dumping.
- Information about public health risks from ocean pollution.
- Better methods to measure public health hazards.

- Persistence of toxic substances in the oceans.
- Methods to determine best sites for ocean dumping with the least harm to the environment.
- Dispersal and distribution of wastes dumped into the ocean.

e. Alteration of normal freshwater inputs

Research on or development of:

- Better techniques to evaluate the effects of individual and collective reservoirs (dams) on estuarine and marine life.
- Effects of a specific dam on salinity, turbidity, and sedimentation in the estuary.
- Pre- and post-construction studies of effects of dams.
- Effects of storage on water quality.

B. Modeling, Monitoring, and Methodology

Studies of or development of:

- Models of the thermal and dynamic processes within the atmosphere and the boundary between the atmosphere and the solid earth and oceans.
- More detailed analysis to second-stage modeling.
- Computer-simulation models of each estuarine system in Virginia.
- Systems for continuous monitoring of hydrographic features of Chesapeake Bay.
- Systems for monitoring of concentrations and locations of chlorinated hydrocarbons and toxic heavy metals.
- In-plant and in-stream monitoring of industrial effluents.
- Effective national and international monitoring systems.
- Infrared imagery use for pollution monitoring.
- Satellite monitoring of global cloud cover, atmospheric heat balance, and surface albedo.
- Systems for worldwide ground monitoring of turbidity, carbon dioxide content, and water vapor distribution in the atmosphere.
- Systems for airborne monitoring of the number, density, size, and composition of particulate matter in the atmosphere.

- Methods for the collection, isolation, and production of all life stages of important aquatic organisms so they are available at all times in sufficient numbers for bioassay studies.
- Improved sampling techniques to provide more truly representative samples.
- Improved methodology for virological examination of water and waste waters.
- Method to reliably estimate the ultimate oxygen demand of biologically oxidizable materials in a short period of time (minutes).
- A uniformity of sampling procedures.
- Testing of several biological parameters which may furnish rapid indices of environmental requirements and safe concentrations of toxicants.
- Analytical methods for the development of micro-analytical toxicological procedures.
- Methods for the detection and quantitation of enzymes, metabolic products, hormones, and changes resulting from exposure to toxic materials.
- Methods for the determination of the effect of two or more biologically active materials that act either in unison, antagonistically, or synergistically.
- Methods to employ radioactive tracers to aid in determining toxicant-altered metabolic pathways, metabolism of toxicants themselves, and their turnover time or concentration sites.
- More accurate methods for compositing samples and taking samples from composites.
- Autopsy techniques to determine the cause of kills.
- Clarification of the chemistry of pollutants.
- Better methods or models for relating the conditions in streams, lakes, reservoirs, estuaries, or coastal areas to various kinds of land-use and to various kinds and amounts of effluents being discharged into these waters.
- Methods to determine new or better analytical methods for identification and quantitation of nutrients, toxicants, and trace elements.
- More highly efficient means of reducing the amount of heat discharged to our waterways.
- Methods to determine subtle changes in water quality.
- Methods for accurately predicting wave heights and periods at locations of interest (Tsunami Warning Service).

- New and better methods to devise and develop effective bioassay methods and other procedures for determining environmental conditions.
- Inexpensive, non-toxic sediment tagging techniques for clay size particles.

1. Equipment, instruments, and facilities

Research on or development of:

- Survey equipment for detailed mapping of bathymetric, geological, and ecological features.
- Survey equipment for three dimensional plotting.
- Design of offshore bulk cargo terminals.
- Data system to make data available on an automatic or rapid retrieval basis.
- New instrumentation to study biological species, distribution, feeding habits, reproduction, and migration (for example, use of acoustic networks to observe movement).
- An experimental continental shelf submerged nuclear power plant.
- Methods for rapid in situ at-sea analyses of chemicals, pH, Eh, etc., of sea water and bottom sediment.
- Magnetic and gravimetric survey instruments for use at depths.
- Mooring and anchoring techniques for deep ocean operations.
- Methods to improve and simplify diving techniques.
- Methods to make free diving possible at great depths.
- Methods for long-range, straightline communications below the water surface.
- Methods for better underwater optical visibility.
- Methods for fast, automatic buoyancy control.
- Tools especially for underwater work.
- Efficient, long-endurance exploration submersibles.
- Compact power sources for vehicles and habitats for underwater exploration.
- Improved propulsion systems for undersea systems.
- Turbulence meters for field use.
- Underwater lighting systems.
- Worldwide navigational system with an accuracy of 0.1 nautical mile.

2. Mapping

Surveys to develop:

- General maps which include measuring and plotting magnetic and gravitational fields.
- Accurate, up-to-date bathymetric and navigational charts of the oceans and estuaries.
- Maps of soil types.
- Detailed maps of surface water resources within the coastal zone.
- Maps of coastal counties showing the locations of all solid waste disposal areas.
- Maps of the coastal zone showing public and private wildlife management areas, hunting areas, distribution of large and small game species, etc.
- Maps of surface and sub-surface geology and of valuable mineral deposits.
- Maps of the major ecosystems, including wetlands, of the counties in the coastal zone.
- Maps of locations of existing and predicted residential areas in the estuarine region.
- Maps of locations of existing and projected or potential industrial areas in the estuarine system.
- Maps of existing and potential agricultural and forest areas.
- Maps showing present and predicted locations of commercial fisheries.
- Maps showing present and predicted locations of public and private game fish management areas.
- Maps showing present and predicted locations of public and private recreational areas.
- Maps of the estuarine region showing existing and proposed transportation networks.
- Maps of the estuarine region showing locations of State, Federal, county, and municipal lands and waters.

II. AIR-SEA INTERACTIONS

Research on or development of:

- Solar radiation to detect trends toward alteration of surface temperature.
- Methods for environmental forecasting, i.e. weather prediction.
- Energy budget-water budget of selected regions.
- Improved methods of precise measurements of the transmission of solar radiation.
- Mass, momentum, and energy exchange; reaeration mechanisms, wave generation, wind wave induced turbulence.
- Adequate humidity sensors.

III. LAND-SEA INTERACTIONS

A. Naturally-Occurring

1. Erosion and sedimentation

Studies on or development of:

- Causes and rates of erosion and sedimentation in specific Chesapeake Bay areas.
- Mechanics of soil erosion and shoreline erosion.
- Prototypes of new shoreline erosion prevention systems.
- Effects of sedimentation on tolerance limits of bottom organisms.
- Mechanics of sediment transport; rivers and coastal.
- Stream channel stability.
- Role of organisms in affecting the flocculation rates of sediments in estuaries and coastal waters.
- Role of organic debris in transporting trace metals to the sediments.
- Biological and chemical transformations occurring in contaminated and uncontaminated sediments.

2. Beach processes

Development of:

- Means to control beach erosion.

3. Storms

Studies of or development of:

- Effects of coastal storms.
- Rapid assessment of storm damage by remote sensing.
- Extent of flooding.
- Storm-surge processes.
- Forecast capabilities to determine extent of storm damage.

4. Miscellaneous

Research on or development of:

- Physiological, chemical, and biological effects of surface phenomena associated with suspended particles.
- Qualitative and quantitative penetration of light relative to silt size and type.
- Exposure of aquatic organisms to high turbidity to determine tolerance limits.
- Effects of turbidity on migration and movement of organisms.
- Stream channel stability studies and the effects of passage of deep draft vessels.

B. Man-Influenced

1. Dredging and mining (including channels, canals, and bottoms)

Studies of or determination of:

- Effects of shelf dumping and mining.
- Mining phosphates without polluting.
- Dredging projects to determine who is doing the dredging, who is checking on the dredger, and what damage is threatened.
- Ownership of bay bottoms being mined.

a. Siltation and sedimentation

Studies of:

- Effects of various silt concentrations on behavior and physiology of organisms.
- Minimization of sedimentation through land use and management.

- Sediment as a transport agent for chemical residues.
- Siltation resulting from man's activities.

b. Spoil disposal

Studies of or development of:

- Methods of disposing of dredge spoil.
- Effects of spoil on the bottom organisms.
- BOD causing and toxicity of sediments in deep and shallow waters of Chesapeake Bay, especially in areas of high dredging intensity.

2. Draining and filling

Research on:

- Effects of land-use changes on run-off.
- Provision of access over tidelands without blocking streams or channels or destroying valuable wetlands.
- Ecological effects of finger-type marshland developments.

3. Shoreline protection

Studies of:

- Effects of jetties, bridges, and causeways on fish movement.
- Enhancement of beach protection and environmental effects.
- Biological effects of hurricane barriers.
- Energy dissipation in the beach region to reduce erosion.

IV. HYDROGRAPHY AND FLUID DYNAMICS

Studies of or development of:

- Circulation patterns in lower Bay and adjacent coastal waters with special reference to the role on population fluctuations and dispersal of pollutants.
- Time and space scales of circulation changes within the first ten miles from the coast with development of predictor equations based on the effects of winds and bay discharge versus current direction and speed.

A. Currents

Research on or development of:

- Detailed, long-term current studies of estuaries and near-shore regions to determine wind and run-off effects on mean currents.
- Detailed studies of exchange of water masses between continental shelf waters and slope waters.
- Detailed studies of net transport of surface and bottom waters at the mouth of Chesapeake Bay as related to seasonal variation in freshwater run-off.
- Ocean current systems.
- Influence of current patterns on reproductive success and on migratory patterns.
- Methods to make actual measurements of tidal, current, and stratification phenomena.
- Effects of intermediate scale variations in the current pattern on the time-varying concentrations of waste components at various distances from the source.

B. Estuarine Flow

Studies of or development of:

- Tide movement as it relates to pollution and shellfish and other aquatic life.
- Tidal discharge patterns in the inlet-marsh channel networks.
- Transient effects on circulation due to floods and storm surges.
- Flushing times of estuaries.
- Physical and numerical models of circulation and water quality.
- Evaluation of stability and generation of interfacial turbulence in a stratified mean flow.
- Evaluation of entrainment, diffusion, and dissipation of buoyant jets and jets in stratified flows.
- Evaluation of effect of vertical diffusion and/or stratification on horizontal dispersion.
- Evaluation of vertical diffusion in a periodic turbulent mean flow.

C. Mixing

Determination of:

- The manner of mixing of Chesapeake Bay water with that of the Atlantic.
- Rates of mixing of both dissolved and particulate materials and how these materials behave in response to mixing of different sorts.
- Mixing coefficients in estuarine circulation.

D. River Flows

Studies of:

- Hydrographic characteristics of streams, the effects of channel modifications and water diversions.

RESOURCE-USE PROBLEMS AND INFORMATION
AND TECHNICAL NEEDS

Outline

RESOURCE-USE PROBLEMS AND INFORMATION AND TECHNICAL NEEDS

I. RECREATIONAL RESOURCES

II. WATER (HYDROLOGICAL) RESOURCES

- A. Desalination
- B. Pollution Dilution
- C. Drinking and Other Domestic Uses
- D. Agriculture
- E. Irrigation

III. BIOLOGICAL RESOURCES

- A. Applied Studies
 - 1. Culture and aquaculture
 - 2. Fisheries
- B. Basic Studies
 - 1. Food chains
 - 2. Control of predators, parasites, pests, and diseases
 - 3. Toxicity (lethal and chronic)
 - 4. Behavior, physiology, and distribution
 - 5. Life cycles
 - 6. Population dynamics

IV. GEOLOGICAL RESOURCES

- A. Minerals
- B. Oil and Gas
- C. Sand and Gravel
- D. Buried Shell

V. BORDERING AREAS

- A. Wetlands
- B. Shorelines
- C. Shallows
- D. Barrier Islands and Reefs
- E. Bottoms

RESOURCE-USE PROBLEMS AND INFORMATION

AND TECHNICAL NEEDS

I. RECREATIONAL RESOURCES

Research on or development of:

- Control of sea nettles and ecological implications of their control.
- Control of nuisance plants, i.e. sea lettuce, water chestnut, Eurasian water milfoil, and other aquatic weeds.
- Improved facilities and access areas for sport fishermen.
- Influence of aesthetic factors on human attitudes toward acceptance of water conditions.
- Methods to evaluate recreational benefits, monetary or otherwise.
- Methods to assess the effects of water pollution on recreation use.
- Treatment and control of wastes affecting recreation uses of receiving waters.
- Tests or procedures for the detection of organisms (indicator organisms, viruses, and non-viral pathogens).
- Monitoring for indicator organisms.
- Degree to which various pathogens are waterborne.
- Levels of exposure to pathogens which constitute infective doses for humans.
- Effective control or disinfection to maintain desirable sanitary levels at bathing beaches.
- Methods to evaluate recreational potential to be realized from waters of less than optimum quality for production of aquatic life.
- Means to assess the impact of the recreationist on water quality.
- Relative degrees of exposure and risk of infection represented by primary and secondary contact recreation.
- Methods to strengthen capabilities for traffic control and search and rescue methods.
- Impact of sport fisheries on fishery stocks.

- Economic significance of recreational fisheries.
- More access routes to the Eastern Shore of Virginia.
- Effect of littering on marine environments, particularly by plastic items, non-returnable containers, and large objects posing a danger to navigation or aesthetic trauma.

II. WATER (HYDROLOGICAL) RESOURCES

Research on or development of:

- Methods to evaluate present quality and quantity of water resources.
- Possibility of converting shallow sands with highly saline water to freshwater sands.

A. Desalination

Development of:

- Methods to expand the present program to develop alternate desalting methods.

B. Pollution Dilution

Studies of:

- The economic significance of utilization of tidal waters to dilute pollutants to enable better cost-benefit analysis and assignment of responsibility for cost-benefits and costs.

C. Drinking and Other Domestic Uses

Development of:

- Methods to determine the materials and organisms responsible for taste and odors in water supplies.
- Methods for judging tastes and odors by chemical or other specific analytical techniques.
- Methods for the enumeration of bacteria and viruses in the public water supply.
- Methods to determine the level of chlorination necessary for effective disinfection.

D. Agriculture

Development of:

- Methods to identify the qualitative aspects of contamination of livestock.
- Specific data on tolerance levels of contaminants by various species of domestic animals.
- Methods to determine the mode of action for toxic contaminants in livestock water supply.
- Satisfactory methods for testing and monitoring livestock water supplies.
- Economically efficient methods of water purification.
- Improved methods to rapidly evaluate water quality for agricultural use.

E. Irrigation

Studies of or development of:

- Means to evaluate salt tolerance in plants.
- Action of salts in soil water.
- Potential spread of pathogens in irrigation water.
- Control of plant pathogens in infected irrigated water.
- Reactions of various trace elements in the soil.
- Methods to determine specific levels of plant tolerance for different trace elements.
- Tolerance of different crops to aquatic herbicides applied in irrigation water.
- Improved engineering design of sediment traps and debris basins.
- Role of sediment in the transport of pesticides and other agricultural chemicals in an adsorbed state.
- Effects of radioactive materials on edible and highly productive plants.
- Rate of increase of inorganic salts in the soil when irrigation is used.

III. BIOLOGICAL RESOURCES

A. Applied Studies

Study of:

--The effects of deforestation and afforestation on tidal waters.

1. Culture and aquaculture

Research on or development of:

- Profitable, intensive aquacultural industries based on shellfish and fish, utilizing natural beds.
- Artificial acceleration of production of commercially desirable species.
- Culture of fish and invertebrates in an artificial (or natural) environment under controlled conditions to provide greater yields.
- Oyster stacking and dietary supplements for higher yields.
- Selective breeding of organisms favored by a modified environment.
- A definition of the chemical, physical, and biological requirements for successful production of soft crabs.
- Manipulation of genetics in fish and invertebrates to provide larger, faster growing, better tasting, disease and pollution resistant organisms.
- Methods to control gametogenesis of oysters to provide a means of channeling more of the metabolic processes into useful growth.
- Seed production potential of estuaries.
- Methods to increase natural set of shellfish.
- Artificial cultch and increased methods of survival on natural beds.
- Methods to determine the optimum food concentrations for oysters.
- Reason for decline of settling of spat in most areas.
- Methods for determining "health" of fish populations.
- Methods to determine the essential and optimal environments for marine life.
- Ecological effects of introducing new plant species to an area.
- Desirability and feasibility of transplantation of selected organisms from one sea area to another.

2. Fisheries

Studies of or development of:

- Assessment of fisheries production potentials of various areas.
- The problems of handling, processing, and marketing fishery products.
- Effective mechanical harvesting techniques for the oyster industry.
- The market for oysters to be artificially cultured.
- Surveys to determine locations and concentrations of sand shrimp and methods by which they could be processed and marketed.
- Better techniques for stock size assessment.
- Unexploited fisheries.
- Rapid compilation and dissemination of fishery statistics.
- Methods to permit escapement of young fishes from nets.
- Methods of utilizing "trash fish".
- Scientific information on which to base regulations to prevent overexploitation of important species.
- Reinstatement or replacement of valuable fish which have become scarce because of environmental degradation.
- Cause of fluctuations of abundance of the actively exploited crustaceans in the Chesapeake Bay.
- A determination of the abundance of the blue crab stock in the Chesapeake Bay.
- A determination of rates of fishing and natural mortality of blue crab.
- Updating of hydrographic charts for bottom trawlers.

B. Basic Studies

Inventory of:

- Biological resources and determination of quality as food.

1. Food chains

Research on or development of:

- Distribution of pesticides, heavy metals, and trace elements in food chains.

- Fundamental information concerning the food web.
- Better methods for determining concentration and movements through food chains.
- Possibility of wastes destroying the bottom of the food pyramid.
- Means to determine the organisms which are the food of the major consumers in the Bay.
- Detailed food chain studies especially on certain important filter feeders, such as oysters, clams, menhaden, etc.
- The degree of selectivity in terms of nutritional utilization.
- Utilization of freshwater marshes and wetlands by marine fishes and their food organisms.
- The absolute and relative contributions of phytoplankton, spermatophytes, and organic detritus to the energy used in food chains.

2. Control of predators, parasites, pests, and diseases

Studies of or development of:

- Beneficial and other effects of sea nettles specifically its predatory habits.
- The cause of the rise in the population of some of the natural enemies of shellfish, i.e. oyster drills, barnacles, starfish, conchs, and cow-nosed rays.
- Control of oyster drills.
- Monitoring of populations of anadromous and residential river fish to establish percent occurrence of diseases and parasites.
- Surveys of the parasite fauna of locally occurring, commercially important fish and shellfish.
- Information of parasite larvae and complete life cycles.
- Red tide, why it occurs, and the biological effects.
- Methods to control the jellyfish without seriously affecting the ecosystem.
- Transmission of MSX, related to temperature and exact effect on oysters.
- The adaptation of microorganisms to the marine environment, especially pathogens and disease production in fish.
- Diseases on confined host populations and development of controls.

- The causes of mass mortalities and determination of the part diseases have in causing them.
- The role of diseases in fluctuating Bay populations.
- The part pollution plays in changing the levels of disease in marine populations.
- Diseases likely to be significant during extensive aquaculture.

3. Toxicity (lethal and chronic)

Determination of or development of:

- High and low tolerance levels of species of economic or ecological importance for several environmental factors.
- The harm pesticides, radioactive materials, etc., have on phytoplankton communities.
- Effects of toxicants on sensitive species and life stages.
- Effects of toxicants on behavior and physiology.
- The toxicity of degradable toxic products and their concentrations and synergistic effects.
- Concentration by animals of toxic materials.
- The plants and animals that concentrate specific chemicals to levels capable of poisoning other organisms in the food chain.
- Better methods for determining biological magnification of nutrients, toxicants, and trace elements.
- Effects of various pollutants on marine organisms, singly and in combination.
- Various environmental stresses and their effects on marine organisms.
- Effects of excess environmental nutrient elements.
- Distribution of pesticides, heavy metals, and trace elements in the wildlife food chain and the tissues of various species, especially migratory birds.
- The concentration of pollutants by edible fish and shellfish to focus on the protection of the public from poison, disease, and infection.
- Long-term effects of low concentrations of pollutants on estuarine organisms.
- Tolerance limits of a variety of estuarine and coastal species to natural environmental factors and to present and anticipated pollutants.

- Life stages versus lethal or sub-lethal conditions.
- Analytical methods to differentiate between the compounds present in the environment versus the absolute amount of compounds available for absorption by plants and animals.

4. Behavior, physiology, and distribution

Studies of or development of:

- Genetics.
- Laboratory culture requirements for major species.
- Detailed inventory of species of plants, animals, and microbes.
- Physiochemical factors of weather.
- Physiological responses of commercial or forage species to changes in environment.
- Community structure in a variety of ecological habitats as baseline for future activities.
- Effects of rate of water flow, water temperature, and type and amount of food on growth rate.
- Behavioral patterns that influence catchability of larvae, juveniles, and adults.
- The effects of oxygen concentration variation on marine organisms.
- Effects of pH on toxicity, oxygen requirements, tolerable carbon dioxide levels, and availability and utilization of nutrients.
- Techniques for determining age, together with studies of decomposition rates.

5. Life cycles

Studies of or determination of:

- Recruitment and life histories of major fouling species.
- The taxonomic identification, life cycles, and ecological significance of marine coccoid fungi and protozoa.
- The life cycles and ecology of noxious species, i.e. mosquitoes, flies, etc.

6. Population dynamics

Research on or determination of:

- Causes of fluctuations in abundance of crabs, fishes, and mollusks of commercial fisheries importance.

- Fish population dynamics and environmental effects on fish population prediction.
- Causes of fluctuations in numbers of various sorts of organisms.
- Population dynamics and year-class fluctuation studies on blue crab, menhaden, and similar species.
- Changes in migratory patterns which cause local changes in abundance irrespective of changes in population size.
- The effects of color on population dynamics and behavioral patterns of game fish.
- Methods to separate fluctuations due to man's activity from natural environmental fluctuations.

IV. GEOLOGICAL RESOURCES

Studies of or development of:

- Ocean age and formation.
- Sea-floor spreading and continental drift.
- Methods to determine origins of continental shelves, slopes, deep-sea trenches, etc.

A. Minerals

Research on or development of:

- Location, extent, thickness, etc., of deposits.
- Reconnaissance scale bathymetric, geophysical, and geological maps of the U. S. Continental Shelves.
- Undersea mineral exploration devices.
- Methods for breaking sea-bottom ores.
- Control of dumping of the tailing near mining operations.

B. Oil and Gas

Research on:

- Drilling and geophysical methods to obtain subsurface work to estimate worth of oil and gas potentials.

C. Sand and Gravel

Determination of:

- Location, extent, thickness, and grade of sand and gravel deposits.

D. Buried Shell

Determination of:

- Location, extent, thickness, and grade of buried shell deposits.

V. BORDERING AREAS

Research on and development of:

- Extent and structure of bottom and sub-bottom groundwater-bearing deposits.
- Distribution of shallow water-bearing formations beneath estuaries and sounds.
- Definition of the salt-fresh water interface extending beneath coastal water bodies.
- Precise definition of value (in monetary sense) of coastal and estuarine wetlands.
- Techniques for salinity mapping.
- Estuarine stratification as it relates to oxygen depletion and large natural changes in concentrations of nutrients.
- Computer simulation models of major estuaries.

A. Wetlands

Research on or development of:

- Methods to preserve wetlands.
- Loss of breeding and nursery areas due to filling operations.
- Control of urban sprawl to prevent unnecessary damage to wetlands.
- Accurate mapping of coastal wetlands.
- Wetland loss and waterline erosion.
- Role of swamps as sediment traps, sanctuaries for rare species, and primary producers.
- Preservation of proper balance between wetlands and waters as the coastal zone is developed.
- Amounts and dominant types of vegetation in wetlands.
- Ability of wetlands to assimilate nutrients and means of augmenting such assimilation.

- Ecological effects of burning of wetlands to reduce fire hazards.
- Impact of aquaculture operations in polluting the marshlands.
- Impact of effluent from chemical and other industrial plants to the pollution of the marshlands and estuaries.
- Methods to protect shallow areas immediately adjacent to coastal wetlands which are highly productive by not leasing them.

B. Shorelines

Research on or development of:

- Effects from beach nourishment around the coasts.
- Bathymetry, current and wave studies of beaches.
- Present shoreline response to extreme events and to long-term processes.
- Transformation of waves in shoaling water.
- Shoreline changes in response to incident wave energy.
- Turbulence in waves breaking at the shoreline.
- Prediction of future behavior of the shorelines.
- Methods to stabilize shorelines and barrier island dunes through the use of vegetation.

C. Shallows

Studies on or development of:

- Effect of burning, dredging, impounding, and other alterations on shallows.
- Methods to prevent despoilation of shallows.

D. Barrier Islands and Reefs

Studies on:

- Interaction between marsh modification and gross circulation within the barrier island-inlet-marsh system.

E. Bottoms

Studies on or development of:

- Effects of modification of deeper areas of estuaries and coastal waters on biological, chemical, and geological characteristics.

- Effects of spoil disposal in deeper areas of the Bay.
- Detailed maps of bottom sediment types in the estuaries.
- Effects of dredging, siltation, solid wastes, pollution, and salinity changes on community structure and ultimately on sediment structure.

MANAGEMENT PROBLEMS AND NEEDS

Outline

MANAGEMENT PROBLEMS AND NEEDS

I. LEGISLATION

- A. Establishment of Guidelines
 - 1. Goals and objectives
 - 2. Criteria
- B. Passage of Specific Statutes
- C. Development of Programs

II. DECISION-MAKING

- A. Structure of Organization
- B. Availability of Information
- C. Data Collection, Interpretation, and Dissemination
 - 1. Inventory
 - 2. Determination of sensitive indices
 - 3. Development of routine monitoring systems
 - 4. Development of better evaluative systems

III. COORDINATION

- A. Private
- B. Governmental
 - 1. Local
 - 2. States
 - 3. Federal
 - 4. International

IV. TECHNOLOGICAL AND ECONOMIC IMPROVEMENTS

V. EDUCATION

A. Public

B. Institutional Training

MANAGEMENT PROBLEMS AND NEEDS

I. LEGISLATION

A. Establishment of Guidelines

1. Goals and objectives

Establishment of methods to:

- Enunciate the goals.
- Set objectives which include options and permit some flexibility.
- Arrive at objectives.

2. Criteria

Development of criteria to:

- Assess the importance of environmental problems in order to assign priorities which will enhance the utility of the scheme or model.
- Consider present and future impact on the marine environment.
- Serve as guidelines for zoning wetlands, shorelines, and shallows.

B. Passage of Specific Statutes

Passage of laws requiring or enabling:

General Interest

- New legislation designed both to decrease pollution and to increase public awareness.
- Severe penalties for continuing blatant acts of pollution.
- Removal of restrictions on the purchase of fishing equipment abroad.
- Ocean dumping regulations by the Coast Guard.
- Amendment of the Outer Continental Shelf Lands Act to give the Secretary of the Interior additional flexibility in assigning mineral rights in areas under federal jurisdiction.

- A permit from the Administrator of the Environmental Protection Agency for the transportation of dumping of all materials in the oceans, estuaries, and the Great Lakes.

General and State Interest

- Governments to assume real authority to control uses of wetlands in private ownership where public interest is threatened.
- Steps to halt uncontrolled and unnecessary alteration of wetlands.
- Pilot testing of a quota or limited entry principle in selected fisheries.
- Restriction or establishment of regulations to reduce or eliminate the discharge or leakage of waste oils and greases into rivers, lakes, estuaries, and coastal areas.
- Halting of ocean dumping of materials clearly identified as harmful to the marine environment or man.
- Designation of safe sites for dumping in the ocean and establishment of penalties for violation of ocean dumping regulations.
- Licenses for fishing in salt water to provide better management and support research.
- Fixation of boundaries in terms of geographic coordinates that can be put on maps.
- Determination of seaward boundaries of the Coastal States.
- Elimination of restrictive laws serving no useful purpose.
- Development of stricter controls on fishing.
- Adoption by the state of a definition of wetlands for use by the governmental units which wish to zone their wetlands as conservation lands.
- Controls on laundry detergents containing phosphates.
- Increased penalties for pollution.
- Better means of zoning all marine resources.

State (Virginia) Interest

- Uniformly and strictly enforced existing State legislation.
- Legislation to give the Marine Resources Commission the statutory authority to approve, modify, or disapprove plans for all proposed modifications or alterations to coastal wetlands.

- Reversion of the tax-delinquent coastal wetlands to the Commonwealth for conservation purposes.
- Determination of precise locations of those coastal wetlands owned by the State.
- Establishment of a new, comprehensive water law for Virginia.

C. Development of Programs

Establishment of or development of:

General Interest

- A field service mechanism administered by an appropriate federal agency to facilitate transfer of technically useful information to fishermen and marine resource users at the local level.

General and State Interest

- Optimal cost-benefit ratios so that the best results can be obtained from limited funding in a given geographical region.
- A systems approach to environmental control.
- A method that will provide optimum overall planning for the use of water in a river basin.
- Methods to determine the extent to which the rather common industrial practice of using water of impaired quality can beneficially be extended.
- Methods to determine the extent to which higher standards of quality for surface water will increase reuse of water within industry.
- Methods to determine actual costs of improving various quality characteristics of water.

State (Virginia) Interest

- Programs to promote Virginia seafood.
- Institution of a fund for the purchase of coastal wetlands.

II. DECISION-MAKING

A. Structure of Organization

Establishment of or determination of:

General and State Interest

- Programs to acquire more mathematicians to handle the problems of analyzing and synthesizing the data collected.
- A role in government for one who would represent and speak solely on behalf of the environment.
- Methods for a dramatic overhaul of financing for environmental quality.

State (Virginia) Interest

- An Interdisciplinary Tidelands Resources Unit to accomplish the planning, preservation, and management of the tidelands resources.
- The leadership role which the Federal Government should play in the development of marine resources.

B. Availability of Information

There is a lack of:

- Significant fishery (commercial and sport) catch and production data.
- Information from industries and municipalities on actual composition, concentration, and temporal and spatial distribution of effluents.
- Data on spills of oil and other hazardous materials in marine environments.

C. Data Collection, Interpretation, and Dissemination

Development of:

General Interest

- Means to augment budgets of marine-related Federal agencies in order to insure proper documentation as well as satisfactory dissemination of data and technology.

General and State Interest

- Methods to widely disseminate information on water and wastewater control practices already in use in local geographical areas and in some industrial plants.
- Methods to facilitate the exchange of information gathered by agencies and departments of local, regional, and state government.
- Methods of acquiring pesticide discharge and application data before and after application.
- Methods to require industry to supply catch efforts and other fishery data required for effective planning and management.
- Methods of requiring industrial concerns and municipalities to supply factual, meaningful information about their effluents or discharges.

State (Virginia) Interest

- A State-wide interagency management information system designed to provide a basis for sound multidisciplinary decisions in Virginia.

1. Inventory

Development of:

General and State Interest

- General inventory and classification procedures.
- Methods for the determination of quantity of each species and each size category caught by each type of gear in each locality.
- Sampling inventory of recreational fisheries by mail survey and/or by creel census.
- Continuing surveys of U. S. coastal and distant-water fishery resources, including sport fisheries.
- Definitive inventory of existing publicly and privately owned public recreational facilities and of potent resources in coastal areas.
- Methods to determine the realistic cost-benefit ratios of present programs for river management.

2. Determination of sensitive indices

Development of:

- Ecological indices of condition of environment and resources.
- Physiological indices of condition to determine the state of health of commercial populations and determine physiological changes in indicator species which would indicate changes in quality of environment.

3. Development of routine monitoring systems

Development of:

- Continuing surveys of promising coastal and distant fishery resources.
- Expanded data networks for the Hurricane Warning Service.
- Continuing inventory of Virginia's wetland resources.

4. Development of better evaluative systems

Development of methods to:

- Anticipate situations and to rule to prevent a critical situation rather than reacting after situations become critical.
- Place values on aesthetic aspects of marine resources.

III. COORDINATION

Development of:

- Cooperation from all sectors of the economy--general public, industrial, academic and scientific, and military and civilian government.
- Data coordination to prevent duplication of data and analyses.
- Decisions on best agency responsibilities for jurisdiction.
- Methods to encourage person-to-person contacts between groups working in related technological fields.
- A means by which scientists can coordinate research in such a fashion that meaningful management solutions can be developed more readily by regulatory agencies.

A. Private

Establishment of:

General Interest

- A mechanism to insure optimum information exchange between the U. S. Government and the petroleum industry.

General and State Interest

- Efforts to increase participation of the private sector in instrument development and other marine engineering work.
- Methods to reduce impacts of conflicting usage of the marine and estuarine areas for industrial and urban development.

B. Governmental

1. Local

Development of:

- Methods to control property and real estate taxes as a means of local revenue causing prejudiced decisions toward immediate development of all available space and against preservation of space as a common resource for future decision.
- Techniques to identify far-reaching effects of local development decisions which are felt far beyond local jurisdiction.

2. State

Development of:

General and State Interest

- Methods to reduce impacts of restrictions on states caused by the geographical extent of their jurisdiction.
- A single locus in each state for guiding the rational development of the coastal zone.
- Program to transfer many of the problems of the coastal zone to the state or regional level, thus omitting the problems encountered by Federally-vested authority.

State (Virginia) Interest

- A state agency to aid the recreational users of Virginia's marine resources.

3. Federal

Establishment of:

- Planning and administrative methods of Government research and development programs so that they can permit private industry to assume responsibility for further technological development at the earliest possible stage.
- Methods to consolidate many marine functions of existing agencies and bureaus.
- A new, adequately funded oceanic agency within the U. S. Government to concentrate in one agency appropriate civilian groups with primary missions and roles in the oceans.
- A business climate encouraging ocean-related investment.
- Standardization of statistical materials and compilations.

4. International

Development of:

- International standards for safe procedures and an international mechanism for their enforcement.

IV. TECHNOLOGICAL AND ECONOMIC IMPROVEMENTS

Development of or establishment of:

General Interest

- A series of National Projects to support advancement into the undersea frontier.
- Revised concepts of fishery management and regulation by the United States.
- Upgraded U. S. fishing fleet through introduction of vessels with modern equipment.
- Proposal by the U. S. Government for a new international framework for exploiting ocean mineral resources to define clearly the limits of National jurisdiction and to govern operations beyond these limits.

General and State Interest

- Standard sampling techniques, analyses, statistical materials and compilations.
- Technically advanced and economically efficient fishing fleet with the minimum number of units required to take the catch over a prolonged period of time.
- A 10-year program of intensive undersea development.
- A fundamental marine engineering and technology program to lower the costs of undersea operations.
- Programs initiated by state governments leasing submarine areas ("seasteading") within U. S. territorial waters to encourage innovative uses of the ocean other than petroleum and hard minerals development.

V. EDUCATION

A. Public

Development of programs for:

- The education of the populace to the point where a groundswell of public opinion will force the enactment of legislation for the protection of wetlands and marine resources.
- Intensified public information and education to fully apprise the public of all aspects of water management programs, including the responsibilities of the individual in maintaining a desirable aquatic environment.
- Presentation of information to the public in a simple and understandable form through educational institutions and the news media.
- Public actions of management personnel to speak more often and directly to the public about the danger of deteriorating environmental quality.
- Increased publicity for the high quality saltwater angling of the states.

B. Institutional Training

Establishment of or development of:

General and State Interest

- Programs to supply more trained personnel for local governments.

- An environmental science education program at primary, secondary, and college levels.
- Designated "university-National laboratories" committed to serve needs of scientific groups affiliated with other institutions.
- Handbooks, technical memoranda, and other engineering design data.
- A coastal zone research institution devoted to basic and applied marine science located in every coastal state and affiliated with one or more academic institutions.

State (Virginia) Interest

- A 1.5 to 2 year Fishery School to train potential fishermen.
- An Estuarine Remote Sensing Laboratory to reduce and analyze estuarine remote sensing data from aircraft and satellite.
- A Department of Fishery Economics for the University of Virginia and the College of William and Mary through the Virginia Institute of Marine Science.

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