THE DEVELOPMENT OF A PROCEDURE AND KNOWLEDGE REQUIREMENTS FOR MARINE RESOURCE PLANNING

Functional Step Two

Knowledge Requirements

Prepared for the
Marine Resource Council
Nassau-Suffolk Regional Planning Board
under
Sea Grant Project GH-63
National Science Foundation

February 1970
4047-387

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1.0 INTRODUCTION

This report contains the results of the second phase of a research program conducted by The Travelers Research Corporation (TRC) under the sponsorship of the Marine Resources Council (MRC) of the Nassau-Suffolk Regional Planning Board on Long Island.

The research program centers around a series of functional steps which are:

(1) to understand the problems associated with the marine resources of Long Island;

(2) to identify the knowledge necessary for making sound decisions with regard to the Long Island marine resources;

(3) to determine the availability, reliability and applicability of existing knowledge and data;

(4) to determine research and data collection requirements;

(5) to collect required data and perform the necessary research; and

(6) to develop a procedure for organizing the knowledge and data, and for providing information to the Long Island marine resource planners.

The activities conducted for the first functional step were described in TRC Report 7722-347b dated April 1969. The April 1969 report contains a framework of eight dimensions used as descriptors for organizing information pertinent to marine resource problems.

The eight dimensions are:

1) Cause—environmental condition - effect relationships
2) Natural environmental characteristics
3) Reasons for dissatisfaction
4) Incidence of costs, damage or dissatisfactions
5) Intensity or severity of the problem
6) Geographic location of the problem
7) Time description of the problem
8) Governmental-administrative jurisdictions

The report also contains preliminary descriptions of seventeen problems which were identified as major problems associated with the marine resources of Long Island. These problems are:

1) Reduction of Commercial Shellfish Production
2) Depletion of Sport and Commercial Fisheries
3) Control of Insects and Related Pests
4) Solid Waste Disposal
5) Destruction of Wetlands

6) Development of Marine Related Industry
7) Coast Stabilization and Protection
8) Dredging
9) Eelgrass
10) Domestic Waste Disposal
11) Boat Pollution
12) Oil Spill Pollution
13) Limited Shoreline Recreational Facilities
14) Duck Waste Pollution
15) Salt Water Intrusion
16) Thermal Pollution
17) Preservation of Sites of Historic or Natural Value

The research program has sinced focused upon the collection of more comprehensive and detailed information about the problems, analyzing this information and identifying the knowledge required for making informed decisions about individual problems, as well as identifying the knowledge requirements common to the set of problems for use in overall coastal zone management.

The purpose of this report is to describe the total "ideal" set of knowledge requirements in sufficient detail and in a way that will allow scientists competent in technical areas to assess the current state of knowledge pertaining to the requirements (to be undertaken in Step 3).

The knowledge requirements are listed in the following section under eight categories which are:

I - Information about current human actions and natural forces affecting the environment.

II - Information about the current physical and chemical states of the environment.

III - Information about the current state of the marine related biota.

IV - Information about desired uses of the coastal resources.

V - Knowledge of processes by which actions and forces affect the physical and chemical characteristics of the environment.

VI - Knowledge of the effects of actions and forces, and physical and chemical conditions on the marine biota.

VII - Knowledge of the impact of physical, chemical and biological environmental characteristics on uses of the coastal resources.

VIII - Knowledge of objective methods and procedures.

These categories were derived during the analysis of the problems and are used because:

1.) they permit one to specify in greater detail the knowledge requirements that apply within a dimension of the framework for problem description.

2.) they permit one to differentiate between the data (information) about what exists at a particular place and time and the knowledge about interactions and processes to apply the data for marine resource management.

3.) they separate the specific requirements in terms of recognized scientific disciplines.

Section 3 describes the approach and rationale used to develop the knowledge requirements and the method for categorizing them. Section 4 contains a brief summary discussion of how the information in this report will be used.

Following the main body of this report there is an appendix section dealing with the questions specifically asked for each of fourteen major resource problems on Long Island.

2.0 SPECIFIC KNOWLEDGE REQUIREMENTS

The following subsections present specific information and knowledge requirements within each of eight categories. While the knowledge requirements are derived primarily from study of the fourteen major problems, analysis across individual problem lines has resulted in a common representative set of requirements. The intent is to provide the guidelines for knowledge formulation and information collection of more general applicability to coastal management both on Long Island and in other areas. The knowledge and information then could be used to attack individual problems, multiple problems and for general planning and management.

Category I - Information About Current Human Actions and Natural Forces Affecting the Environment

I-A. Information Pertaining to Waste Disposal/Water Quality

- the volumes of sanitary wastes, the degree of treatment and location of outfalls and volumes of flow
- the locations, volumes, and nature of wastes generated by industrial and agricultural processes, the types of treatment, nature of the effluent and the chance of inadvertant spills or accidents. (This inventory must include radioactive and thermal wastes as well as chemical and biological wastes.)
- the location and size of installations and shipping lanes where potential oil spills may occur, the kind and volume of material which would be involved in such an accident, existing equipment for handling a spill
- the number of boats and their sanitary waste handling facilities including location and kinds of dockside facilities for waste handling
- the location, volume and composition of solid waste deposits, types of treatment and nature and location of resulting effluents
- the location, intensity and nature of pesticides being used on-shore and in the coastal waters
- current activities related to dredging for the mining of sand and gravel, maintenance of beaches and channels, location, frequency and volume of materials and the volume and location of dredging spoil disposal.

I-B. Information Pertaining to Resource Demand/Utilization

- the "take" of the various species of finfish in terms of landings, value, and location of fishing activity for both commercial and sport fishing in Long Island's coastal waters
- the volume, value and location of harvesting of the various species of shellfish, the location and size of commercially managed and controlled shellfish enterprises
- location and extent of public and private areas used for swimming, sunbathing, picnicing; marinas, boat launching, recreational shellfishing and intensity of use of each of the areas, peak load, time of use, etc.
- location and intensity of other activities in coastal areas
- the location, character and value of structures built in shoreline areas for such purposes as:
  - residential
  - residential/recreation
  - commercial
  - industrial
- current plans for development in terms of:
  - type of structures and use
  - value
  - location
  - time
  - projected intensity of use

I-C. Information Pertaining to Natural Forces

- direction, location, velocity, and time patterns of prevailing currents in coastal waters
- the nature of normal and storm tidal actions in all Long Island coastal waters
- existing circulation patterns (velocity, direction and time patterns) in the numerous bays and harbors of Long Island
- frequency, intensity, direction, etc., of expected storms which affect the coastal waters of Long Island
- prevailing wind direction and speed

Category II - Information About the Current Physical and Chemical Characteristics of the Environment

II-A. Physical Characteristics of Coastal and Estuarine Areas

- location and volume of stream flows into coastal waters
- location and volume of ground water flows into coastal waters
- water surface area in bays, harbors, etc.
- water depth by location
- physiography of benthic areas by location
- composition of benthic areas
- physiography of shoreline areas by location
- size and location of salt marshes, salt meadows and other wetlands
- location and extent of offshore sandbars
- location and size of inlets to bays and other estuarine areas
- location, size, type and number of structures such as docks and erosion control structures which may affect circulation, tides, storm surges, etc.

II-B. Chemical and Physical Conditions of Coastal and Estuarine Waters

(by time and location for bays, harbors, streams, estuarine areas and coastal waters)

- water temperature
- pH
- salinity
- dissolved oxygen
- turbidity
- water color
- plant nutrients (primarily compounds of nitrogen and phosphorus) levels and ratios
- coliform bacteria
- floating and settleable material
- toxic materials such as radionuclides, pesticides, and heavy metals
- oil

Category III - Information About the Current State of the Marine Related Biota

III-A. Population characteristics of important shellfish species (oyster, lobster, sea scallop, bay scallop, surf clam and hard clam) by time and location

- numbers of individuals
- size distribution
- age distribution
- growth rates of individuals
- growth rates of biomass
- population trend

III-B. Population characteristics of important finfish species (Bluefish, Cod, Fluke, Menhaden, Scup, Sea Bass, Striped Bass, Whiting, Yellowtail Flounder, Butterfish, Blackback Flounder) by time and location

- numbers of individual
- size distribution
- age distribution
- growth rates of individuals
- growth rates of biomass
- population trends

III-C. Population characteristics of other important marine fauna including marine predators and pests (e.g., oyster drills, starfish)

- numbers of individuals
- size distribution
- age distribution
- growth rates of individuals
- growth rates of biomass
- population trends

III-D. Population characteristics of important marine plant species (eelgrass, marshgrass, phytoplankton, algae)

- population density
- size of individuals
- growth rates of individuals
- growth rates of biomass
- population trends

III-E. Population characteristics of important migratory birds and other wildlife species

- numbers of individuals
- size and age distributions
- growth rates of individuals
- population trends

Category IV - Information About Desired Uses of Coastal Resources

- locations, intensity, and use trends for human activities (both current and planned) such as:
  - swimming
  - beach recreation
  - aesthetic enjoyment
  - finfishing
  - shellfishing
  - boating
  - commercial navigation
  - industrial water use
  - residential development
  - commercial development
  - industrial development
  - mineral extraction
  - other
- New York water quality standards for the classes of fresh surface waters (AA, A, B, C, D)
- New York water quality standards for the classes of tidal salt waters (SA, SB, SC, SD)
- New York water quality standards for the special classes of certain tidal waters (I, II)
- New York water quality standards for the classes of ground water (GA, GSA, GSB)
- the water quality classifications assigned to all coastal and estuarine waters of Long Island.

Category V - Knowledge of Processes by Which Actions and Forces Affect the Physical and Chemical States of the Environment

V-A. Physical Processes

- the transport and dispersion of nutrients, coliform bacteria, etc., from a sewage effluent source
- the suspension, transport and deposition of sediments which cause shoaling and channel filling
- the transport, dispersion and deposition of pesticides
- the transport and dispersion of nutrients and flushing in wetlands
- changes in circulation and flushing due to physiographic changes in or around a water body
- transport, stratification and diffusion of thermal discharges within the aquatic environment
- transport of water and associated materials through ground water media
- the dissipation of the energy of storm surges and waves by wetland areas and structures
- transport and dispersion of oil.

V-B. Chemical Processes

- effect of temperature on levels of dissolved oxygen and other chemical constitutents
- processes of synthesis of chemicals in the aquatic environment
- processes of decomposition, degradation and change in composition of chemicals over time including pesticides, oil, dissolved oxygen, phosphorus, nitrogen, etc.
- effects of mixing and flushing action on salinity levels

Category VI - Knowledge of the Effects of Actions and Forces, and Physical and Chemical Conditions on the Marine Biota

VI-A. For each important species (as identified in Category III) and each stage in the life cycle the influence of:

- temperature
- dissolved oxygen
- salinity
- nutrients
- turbidity
- pH
- pesticides
- radionuclides
- heavy metals
- oil
- other

VI-B. Habitat requirements for each stage of each important species

- water circulation
- water depth
- benthic composition
- benthic physiography

VI-C. Factors and processes in:

- competition
- predation (including man's harvesting)
- production
- energy transfer
- population growth and control
- diversity of species

Category VII - Knowledge of the Impact of Physical, Chemical and Biological Environmental Characteristics on Uses of the Coastal Resources

For each possible desired activity utilizing the coastal resources such as:

- swimming
- beach recreation
- aesthetic enjoyment
- finfishing
- shellfishing
- boating
- commercial navigation
- industrial water use
- residential development
- commercial development
- industrial development
- mineral extraction
- other

Identify and describe limits and/or degree of impact of:

VII-A. Water quality characteristics such as:

- salinity
- temperature
- pH
- dissolved oxygen
- turbidity
- color
- coliform
- toxic materials
- nutrients
- floating and settleable solids
- other

VII-B. Biological characteristics

- population of finfish by species
- population of shellfish by species
- population of important aquatic plants
- population of microscopic plants and animals
- population of marine "pests"
- other

VII-C. Physical characteristics such as:

- water depth
- water surface area
- current and tidal flow
- wave action
- height of shore-adjacent land

- area of adjacent land
- composition of adjacent land
- topography of adjacent land
- topography of benthic areas
- visual form of shore land
- other

Category VIII - Knowledge of Objective Methods and Procedures

VIII-A. Methods for predicting physical, chemical and biological states resulting from changes in causal factors such as:

- effects of boundary condition changes on water circulation
- salinity
- temperature distributions resulting from thermal effluents
- transport of dissolved and suspended materials and resulting concentrations
- turbidity
- deposition of solids (shoaling and silt deposition)
- dissolved oxygen
- effects of chemical processes and interactions on pollutant concentrations
- population and biomass of important biological species
- other

VIII-B. Methods of objectively and quantitatively predicting the combined effects of physical, chemical and biological conditions on resource use.

VIII-C. Methods of objectively and quantitatively determining the direct costs associated with implementing alternative courses of action.

VIII-D. Methods of objectively and quantitatively assessing the social and economic values associated with particular resource uses and alternative actions.

VIII-E. Methods of objectively and quantitatively evaluating and comparing results of alternative courses of action.

VIII-F. Methods of objectively and quantitatively delineating combinations of courses of action which best meet the stated goals or uses of the coastal resources.

VIII-G. Procedures for combining the above methods, the necessary data and information and knowledge into a systematic management procedure.

3.0 APPROACH AND RATIONALE FOR DEVELOPMENT OF KNOWLEDGE REQUIREMENTS

In the first step of the research program an eight-dimension classification framework was developed to facilitate the collection, organization and analysis of information pertaining to marine resource problems. This framework, described in the earlier report (TRC Report 7722-347b) guided the initial collection and analysis of information which led to the identification and description of seventeen major marine resource problems on Long Island also described in that report.

Subsequent to that an extensive amount of time and effort has gone into the collection of additional information on the problems. This information has been collected generally on a problem-by-problem basis within the framework of the eight dimensions. Analysis of the information has led to more detailed and specific statements about both the background underlying the problems and the particular situation on Long Island. A general indication of the information needs for each problem was also developed during this analysis. These statements and needs for fourteen of the problems are presented in a companion report, TRC Report 7722-377 dated January 1970.

Using the eight dimensions of problem information as a guide further analysis was conducted for the purpose of deriving specific knowledge requirements. In this analysis a series of questions was asked for each problem, which, if answered, would provide the knowledge and information to manage that problem. (These question sets are located in the Appendix to this report.) Underlying each question is the need for specific information and knowledge upon which to base the answer. The identification, compilation and organization of these needs across problems resulted in the common set of "ideal" requirements for marine resource planning and management.

In order to specify the requirements in a way that will be useful for ascertaining the state of existing knowledge and data, a method was needed for grouping them so as to differentiate between information in the form of observed data, and knowledge about the principles, processes and interrelationships involved in environmental changes and man-environment interactions. The groupings must also permit easy identification of subject areas and scientific disciplines which will be the sources of the information and knowledge.

The original problem classification framework, designed for organizing the information for describing and analyzing problems, is not suited to the purpose of categorizing knowledge requirements. Consequently, the eight categories listed in the Introduction and used to group the requirements in Section 2 were developed for this purpose.

The first four categories pertain directly to the existing situation and are location and time specific information requirements in the form of observational and descriptive data for the region, in this case Long Island and its coastal waters. The other four categories pertain to the understanding of man-environment interactions and the dynamic processes involved in environmental changes and their impacts, and will be applicable regardless of place and time.

4.0 SUMMARY

The development of knowledge requirements is an evolutionary process. The initial list, developed within the time and level of information available, is necessarily quite general, open ended and subject to restatements and changes as the specific requirements become better defined. The itemized list described in Section 2 is the result of our "first cut" at the development of the "ideal" set of knowledge and information requirements for attacking individual problems, combinations of problems, and for general planning and management.

The hope is that the requirements listed will be scrutinized by people with special expertise and experience in the various subject areas for two principal reasons. First, they will no doubt be able to identify gaps and omissions and assist in restatement of requirements which are not clearly stated at this time.

Second, using the requirements list as a guide, they can, at this stage of the program, assist in assessing the state of existing knowledge and information in the particular categories, identifying sources, and providing guidance in the formulation of research and data needs and priorities.

It must be emphasized that the knowledge requirements listed here, if fully satisfied, would provide perfect information for the planning and management of Long Island's marine resources. This ideal, of course, is not feasible from a technical standpoint. Nor is it likely to be feasible from an economic standpoint. However, the requirements listed do provide the framework for evaluating the present state of knowledge, for establishing research needs and priorities and for incorporating new developments and new knowledge as they become available.

APPENDIX

Specific Questions Related to the Problems

TRC Report 7722-377 dated January 1970 contains discussions of fourteen of the major Long Island coastal resource problems. The problems discussed are:

1. Sport and commercial finfish
2. Shellfish
3. Eelgrass
4. Wetland destruction
5. Domestic and industrial wastewater disposal
6. Wastewater from vessels
7. Wastewater from duck farms
8. Solid waste disposal
9. Thermal pollution
10. Oil spill pollution
11. Chemical pesticides
12. Dredging and spoil disposal
13. Shoreline recreation
14. Coast stabilization and protection

In the analysis conducted for deriving knowledge requirements a series of questions was asked for each problem which, if answered with specifics, would provide the knowledge and information to manage that problem. Then the question was asked, "What do I need to answer this question?".

This analysis resulted in the development of the eight knowledge and information requirements categories used in the main body of this report.

To provide the reader further insight into this process twelve series of questions related to the problems follow. There are twelve because the wastewater from vessels and duck farms are included with domestic and industrial wastewater disposal. The Roman numerals in brackets which follow each question refer to the knowledge and information categories which most nearly will provide answers to the question.

1. Questions Related to Finfish

1.) What are the important species of finfish in Long Island waters? [III, IV]

2.) What are their populations, size characteristics(biomass), locations and time of residence in these waters? [III]

3.) What are the commercial landings and values by species, where and when are they caught? [I]

4.) What are the important species for sport fishing, the "take" of each species, location and time of sport fishing activity and the value of this activity (outlay by the sport fisherman)? [I]

5.) Are the catches of any species decreasing or below desirable (and believed attainable) levels? [I, IV]

6.) What physical, chemical and/or biological environmental conditions can this be attributed to? [II, III, VI]

7.) What natural forces or human activities are causing these conditions? [I, V, VI]

8.) Can these be altered or controlled to change these conditions in an acceptable way? [I-VIII]

9.) What other activities will be affected and how? [I, IV, VII]

2. Questions Related to Shellfish

1.) What are the important shellfish species in the Long Island area? [III, IV]

2.) What are their populations, size and locations? [III]

3.) What is the commercial harvest by species, weight, value and location? [I]

4.) Is the harvestable "crop" decreasing or below a desirable level for any species at any location suitable for its growth? Or is there a restriction on harvesting in any location? [I, IV]

5.) What physical, chemical and/or biological environmental conditions are responsible for this problem? [II, III, VI]

6.) What natural forces or human activities are causing these conditions? [I, V, VI]

7.) Can they be altered or controlled to change these conditions in an acceptable way? [I-VIII]

8.) What other activities will be affected and how? [I, IV, VII]

3. Questions Related to Eelgrass

1.) Where and when does eelgrass appear in Long Island waters? [III]

2.) What and how are human activities affected by the presence of eelgrass? [I, IV, VII]

3.) What and how are biological, physical and/or chemical conditions altered by eelgrass? [II, III, VI]

4.) What are the physical, chemical and biological conditions which influence the growth of eelgrass? [VI]

5.) Can these conditions be altered to control eelgrass in an acceptable way? [I-VIII]

6.) What activities would be affected and how? [I, IV, VII]

4. Questions Related to Wetlands

1.) What are the locations and extent of Long Island wetlands? [II, III]

2.) What are the physical, chemical and biological characteristics of each? [II, III]

3.) How does each relate to the estuarine ecology of the adjacent waters? [VI]

4. How will changes in wetlands affect physical, chemical and/or biological conditions in adjacent waters? [V, VI]

5.) What human activities are related to wetland utilization and how are they affected by physical, chemical and/or biological changes in a wetland? [I, IV, VII]

6.) What natural forces or human actions cause alteration in wetland conditions? [I, V, VI]

7.) Can they be altered or controlled in an acceptable way? [I-VIII]

8.) What other activities will be affected and how? [I, IV, VII]

5. Questions Related to Domestic and Industeial Wastewater, Wastewater from Vessels, Wastewater from Duck Farms

1.) What are the nature, volumes and locations of wastes generated? [I]

2.) How are these wastes treated? [I]

3.) Where are they disposed of? [I, II, III]

4.) How do they affect environmental conditions? [V, VI]

5.) What desired activities are affected by these environmental conditions and how? [I, IV, VII]

6.) How will planned changes in waste disposal practices affect environmental conditions? [V, VI]

7.) How will these environmental conditions affect planned activities? [IV, VII]

8.) Are there ways to control these effects in an acceptable manner? [I-VIII]

9.) What other activities may be affected and how? [I, IV, VII]

6. Questions Related to Solid Waste Disposal

1.) What are the volumes and kinds of solid wastes generated? [I]

2.) How and where are they being disposed of? [I, II, III]

3.) What physical, chemical and biological conditions are being affected by the disposal and how? [V, VI]

4.) What activities are affected by these conditions and how? [I, IV, VII]

5.) What disposal alternatives exist? [VIII]

6.) How would the alternatives affect environmental conditions? [V, VI]

7.) How would these conditions, in turn, affect human activities? [IV, VII]

7. Questions Related to Thermal Pollution

1.) What activities are generating waste heat and disposing of it in Long Island waters? [I]

2.) Where and what is the volume and temperature of such discharges? [I]

3.) What physical, chemical and biological conditions are being affected by these discharges, and how? [II, III, V, VI]

4.) What desired activities are affected by these environmental conditions and how? [I, IV, VII]

5.) What additional discharges are planned, where, what volumes and temperatures? [IV]

6.) How will these affect existing physical, chemical and biological conditions? [V, VI]

7.) What alternative methods of heat disposal are available? [VIII]

8.) How will they affect environmental conditions and human activities? [IV, V, VI, VII]

8. Questions Related to Oil Pollution

1.) What and where are the sources of potential oil spills in the Long Island area? [I, II, III]

2.) What methods are available for safeguarding against spills? [VIII]

3.) What methods are available for cleaning up spills? [VIII]

4.) How do oil spills and clean-up methods affect the physical, chemical and biological conditions? [V, VI]

5.) What activities would be affected by these conditions and how? [I, IV, VII]

9. Questions Related to Pesticides

1.) Where, what kinds and quantities of pesticides are being used and why? [I, II, III]

2.) How do pesticides "travel" through the environment (physically and biologically)? [V, VI]

3.) What are the present levels of pesticide residues in the environment? [II, III]

4.) What effects do specific pesticides have on biological species important to Long Island activities? [IV, VI]

5.) How do these biological conditions affect activities? [VII]

6.) What effects do pesticides have on humans specifically?

10. Questions Related to Dredging

1.) Where and for what purpose is dredging being conducted? [I, IV, VII]

2.) Where is the spoil being disposed of? (The solid waste questions now apply here.) [I]

3.) How do the dredging operations affect the physiography of the area? [II, V]

4.) How does the dredging operation affect the physical, chemical and biological environmental conditions? [V, VI]

5.) What and how are desired activities affected by the changes in environmental conditions? [IV, VII]

11. Questions Related to Shoreline Recreation

1.) What is the current and projected demand for recreation facilities on Long Island? [I, IV]

2.) What environmental conditions are important to the various recreational experiences and how? [VI]

3.) Where on Long Island are the conditions suitable? [II, III]

4.) What environmental conditions preclude use of otherwise desirable areas for recreation or limit their value as recreation areas? [VII]

5.) How can natural processes or human actions be altered or controlled to make the environmental conditions more suitable? [I, V, VI]

6.) What other activities would be affected and how? [IV, VII]

12. Questions Related to Coast Stabilization and Protection

1.) Where and to what extent does coastal erosion occur on Long Island? [I, II]

2.) What environmental conditions are or can be altered by coastal erosion? [IV, V]

3.) What activities are affected by these conditions and how? [VI]

4.) What actions and processes cause coastal erosion? [V]

5.) How can these actions and processes be altered to reduce the problem? [I, V]

6.) What activities would be affected by these alterations and how? [VII]