Narragansett Bay National Estuarine Sanctuary

Management Plan

ITMENT OF COMMERCE
ceanic and Atmospheric Administration
ean and Coastal Resource Management
rograms Division
D.C. 20235

STATE OF RHODE ISLAND
Department of Environmental Management
Office of Planning and Development
Providence, Rhode Island 02903

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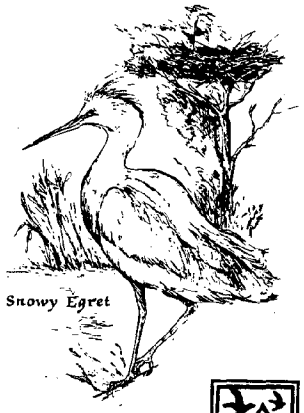

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
Office of Ocean and Coastal Resource Management
Sanctuary Programs Division
Washington, D.C. 20235

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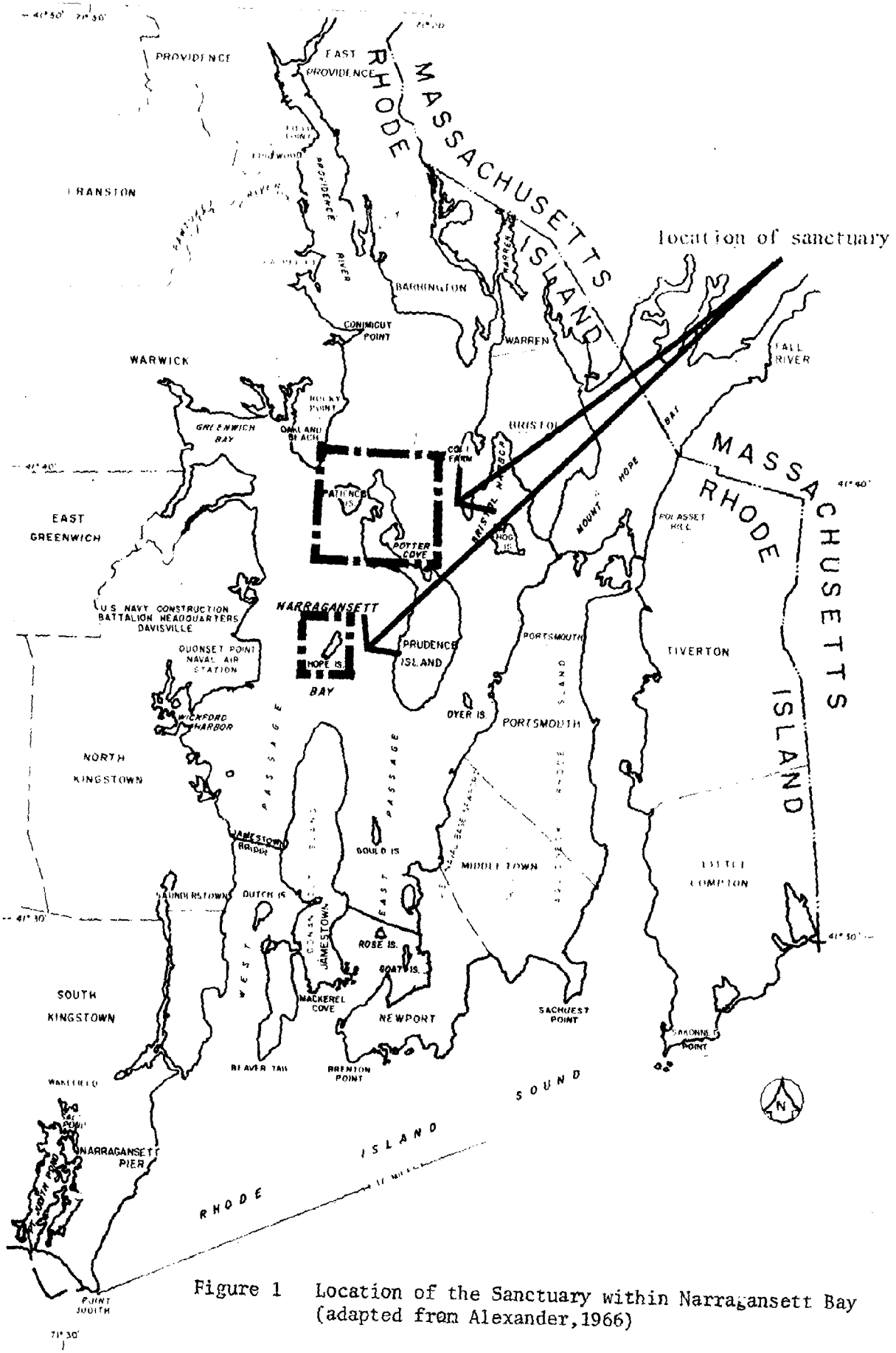

Figure 1 Location of the Sanctuary within Narragansett Bay (adapted from Alexander, 1966)

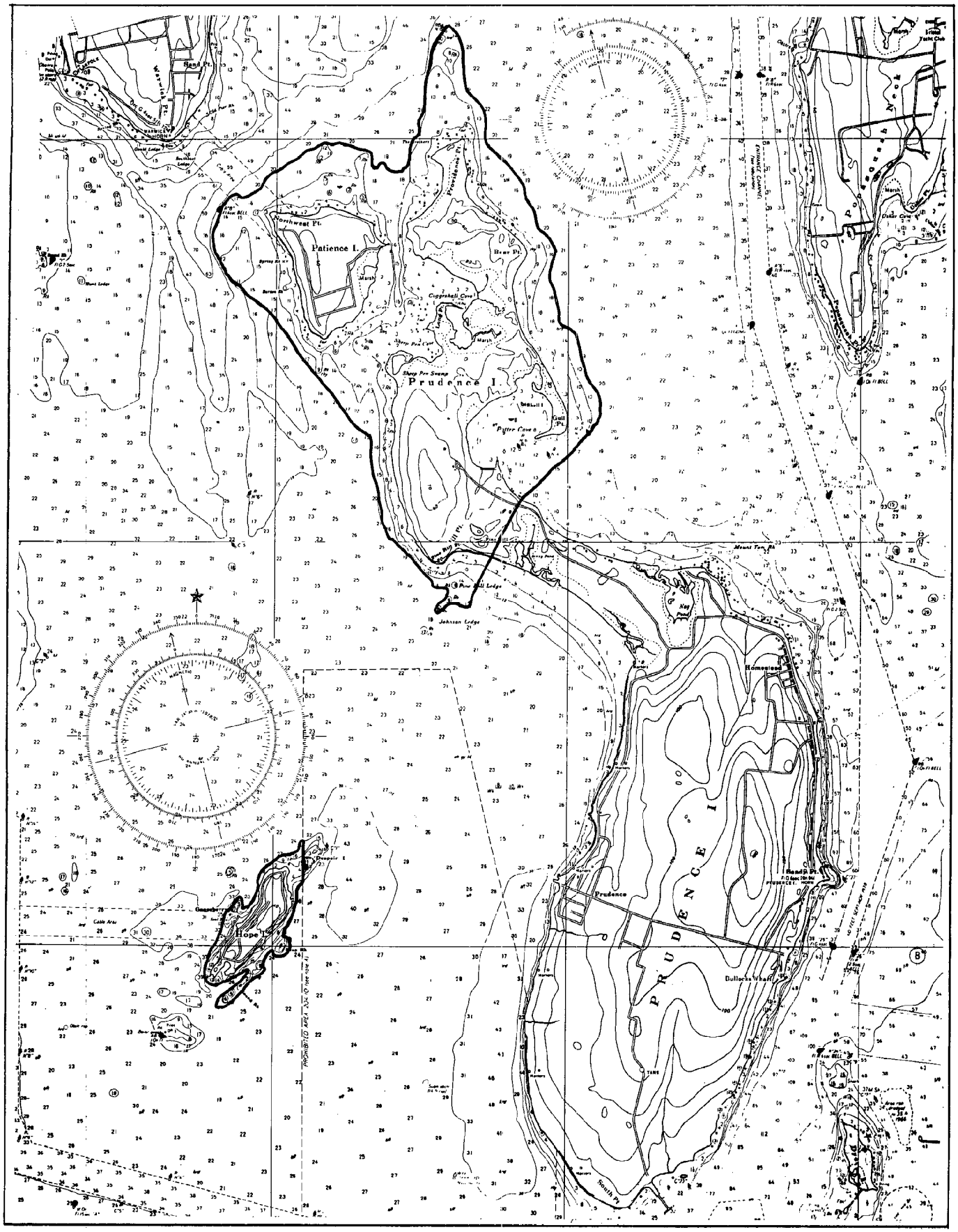

Figure 2 Boundaries of the Narragansett Bay National Estuarine Sanctuary

Real property is composed as follows:

Area	Acres
Patience (204 acres)	
Private Ownership	1
State Owned	203
North Prudence (737 acres)	
Private Ownership	34
State Owned	703
Hope Island (94 acres)	
State Owned	94
Adjoining State Owned Waters to 18' Isobath	1,591
Total Land and Water Within Sanctuary	2,626

The idea of preserving these islands received its first public recognition in the State's 1965 Recreation Guide Plan. That plan specifically identified the northern end of Prudence and Patience Islands as valuable natural areas and recommended that the State acquire them. Subsequent plans, including the Statewide Comprehensive Outdoor Recreation Plan and the Coastal Resources Management Plan, supported the idea of preserving these areas as part of the Bay Islands Park. In 1974, Hope Island was offered as surplus property by the Navy and was acquired by the Rhode Island Department of Natural Resources, the predecessor of the Department of Environmental Management (DEM) one year later. In 1979 DEM acquired 703 acres on North Prudence.

In 1979, DEM began a year-long effort to develop a detailed management plan for the Bay Islands Park. One major goal of the plan was to preserve undeveloped and ecologically sensitive or significant areas in the park while directing heavier use of the park toward those areas that could support it. Because of their isolation, relatively more natural state, and, in the case of Hope Island, the significance of the rookery, North Prudence, Patience and Hope Islands were identified as park sites where only low-level recreation activities compatible with the preservation goal were to be permitted.

When DEM and the Office of Ocean and Coastal Resource Management (OCRM -- then the Office of Coastal Zone Management) discussed the idea of an estuarine sanctuary in Rhode Island, the North Prudence-Patience site emerged as a good choice for sanctuary designation for several reasons, including the following:

1. The area is essentially undeveloped and is returning to a natural state, with a wide range of marine and terrestrial life.

2. Located just south of the present shellfishing closure line for the bay, the area has the potential for very significant research into pollution problems and dynamics of the bay. Such research could be tied closely to other ongoing research efforts in the upper bay and could be applicable to other estuaries in the Northeast.

3. The islands are located in the center of a large urban population and offer great opportunities for educational activities at many levels.

4. The sanctuary goals of preserving estuarine areas for research and education are compatible with the intended uses of the park.

5. The sanctuary designation can serve as a symbol of the cleanup and preservation of the bay.

Designation of the sanctuary commits the state to preservation of these areas, primarily for research and education, but also for other activities that are compatible with the overall goal within the sanctuary. Four general types of activities will occur: (1) Education; (2) Research; (3) Recreation; and (4) Wildlife management by hunting.

Each of these activities will make certain types of demands on the sanctuary. Some of the activities may be compatible or even complementary; others may present potential conflicts. Given that scientific research, educational programs, recreational activities, and wildlife management are going to occur within the sanctuary, one of the primary purposes of this plan is to set up guidelines and a management framework that will accommodate them all.

D. SANCTUARY OBJECTIVES

The objectives of the Narragansett Bay National Estuarine Sanctuary are:

1. Monitoring and Research Objectives

° To gain a clearer understanding of the ecological relationships within the estuarine environment through a coordinated program of baseline studies and related ecological research. This information will then be used in making management decisions concerning the estuarine environment.

- To identify significant changes that may occur in the estuarine environment; and

- To assess the effects of man's impact on the ecosystem and to forecast or mitigate possible environmental deterioration caused by human activities.

2. Education Objectives

- To help people better understand the ecological relationships within this estuarine environment through a broad range of education programs;

- To increase the public's awareness of the problems that can arise from man's misuse of this environment; and

- To foster a higher level of commitment toward solving some of the Narragansett Bay-related problems.

3. Resource Utilization (Recreation and Commercial Use) Objectives

- To provide for traditional resource utilization (such as fishing, shellfishing and hunting) at levels which maintain the resources at stable, healthy levels; and

- To encourage low impact recreational activities that will help people to appreciate and understand the estuarine environment.

4. Resource Protection

- To protect the sanctuary's fragile or rare natural resources;

- To preserve cultural resources including archaeological sites; and

- To balance the demands placed on the sanctuary's resources through various activities to determine the level and types of uses consistent with protecting the estuarine environment for future generations to study, enjoy and utilize.

The management measures outlined in Section III reflect DEM's strategies directed toward achieving these objectives.

II. MANAGEMENT CONTEXT

A. INTRODUCTION

Narragansett Bay is one of the most intensively studied estuaries in the world. Scientists from the University of Rhode Island (URI) Graduate School of Oceanography, the Environmental Protection Agency Laboratory at Narragansett, and DEM are conducting a wide variety of scientific investigations to monitor both the physical and biological features of Narragansett Bay. Extensive research has also been conducted on the commercial and recreational uses of the bay, with some studies dealing with the conflicts that occur among competing uses. Still other studies explore the ecological impacts that various human activities have on this estuarine environment.

This first section provides a brief overview of some of the studies that have been undertaken within Narragansett Bay followed by identification of bay-related issues and problems that can be addressed through sanctuary programs.

The second section describes the physical, biological, and cultural resources of the sanctuary itself. Within this section is an analysis of these resources with regard to their management implicactions (italicized type).

B. NARRAGANSETT BAY

1. General Description

Narragansett Bay is an estuary opening into Rhode Island Sound with a total area, including the Sakonnet River and Mount Hope Bay, of 174 square miles and a shoreline approximately 250 miles long (Figure 3). The Bay is considered as extending north of a closing line connecting Point Judith on the west with Sakonnet Point on the east. The length of the north-south axis is 26 miles and an average east-west width is 4-5 miles (Alexander, 1966).

The Narragansett Bay estuary includes approximately 2,686 acres of salt marshes (Halvorson and Gordines, 1976). These salt marshes vary in size from fringe marshes that are less than 5 yards wide, to extensive marshes that exceed 100 acres in size. Of the 250 miles of Narragansett Bay shoreline, approximately 51 miles are rimmed by fringe salt marshes.

2. Physical Setting

Rivers flowing into Narragansett Bay have a drainage basin of 1,800 square miles. The fresh water flow varies seasonally, with an annual average of 1,300 cubic feet per second entering the bay. A relatively small freshwater input and large tidal volume results in a well-mixed water column and a small salinity gradient down the bay.

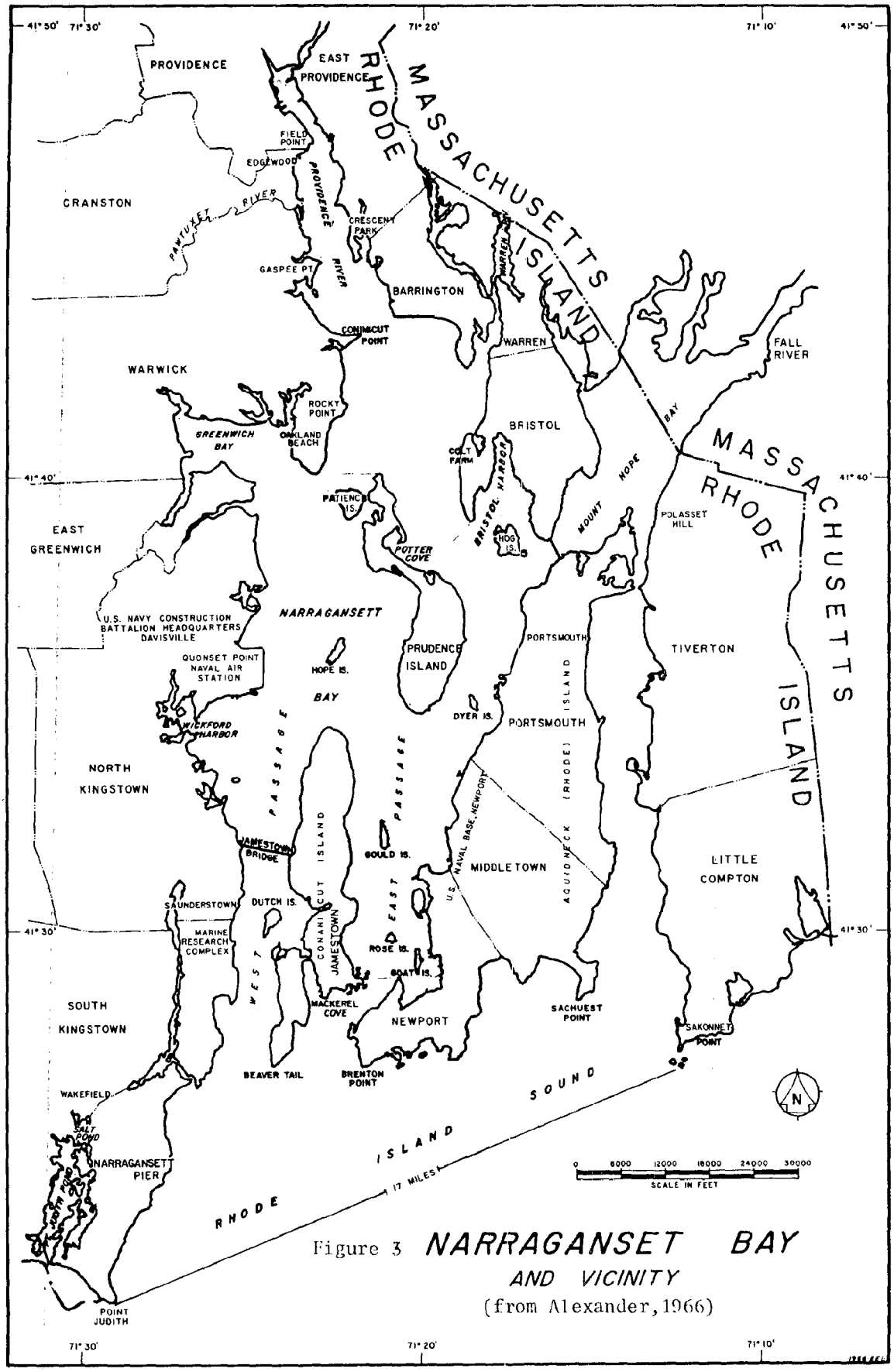

Figure 3 *NARRAGANSET BAY AND VICINITY*
(from Alexander, 1966)

The mean depth of the bay is 29.5 feet. The West Passage is relatively shallow with a mean depth of 24.6 feet. Since the East Passage is deeper, with a mean depth of 49.9 feet, this passage has become the shipping route to the Port of Providence (Figure 4). Bottom composition on the floor varies from predominantly silt-clay sediments in the upper bay to sandy sediments near the mouth of the bay (Figure 5).

Water quality in most of Narragansett Bay is excellent, with 92 percent of the Bay classified as SA (highest) or SB (second highest). The main exception is the Upper Bay, where waters are polluted by inadequately treated sewage from Providence and combined sewer overflow from Providence, Pawtucket, and Central Falls during storms. Waters from the Providence River south to Gaspee Point are classified as SC, while the waters south from there to a line drawn connecting Rocky Point and Rumstick Point are classified as SB. North of this line, the bay is permanently closed to shellfishing; south of this line to a line connecting Warwick Point, Providence Point on the northern tip of Prudence Island, and Popasquash Point, the waters are conditionally open for shellfishing. This conditional area is closed following rainfall of more than 0.5 inches during any 24-hour period (Figure 6).

The estuarine sanctuary is just south of the transitional water quality zone in Narragansett Bay. The waters to the east, west and south are classified SA (except Potter Cove on North Prudence, which is classified SB during the summer because of pollution from the recreational boats anchoring there), while those waters to the north are classified SB.

3. Biological Setting

The following description of the biology of Narragansett Bay is excerpted from A Coastal Marine Ecosystem by J. Kremer and S. Nixon.

> "Narragansett Bay is a phytoplankton-based ecosystem in which water depths and turbidity, as well as the lack of a firm substrate, have minimized the importance of attached algae and vascular plants. The major consumers of the bay are zooplankton which appear in greatest numbers in early summer. The zooplankton are subjected to predation from a number of sources. These predators include fish larvae and carnivorous ctenophores (Mnemiopsis leidyi). During the summer butterfish (Preprilus triacanthus) feed extensively on ctenophores and may play a role in seasonal decline of ctenophores in the bay. Menhaden (Brevoortia tyrannus) are also plentiful during the summer. They are preyed upon by striped bass (Morone saxatilis) and blue fish (Pomatomus saltatrix).
>
> The community of large benthic animals, however, is not dominated by the finfish but by dense populations of hard clams (Mercenaria mercenaria) which are also called quahogs. These animals are filter feeders and can exert a strong grazing pressure on the phytoplankton except when the water temperatures are low.

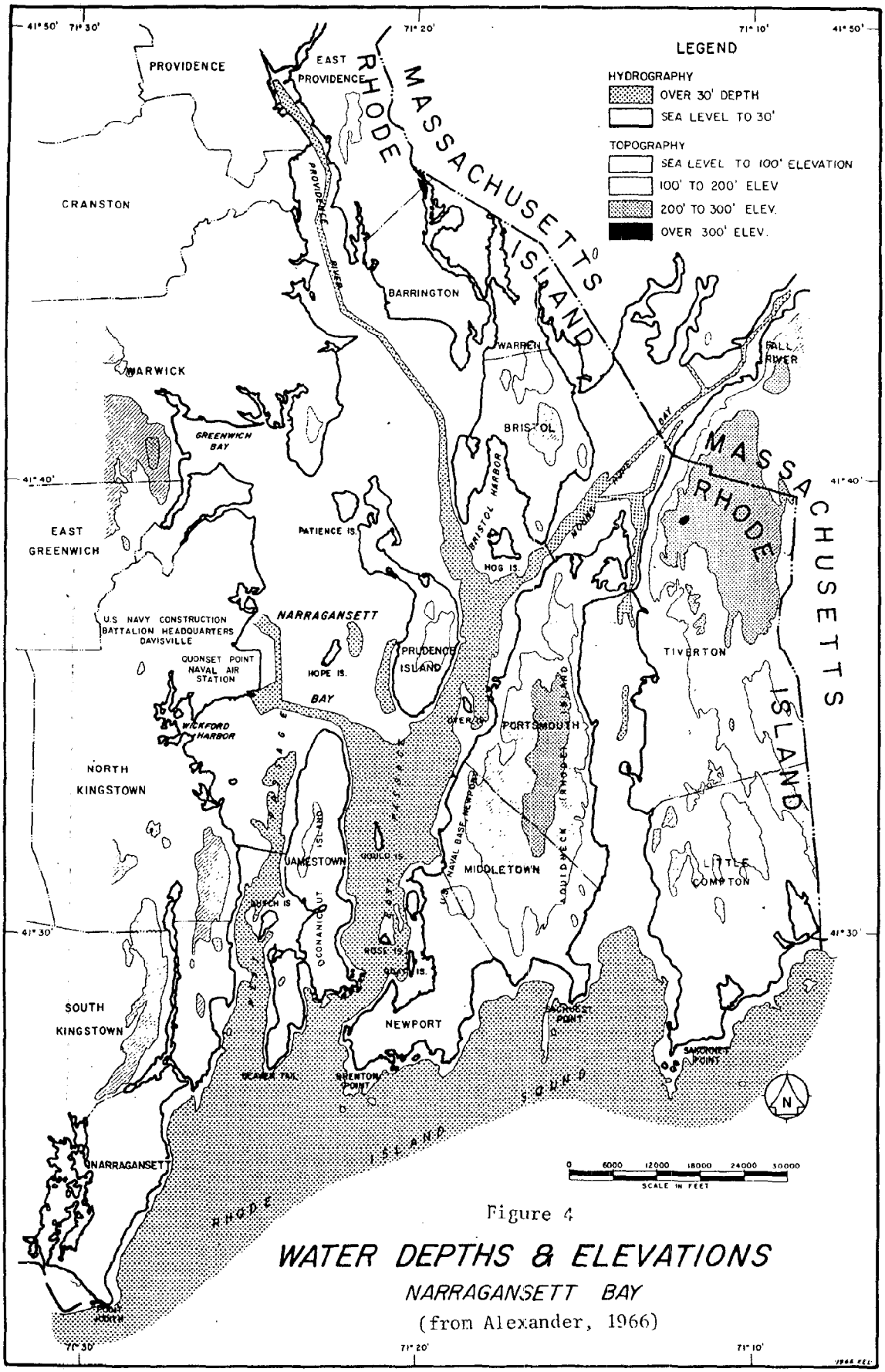

Figure 4

WATER DEPTHS & ELEVATIONS

NARRAGANSETT BAY

(from Alexander, 1966)

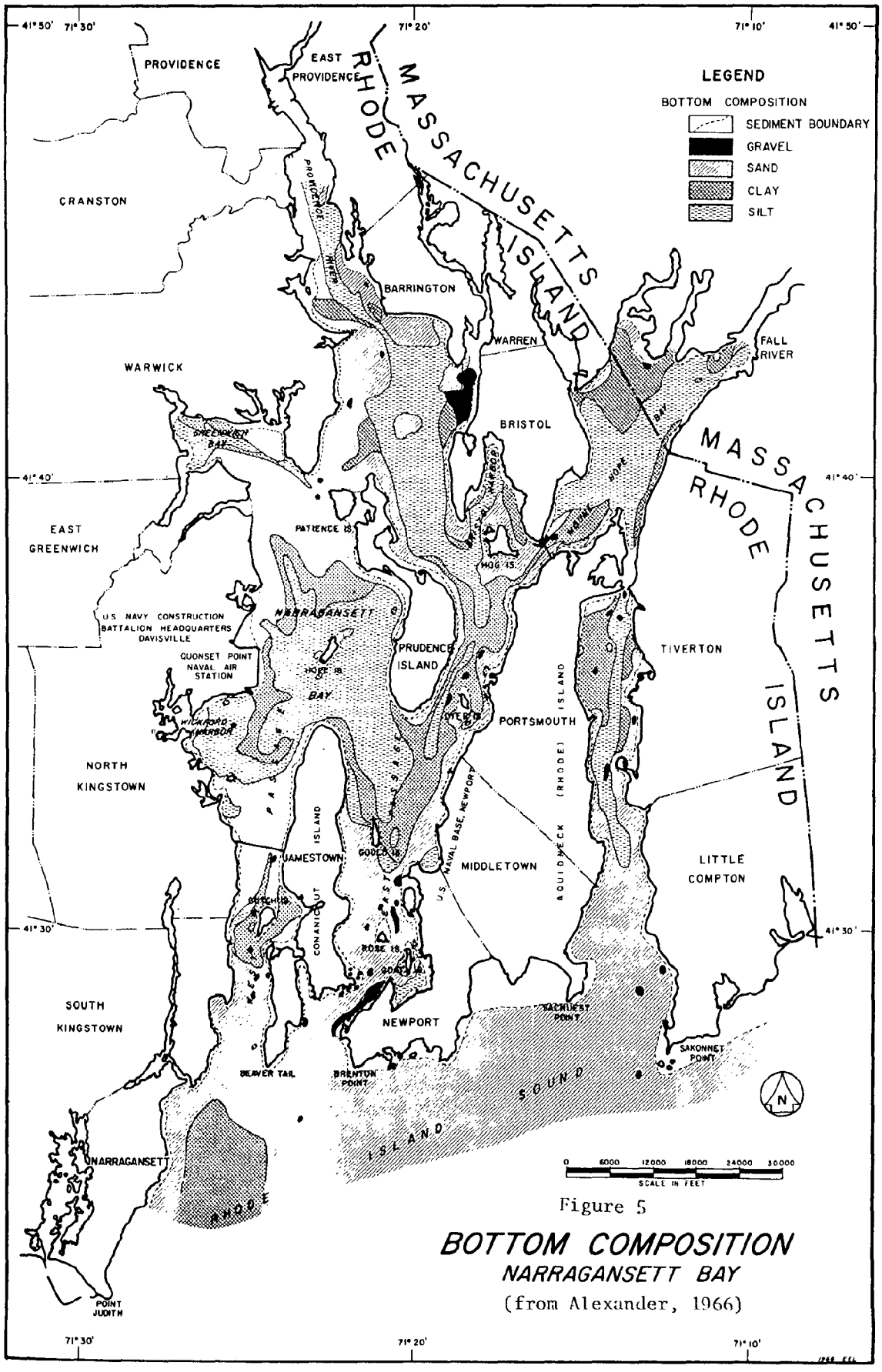

Figure 5

BOTTOM COMPOSITION
NARRAGANSETT BAY
(from Alexander, 1966)

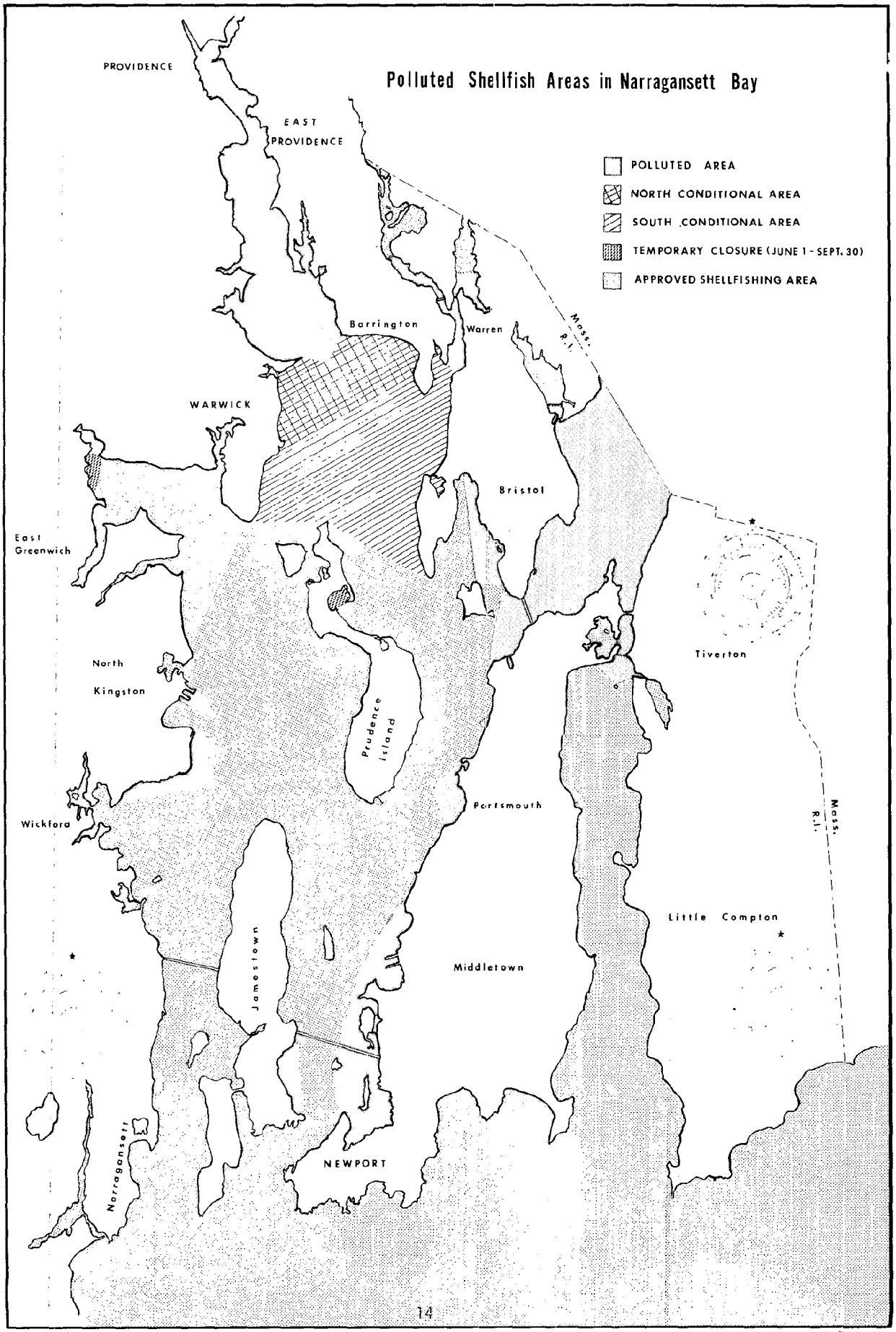

Figure 6 Narragansett Bay Shellfish Closure Areas

On the basis of the standing crop maintained, it appears that much of the high phytoplankton production of the bay is directed to benthic food chains and the support of an abundant infauna and large populations of bivalve mollusks and flounder. Inputs of energy from marsh detritus and sewage may also be important in the Upper Bay."

4. Historical Setting

Narragansett Bay and the Bay Islands have a long history, beginning shortly after the last glaciation and spanning perhaps as much as 12,000 years. During most of this period, the bay and its islands were inhabited by American Indians. At the time of European explorations these Indian groups were the Wampanoag and Narragansett tribes.

Giovanni de Verrazano explored Narragansett Bay in 1524 and left records of the Indian inhabitants in this area. Later, Roger Williams wrote a great deal about the native inhabitants of this area in the 17th century. Other early New Englanders also mentioned them. Both Verrazano and Williams were quite impressed with the people themselves; Verrazano writes, "These people are the most beautiful and have the most civil customs that we have found on this voyage" (Wroth 1970:138). They are described as tall, proud, and handsome, with many rich ornaments of feathers, copper, and shell.

Williams describes the seasonal movements and food-getting strategies of the Narragansetts and archaeological research thus far has confirmed the picture he left us. He states that summers were spent near their fields where they grew corn, beans, squash, tobacco, and several other plants. Such fields were often located near the coast to take advantage of the cool summer breezes as well as fish and shellfish until the crops were ready for harvesting.

In the fall, corn and other crops were harvested and put in baskets which were then stored in great pits lined with grass. Autumn was also an important time for hunting trips and fishing trips to acquire foods that could be smoked for the winter. Such trips sometimes involved hunting and fishing near the villages but often small groups would establish separate campsites closer to the hunting or fishing areas.

In winter, people moved away from the exposed coasts and to more sheltered inland valleys. Here they lived on stored foods but also hunted deer and fished through the ice on ponds and streams. Winter was a good time for working hides into clothing, for making ornaments such as shell beads, and for repairing tools such as bows and arrows, spears, drills, knives, and bone tools.

In spring, people gathered in large villages at the heads of estuaries and near the falls of rivers to harvest the spring runs of anadromous fish. This may have been an important ceremonial season as well since everyone was glad to welcome the end of winter and to be able to gather in large groups again.

Leadership among the Narragansetts was provided by the principal sachems who inherited their positions. Such sachems governed with the guidance of councils of lesser sachems representing villages and families. Villages seem to have been fairly autonomous but were usually allied with other villages in a complex web of political relations.

Religious leaders were called "powwows," and these people presided over important rituals and ceremonies. The Narragansetts believed in a variety of gods and spirits. They believed that, after death, the spirit of a good person would go to the house of Cautantowwit who was one of the greater gods. There the spirit would live an after-life similar to the life that the person had lived near the shores of Narragansett Bay.

5. Socio-Economic Setting

a. Military

Narragansett Bay's strategic location and excellent harbors led to its early use as a base for U.S. Navy operations. The Navy was formerly the largest single employer in Rhode Island and produced the highest level of dollar output directly attributable to the bay. Following the closure of major Navy bases in the Bay during 1974-77, Rhode Island's population fell from 950,000 in 1970 to 935,000 in 1978. There is currently discussion of reintroducing naval ships to the bay.

b. Commercial Shipping

Passages between the islands of Narragansett Bay are sufficiently deep to permit the navigation of large ships. Channel dredging is necessary only at the mouth of the Providence and Taunton Rivers. Major ports in Narragansett Bay are Providence and East Providence at the head of the bay, and Fall River and Tiverton in Mount Hope Bay. The value of the imports passing through the bay in 1975 was more than $1 billion, with petroleum products the major import. The principal shipping channel to these four ports passes 1.5 miles to the east of North Prudence Island (Figure 7). This channel requires periodic maintenance dredging to keep the port accessible to large ships. Dredging has been halted because of disputes over where to dump the polluted dredge material.

c. Commercial Fishing and Sportfishing

The bay supports a rich sport fishery of striped bass, bluefish, winter flounder, and tautog. With the exception of two commercial menhaden seining vessels, there is no commercial finfishing in the vicinity of the sanctuary. Limited commercial trawling takes place in the bay to the south of the sanctuary (Figure 8).

There has been long-standing disagreement between commercial and recreational fishermen in the bay. The recreational fishermen contend that when large schools of menhaden are netted and removed from the bay, an important food source for game fish is eliminated from the bay and thereby

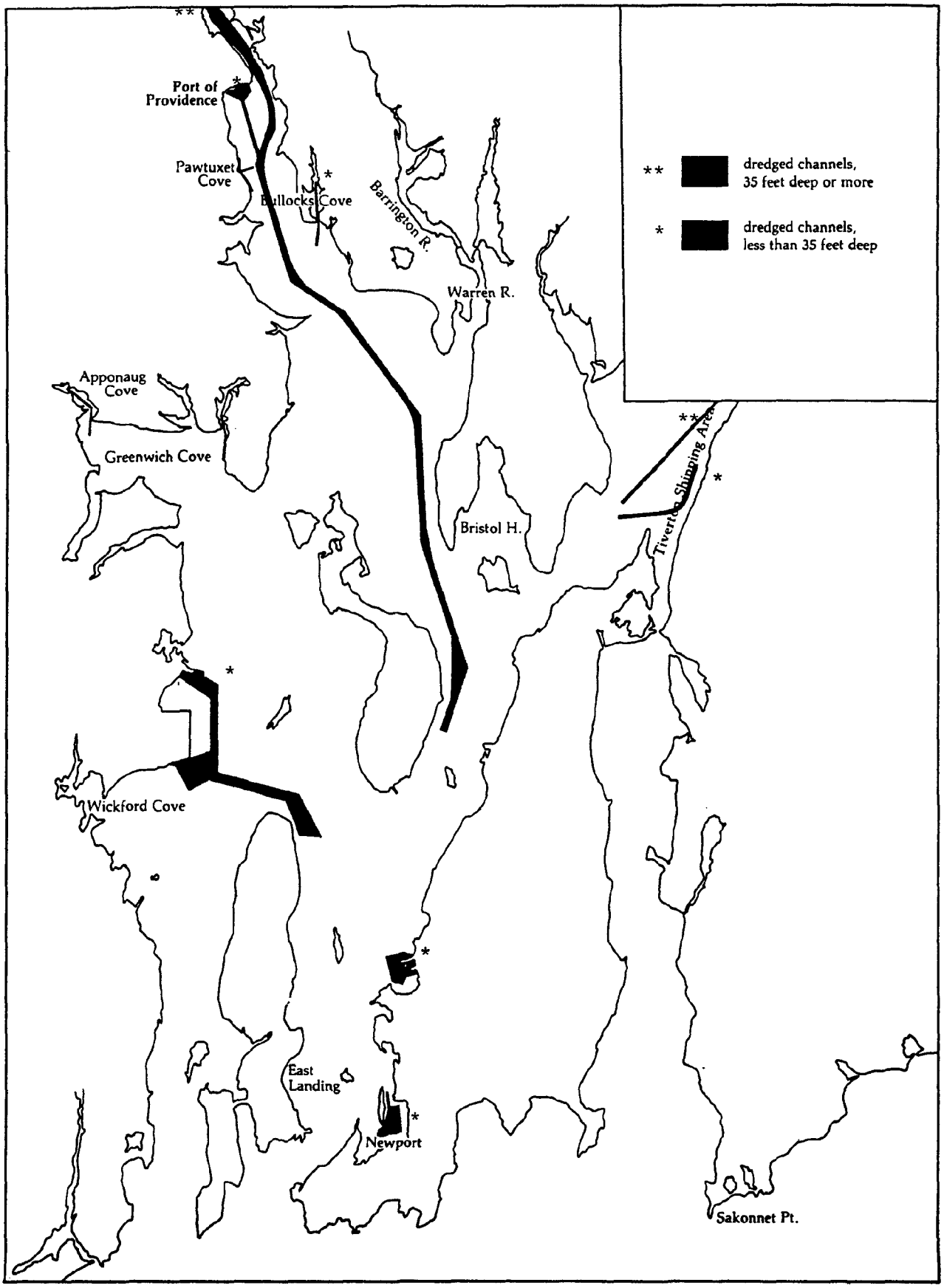

Figure 7 Dredged Ports and Channels
(from Seavey and Pratt, 1979)

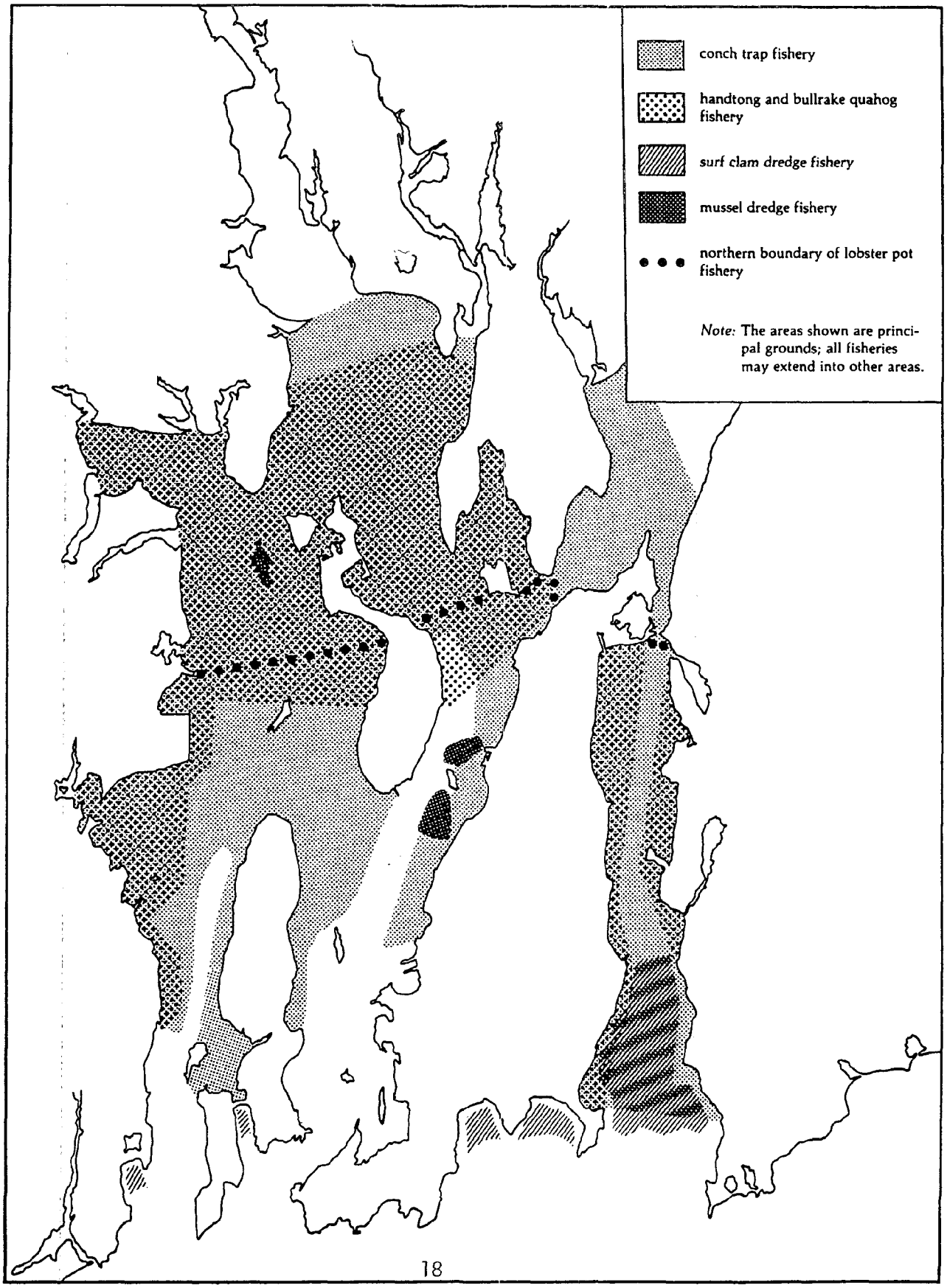

Figure 8 Principal Grounds for Commercial Shellfishing in Narragansett Bay (from Olsen, Robadue, and Lee, 1980)

lessens the number of gamefish present in the bay as well. Studies have been conducted by scientists at the University of Rhode Island Graduate School of Oceanography and by Rhode Island State marine biologists in order to determine the validity of such claims. This disagreement is one of the many conflicts which arise among users of the bay's resources.

Quahogging is a significant industry in Narragansett Bay. In 1982, there were more than 3,000 licenses issued. The most productive quahog beds are in the upper bay and in the lower Providence River where there are an estimated 3,300 pounds of quahogs per acre (Figure 8). The lower Providence River is permanently closed because of high coliform counts in these waters (Figure 6). Opening some of these areas that have been long closed to shellfishing hinges on the improvement of municipal sewage disposal facilities that discharge into the upper bay. In spite of the areas closed to shellfishing in the upper bay and lower Providence River, Narragansett Bay yields 10 percent of the nation's total commercial quahog catch.

Lobstering is quite intense within the lower bay. Approximately 300 commercial and 900-1000 recreational lobstermen set their pots in these waters. Some of these commercial lobstermen set as few as 25 pots, but some set up to 800 pots. With such pressure being exerted on this resource, approximately 80 percent of the lobsters reaching legal size in any year are caught and eaten. Most of the lobsters that are harvested from the bay are no more than a few millimeters over legal size (which is a lobster having a carapace measuring at least 3 3/16 inches).

Oystering was a major industry in Narragansett Bay during the late 1800's and early 1900's. The industry was at its peak in 1910 when 20,000 acres of Narragansett Bay were leased to oystermen who purchased "seed" oysters from the Chesapeake Bay and elsewhere, allowing oysters to grow in Narragansett Bay for several years before harvesting. The last bay oyster business closed in 1957. The industry's decline was probably caused by the increased cost and scarcity of seed-oysters as well as management problems that led to widespread poaching (Robadue and Lee, 1980). However, a pilot oyster culture project, located on Prudence Island is attempting to revive the industry.

There is also an increased use of mussels as food in Rhode Island and there are also some experimental mussel culture projects in the bay. However, some conflicts have arisen between quahoggers and mussel farmers since quahoggers are not able to work the floor of the bay under a mussel farm.

d. Recreational Boating

In 1980, there were approximately 28,000 registered recreation boats in Rhode Island (approximately 28 boats per 1,000 Rhode Island residents). Approximately 7,000 boats are kept at slips or moorings at marinas, boatyards, private yacht clubs, state piers, and town docks throughout the bay. An estimated 80 percent of the Rhode Island recreational fleet is used in salt water, particularly on Narragansett Bay.

6. Issues and Problems

This section deals with some current bay-related issues and problems that can be addressed through sanctuary programs. At the end of each subsection on a particular issue or problem there will be an item entitled Management Actions, suggesting ways in which the sanctuary can assist in clarifying the issue or mitigating the problem. Other bay-related issues and problems that arise in the future will also be dealt with through sanctuary programs.

a. Water Quality

Although 80 percent of Narragansett Bay waters are classified as SA (suitable for swimming and shellfishing), 5,600 acres of the upper bay are closed to shellfishing because of high coliform bacteria counts in these waters. One of the primary causes of these high bacterial counts is the effluent from municipal sewage treatment plants that flows into the Providence River and then into the upper bay. In fact, approximately one quarter of the river water entering the bay is effluent from sewage treatment plants, with the Field's Point plant on the Providence River contributing 6 million gallons per day.

The problem is compounded by combined sewer overflow (CSO) systems used by Providence and some other municipalities that border the bay. This system allows water from storm drains to flow into the sewerage system which causes the system to become overloaded following a period of heavy rain. When 1/2 inch or more of rain falls in the Providence area during a 24 hour period, it becomes necessary to close an additional 9,400 acres in the upper bay because the overload results in raw sewage being dumped directly into the bay. This conditional shellfishing area remains closed for 7 days following such a rain. Closures during 1982 kept the area closed to shellfishing for 169 days of the year, or 47 percent of the time.

This water pollution problem in the upper bay has been faced by Rhode Island voters who passed a $87 million dollar bond referendum to develop and upgrade sewage treatment facilities with the intent of reducing pollution in the bay. The passage of this 1980 bond referendum resulted in the formation of the Narragansett Bay Water Quality Management District Commission which has the responsibility of acquiring, planning, contracting, extending, improving, operating, and maintaining publicly owned sewage treatment

facilities in the district. The state is also beginning a water quality plan for the bay which will identify, through existing literature and new research, the causes of pollution that affect use of the bay and methods to improve water quality to attain these desired uses.

One problem associated with the high coliform bacteria counts in some areas of the bay is the illegal harvesting of quahogs from these closed areas. There have been instances of humans contracting diseases from eating contaminated quahogs which were harvested from these areas.

DEM has increased the number of conservation officers assigned to enforcing shellfishing laws in an effort to reduce the number of people quahogging in closed areas. DEM has also developed a public awareness campaign to inform people about the problem, the specific areas that are closed, and urge them to assist in stopping illegal quahogging by reporting violations to DEM.

Although the sanctuary is not actually in a closure or conditional closure area, it is on the border of a closure area and there are some management practices that will be undertaken to address this water quality problem.

Management Actions

Research

Research projects will be encouraged that:

- *Analyze water quality in the vicinity of the sanctuary;*
- *Monitor water quality on a long-term basis; and*
- *Monitor coliform bacteria content of quahogs living at various sites within sanctuary waters.*

Education

Education programs will be designed to:

- *Inform people about the importance of having high water quality in the upper bay, including the biological, sociological, and economic impacts resulting from pollution in the upper bay; and*
- *Motivate people to support and participate in efforts to improve water quality.*

Resource Protection/Resource Utilization

Management strategies will be adopted that:

- *Protect the water quality of Potter Cove from deteriorating through overuse.*

b. Dredging

Dredging of harbors and channels has occurred regularly in Narragansett Bay for more than 200 years to improve marine transportation of goods and people. It is estimated that 20 to 25 million cubic yards have been dredged from the bay since the first dredging was begun. Recently, however, very little dredging has been undertaken because of the dilemma that arises over the disposal sites of dredge materials. Potential disposal methods include offshore disposal at Brenton Reef or Brown's Ledge, creating salt marshes with the dredge material, and island building or expansion.

Opposition exists regarding each of these options because of potential environmental impacts since much of the dredge material would be from polluted areas of the bay. Pollutants in the dredge material may include hydrocarbons, pesticides, or pathogenic microorganisms. Offshore fishermen are concerned about the impact on productive fish and lobster populations in the vicinity of the proposed Brenton Reef dumpsite. There is also opposition to some of the other proposed sites within the bay.

A recent survey of facility operators indicates that approximately 1.6 million cubic yards would be dredged between 1981 and 1986 if there were a suitable place to dispose of the dredge spoils. Maintenance dredging of the Providence River channel alone would result in 200,000 cubic yards of material.

The controversy continues since there is both a need to protect this estuarine environment and also a need to maintain channels and harbors which are extremely important to the economy of the state.

Management Actions

Research

- *When dredging resumes and if the dredge spoils are dumped within the bay, monitoring programs will be designed and undertaken to assess any environmental impacts within the sanctuary.*

Education

- *An education program is being developed to help people better understand this problem and prepare them for participation in local meetings on the issue.*

c. Conflicting Uses of Bay Resources

There are numerous issues and problems relating to multiple uses of estuarine resources. A good example is the conflict that has arisen between recreational fishermen and commercial menhaden fishermen. This is an excellent example of competing uses since it involves: commercial vs. recreational uses, legal rights of individuals to utilize a resource, governmental regulations, and ecological relationships occurring within the estuary.

Recreational fishermen have traditionally fished for striped bass and bluefish in Narragansett Bay, just as commercial fishermen have traditionally seined for menhaden in the bay. The key factor in the conflict that arises is the fact that Narragansett Bay bluefish and striped bass feed extensively on menhaden. The conflict developed as the technology used in commercial menhaden fishing increased, causing a greater percentage of the bay's menhaden to be netted and therefore not available as food for bluefish and striped bass. A study showed that in 1976 40 million pounds of menhaden were caught of an estimated 50 million pounds in the bay, indicating that approximately 80 percent of the bay's menhaden population was caught by commercial fishermen. A Rhode Island State law barring the large out-of-state menhaden boats from the bay was found unconstitutional and the fishing, as well as the controversy, continued.

Scientists from URI Graduate School of Oceanography and biologists from DEM who have studied the relationship between menhaden populations and sportfish populations found that increased harvesting of menhaden has not caused a decline in bluefish and striped bass, but the controversy still continues.

Management Actions

Education

- *The sanctuary's involvement in problems relating to conflicting uses will be primarily in developing educational programs that address multiple uses of bay resources in general, and which also address the individual multiple use issues. Often such issues are complex, having biological, sociological and economic components. The programs, therefore, will not only focus on biological aspects but should delve into these other aspects as well.*

Resource Protection/Resource Utilization

- *In instances where conflicting uses arise within the sanctuary, it may be necessary to resolve such conflicts through developing and enforcing appropriate regulations.*

C. NARRAGANSETT BAY NATIONAL ESTUARINE SANCTUARY

1. North Prudence Island

a. Physiography

Prudence Island is located in the center of Narragansett Bay. The closest point to the mainland is at the northern end of the island which is 1 1/2 miles southeast of Warwick Neck and 1 3/4 miles southwest of Popasquash Point, Bristol. Over 700 acres on the northern end of the island are included in the sanctuary (Figure 1).

The sanctuary land is very irregular in shape, with two coves on the west side and one on the east side. The terrain has a low profile, with slopes of 3-15 percent and a maximum elevation of 70 feet. Isolated hummocks and a long north-south ridge of unconsolidated glacial material are among the area's notable upland features. The coves on the western shore combine to form ninety-two acres of salt marsh.

b. Geology and Soils

Approximately half of North Prudence is glacial till and the other half is glacial outwash. Near Pine Hill (within the outwash area) is a kettlehole created during the glacial period. This depression interrupts groundwater, so the kettlehole has become a small pond that is used extensively by deer. There is another wetland north of Coggeshall Cove; this one is not as deep and does not have standing water throughout the entire year. It does, however, provide fresh water for wildlife during much of the year. Except for these two freshwater areas, there is very little water available to wildlife in this area.

The glacial till near Potter Cove and in the vicinity of the old airstrip is classified as Newport silt loam. The silt in this rich soil retains moisture better than the sandy outwash soils that cover much of North Prudence.

Several features exemplify the dynamic aspect of coastal geologic processes. A bay spit in front of Jenny Creek is moving into the salt marsh at the rate of about one meter per year. A recurved spit, Gull Point, is continually growing and being reshaped by the northeast and northwest winds.

There are extensive salt marshes on the west side of the island. These marshes, like most salt marshes in the northeastern United States, are believed to have been formed during the past 3,000 to 4,000 years, a time when relative sea level has been slowly rising at approximately 1 mm per year. These marshes have been ditched; that is, straight ditches have been dug from the upper marsh to the tidal creeks. This was done, probably during the 1930's, to drain pools and standing water from the marsh and thereby prevent the breeding of mosquitoes (Nixon, 1972). (By 1938, almost 90 percent of the salt marshes from Maine to Virginia had been ditched in this way (Bourn and Cottam, 1950).)

Management Actions

Research

- *Monitoring programs will be initiated to measure the changes occurring at the Jenny Creek bay spit (believed to be moving into the marsh at the rate of one meter per year), and at the Gull Point bay spit (which is continually growing and changing the shape of Potter Cove.)*

Education

- *The bay spit will be used for educational programs after September 1st following the tern nesting season. The site is near the ferry landing and will be used for on-site interpretive programs concerning coastal geological processes. It will be used primarily for school programs since the area could not be used until after September 1st.*

Resource Protection

- *The two freshwater kettlehole wetlands will be protected from excessive human impacts because they are important for wildlife.*

Recreation

- *If part of North Prudence is to be zoned for recreational use, the area near Potter Cove would be suitable because of its proximity to the dock used by ferries and recreational boaters. The silty loam soils in this area are suitable for recreational use since mowed fields would remain moist and green throughout the summer and would be good picnic areas.*

c. Vegetation

The vegetation of the uplands reflects the extensive farming that took place in the area until the early 1900's. After the fields were abandoned, woody plants gradually replaced the herbaceous species. The uplands are now covered with dense shrub growth of arrowwood viburnum (Viburnum recognitum), bayberry (Myrica pensylvanica), blueberry (Vaccinium corymbosum), shadbush (Amelanchier canadensis) interspersed with red cedar (Juniperus virginiana), red maple (Acer rubrum), sapling oaks (Quercus sp.), pitch pine (Pinus rigida), black cherry (Prunus serotina), common greenbriar (Smilax rotundifolia), and blackberry (Rubus allegheniesis). Deciduous forest, primarily mixed oak, is slowly replacing the shrubs in some areas.

Golden aster (Chrysopsis falcata) has been found growing on a sandy embankment overlooking the kettlehole pond. This is a coastal plain species that is uncommon within its range of southeastern Massachusetts to New Jersey. It grows in sandy, dry habitats, often in association with false heather. This is only the fifth recorded site for golden aster in Rhode Island and this is the most prolific stand in the state. Golden aster is considered to be a "regionally significant species" by the New England Botanical Club. It is designated as "state threatened" by the Rhode Island Natural Heritage Program.

There is also a wetland species within the sanctuary that is of particular interest. During a preliminary survey of the freshwater wetlands at the north end of the island, a wetland ecologist found a liverwort (Ricciocarpus sp.) that he had not found in any other wetland in Rhode Island.

The salt marsh plant community dominates the north-west shore. The predominant plant species in the salt marshes are salt meadow grass (Spartina patens), cordgrass (Spartina alterniflora), and spike grass (Distichlis spicata). Other common salt marsh plants include: black rush (Juncus gerardii), saltwort (Salicornia europaea), marsh lavender (Limonium carolinianum), and high tide bush (Iva frutescens).

Management Actions

Research

- *Further investigations will be conducted to determine if there are any other locations within the sanctuary where golden aster and the liverwort Ricciocarpus are growing.*

Education

- *The golden aster will be used for off-site educational purposes to demonstrate the way in which a particular species has been affected by the sanctuary designation at the north end of the island.*

- *The extensive salt-marsh community on the west side of the island is easily accessible from Potter Cove and will be used for on-site educational programs.*

Resource Protection

- *Educational efforts involving the stand of golden asters would be off-site to protect the site from human impact. Such off-site interpretation will be in the form of a pamphlet or as a section in a larger brochure about the vegetation of the sanctuary.*

- *In order to protect the salt marsh vegetation from human impact a raised wooden walkway will be constructed over part of the marsh. This will allow people to learn about the marsh through a self-guided walk including a pamphlet and wayside exhibits; at the same time, the marsh vegetation will be protected.*

d. Wildlife

i. Upland

The upland wildlife species that attracts the most attention is the white-tailed deer (Odocoileus virginiana). The island supports the densest white-tailed deer herd in New England, numbering approximately 400 at fawning time in the spring. The early successional vegetation at the north end of Prudence Island provides accessible browse for the deer. The herd, however, has grown so large that there is not enough browse, and as a result, the deer weigh less than mainland deer and some die of malnutrition each spring. A controlled bow hunting season has reduced the size of the herd and caused a dramatic increase in the weights of the deer. An additional effect of hunting has been a reduction in the number of deer dying of malnutrition.

The large herd has had a noticeable effect on the vegetation. Many species, especially red cedar, are often browsed clean of branches as high as the deer can reach. Therefore, many of the trees have no branches for at least four feet up their trunks. Red cedars growing in fields are often browsed to this extent, giving the plant an unusual appearance since field red cedar are generally well branched all the way to the ground.

Raccoons (Procyon lotor), eastern red fox (Vulpes fulva) and eastern cottontail rabbits (Sylvilagus floridanus) are plentiful at the north end of the island. These large populations probably result from the nearly ideal habitat that exists there.

A newly described species of deer tick (Ixodes dammini) has been found on Prudence Island's white-tailed deer, raccoons, eastern cottontail rabbits, white-footed mice (Peromyscus leucopus), domestic dogs (Canis familiaris) and humans. These ticks can carry Lyme disease, and, in fact some humans on the island have contracted this disease. People leaving the trails to go through brushy areas are more likely to come into contact with deer ticks.

ii. Tidal Wetlands

Birds

A colony of least terns (Sterna antillarum) nests during the summer on Gull Point, a sand spit that separates Potter Cove from the East Passage. This is one of only eight least tern nesting sites in Rhode Island and is particularly vulnerable to human intrusion because of its proximity to Potter Cove which is used extensively by recreational boaters. These birds nest directly on the beach and are adversely affected by human intrusion.

The large salt marshes at North Prudence Island are used as feeding areas by a number of large wading birds--great blue heron (Ardea herodias), green-backed heron (Butorides virescens), little blue heron (Egretta caerulea), great egret (Casmerodius albus), snowy egret (Egretta thula), black-crowned night heron (Nycticorax nycticorax), and the glossy ibis (Plegadis falcinellus).

All of these species, except the great blue heron and green-backed heron, nest on Hope Island, which is only four miles from the marshes at Coggeshall Cove and Sheep Pen Cove. These marshes, and Jenny Creek nearby, are the only large salt marshes so close to this major wading bird rookery on Hope Island.

The salt marsh at Coggeshall Cove may be a nesting site for the seaside sparrow (Ammodramus maritimus), a species classified as "of special concern" by the Rhode Island Natural Heritage Program. The species nests in salt marshes and is believed to be breeding in nine general locations throughout the state. In Narragansett Bay, nesting has been confirmed in only seven marshes.

Mammals

The following mammals are upland species that visit the marshes to feed on shellfish, bird eggs, vertebrates and invertebrates--red fox (Vulpes fulva), raccoon (Procyon lotor), and skunk (Mephitis mephitis).

Two other species, meadow vole (Microtus pennsylvanicus) and the white-footed mouse (Peromyscus leucopus), live in the upper marsh.

Crabs and Snails

An extremely common crab in the Coggeshall Cove marsh is the fiddler crab (Uca pugnax), a crab that is believed to be an indicator of a relatively clean salt marsh. They are most abundant along the channel embankments. The green crab (Carcinus maenas) is also found at the marshes at North Prudence.

Common snail species of these marshes are salt marsh snail (Melampus bidentatus), mud snail (Nassarius obsoletus), and common periwinkle (Littorina littorea).

Fish

The most abundant fish in the salt marsh channels are common mummichogs (Fundulus heteroclitus) and silverside (Menidia menidia).

iii. Tidal Deepwater

The hard-shell clam (Mercenaria mercenaria), also called a quahog, is a commercially important shellfish that lives in the soft sediment. They are particularly abundant in the area west of Coggeshall Cove and Sheep Pen Cove. This area, and other areas within the sanctuary waters, are worked by commercial quahoggers. Shallow areas near shore are also worked by recreational quahoggers.

Management Actions

Research

- *The monitoring of the island's white-tailed deer herd will be expanded to obtain a clearer understanding about the ecology of this herd.*
- *Recently initiated studies of the deer tick and the prevalence of Lyme disease among Prudence Island mammals will be expanded to determine the degree of risk to which sanctuary visitors will be exposed.*
- *Studies of the Gull Point least tern colony will be expanded.*
- *Coggeshall Cove fiddler crab population will be monitored since this species is an indicator of relatively clean salt marshes.*
- *Human use of the intertidal zone will be monitored to identify patterns of use that might have an impact.*
- *Efforts will be made to determine the status of seaside sparrows at the salt marshes within the sanctuary.*

Education

- *An education program will be designed to inform Potter Cove users about the existence of the Gull Point tern colony and the possible impact of human intrusion upon the colony.*
- *An education program will be designed for visitor interpretation on the presence of large wading birds in the salt marshes and their link to the Hope Island rookery.*
- *An education program will be designed to inform people about the ecology of salt marshes and the management strategies that have been developed to protect them.*
- *An education program will be designed to inform people about: (1) the Prudence Island deer herd, (2) the delicate balance that exists between the size of the herd and the limited browse that is available, and (3) the management measures that are undertaken to help maintain this balance.*

Resource Protection

- *Fences will be placed around the Gull Point least tern colony and appropriate signs will be posted explaining that the area is closed to human use. (A similar management technique has been very successful at another least tern colony in Rhode Island.)*

- *A raised walkway will be constructed over part of the Coggeshall Cove salt marsh. This will allow sanctuary visitors to have access to the marsh without having a negative impact on the marsh. The walkway will also direct people away from particularly sensitive areas where wading birds tend to feed.*

- *The deer herd will continue to be managed in such a way that the size of the herd is in balance with the available food.*

Resource Utilization

- *Commercial and recreational quahogging, both of which are traditional activities in these waters, will be allowed to continue in accordance with existing state shellfishing laws as long as these activities do not conflict with a specific research project in particular areas or unless this shellfishing activity threatens to have a long-term negative impact on the quahog population.*

- *Upland areas that are utilized by people will be managed in such a way as to reduce the risk of humans contracting Lyme disease, which is transmitted by the deer tick (Ixodes dammini).*

e. History

Prudence and Patience Islands appear to have been rather peripheral to the main districts of Narragansett activity. When Roger Williams entered the areas, Prudence and Patience were at the eastern edge of the Narragansett territory which extended over most of modern Rhode Island.

In general, the historic and archaeological references suggest occasional use of these islands for specific resources, but they do not indicate that there were large Indian settlements on either Prudence or Patience Islands. A number of factors may account for the presence of only small numbers of Indians on this island. Prudence may be just enough smaller than Conanicut, for example to have made permanent settlement impossible. Prudence and Patience may simply not have offered resources that were any different from, or more plentiful than, those available all along the shore of Narragansett Bay, and this meant there was little incentive for a long and possibly dangerous trip by canoe.

Another possible explanation for the paucity of Indian settlements is a political one. Although the Narragansetts claimed Prudence Island in 1637, the Wampanoags, who inhabited the eastern shore of Narragansett Bay also laid claim to the island at a later date. Narragansett Bay itself is a natural geographic boundary and the islands in it may be natural no-man's lands. People may have felt free to visit and use the islands for special purposes but may not have felt that it was safe to use the islands on a permanent long-term basis.

Low population levels have continued from the initial period of European settlement in the seventeenth century to the present. An agricultural economy was established on Prudence and the other Bay Islands before the Revolution, but in 1776 and 1777 the residents left the island and most of the island's homes and a windmill were burned by the British. The British also landed and burned two homes on Patience Island in 1776. In the same year a British schooner went aground between Prudence and Patience and was blown up.

After the Revolutionary War, Prudence Island slowly returned to an agricultural existence, largely devoted to grazing, with some grain being raised as well. There were less than two dozen families inhabiting the island.

At the end of the nineteenth centry, Prudence, like other parts of the Rhode Island bay and shore, attracted summer residents. Around 1876, two cottages were built along the west side of the island and by the end of the century Prudence Park, which was served by a steamboat from Providence, contained more than three dozen "handsome cottages." In 1896, a school, the fourth on Prudence, was built in the center of the island. In 1904, the present ferry from Bristol was started by Halsey Chase, who ran a hotel on the island. A wharf built on the east side in 1909 by the Herreshoffs helped engender a summer settlement, and, later, a wharf was built at Sandy

Point. In 1921, the Prudence Island Navigation Company was chartered and regular trips to the island began, helping to precipitate a prosperous era in the island's history; eventually, a string of "colonies," or settlements sprang up along the east shore of Prudence. Today, Prudence II makes passenger and freight trips to the island on a regular basis and stops, in the summer, at Hog Island. Prudence now supports a year-round population of approximately 50 people.

f. Cultural Sites

i. Native American Campsite

Near Pine Hill, there is an undisturbed campsite of the Late Woodland Period, probably in use from approximately 1000-1500 AD. The site has shell middens containing shells of oysters, quahogs, soft-shell clams, scallops, whelks, and slipper limpets. Numerous fire-cracked rocks indicate that the site was used for processing shellfish. Gunflint fragments found in the area indicate that the campsite may have been used into historic time. This site is recommended for the National Register of Historic Places.

ii. North End Farm

This farm at the north end of the island was probably established by John Brown twenty to thirty years after the close of the Revolutionary War. The land was farmed by various tenants for about 200 years. Farm buildings were added throughout the farm's history, with the last one being built around 1895. The house was still standing in the 1930's. The farmsite has been nominated for the National Register of Historic Places. The farmsite is located near the intersection of two dirt roads, so it is readily accessible to the public.

iii. North End School House

Within the sanctuary is the foundation of a one-room school that was established in 1854 and ceased operation in 1904. It remained standing until the late 1930's. This site is just north of Potter Cove, an area heavily used by sanctuary visitors, and is located just off an existing dirt road.

Management Actions

Research

- *Documentary research will be conducted for the North End Farm.*

Education

- *Educational programs will be developed to help people understand the historical importance of the North End Farm and the North End School House. Both of these sites are easily accessible for organized programs as well as for self-guided walks.*

Resource Protection

- *The Native American Campsite will be protected from human impact since indiscriminate digging at the site would be extremely damaging. This site will be protected by designing a trail system that avoids the area.*

- *The North End Farm should also be protected from negative human impact. This site, however, is along-side a dirt road, so it is not practical to keep people away from the site. A better way to protect this site is by designing an educational program that stresses the historical importance of the farmsite.*

2. Hope Island

a. Physiography

Hope Island, 94 acres in size, is located 3 miles south of Patience Island and 1.5 miles west of Prudence Island. The State of Rhode Island acquired Hope Island in 1975 when it was abandoned as surplus property by the Navy, which had used it as an ammunition depot during World War II.

Hope Island's topography is very irregular, with numerous low hills, ledges, and rocky outcrops. Maximum elevation is 60 feet. The shoreline is generally steep and rocky.

b. Geology and Soils

There are many outcrops of bedrock on the island. This bedrock is part of the Rhode Island Formation. It is Pennsylvanian-age slate, siltstone, sandstone, and conglomerate that has been highly metamorphosed (in the garnet isograd).

The soils are extremely rocky, fine, sandy-loam derived from glacial till. This soil of the Canton and Charlton series is relatively thin in some areas and thick in other places over the bedrock. Two small freshwater wetlands in depressions in the north-central and south-central portions of the island generally have standing water throughout the year. These ponds may be pocketed on bedrock or be underlain by tight soil material (hardpan).

c. Vegetation

The vegetation is primarily early successional, resulting from DEM's management practice of periodically burning large areas of the island. Much of the northern end of Hope Island is predominantly vegetated by grasses. Many other areas have low shrubs: bayberry (Myrica pensylvanica), rose (Rosa sp.), blackberry (Rubus spp.), and poison ivy (Toxicodendron radicans). The central part of the island contains tall shrubs and sapling trees including: red cedar (Juniperus virginiana), staghorn sumac (Rhus typhina), shadbush (Amelanchier canadensis), black cherry (Prunus serotina), and black willow (Salix nigra). A single stand of black locust (Robinia pseudo-acacia) occupies a low hill on the northern part of the island.

d. Wildlife

i. Upland

The low, dense vegetation on Hope Island is utilized by the eastern cottontail rabbit. The vegetation on the northern end of the island is burned periodically to maintain the vegetation at a stage that provides suitable habitat for rabbits.

Hope Island has become one of the most significant nesting areas on the East Coast for wading birds. In addition to the egret and heron rookery, many black-backed gulls (Larus marinus) and herring gulls (Larus argentatus) nest on the rocks of Hope Island.

During the fall, the island is an important stopover point for migrating birds, including many kinds of warblers, vireos, and sparrows.

ii. Tidal Wetlands

During the winter, harbor seals occasionally use the exposed offshore rocks as haulout and resting sites.

iii. Tidal Deepwater

Soft-shelled clams (Mya arenaria), quahogs (Mercenaria mercenaria), lobsters (Homarus americanus), striped bass (Roccus saxatilis), tautog (Tautoga onitis), black-back flounder (Pseudopleuronectes americanus), bluefish (Pomatomus saltatrix), and sea trout (Cynoscion regalis), are abundant in the waters around Hope Island.

e. Cultural Sites

There is an 18th century farmsite on the west side of Hope Island. To date, no archaeological work or documentary research has been carried out relating to this site.

During World War II the island was used by the Navy as a munitions dump. There are still ammunition bunkers and concrete roads remaining from this period.

Management Actions

Research

- *Monitoring of the rookery will continue to determine if the four-year decline in nesting (1978-1982) continues.*
- *Identify possible causes for this decline in nesting.*
- *Archaeological work and documentary research will be conducted on the Hope Island farmsite.*

Education

- *Education programs will be developed that stress the uniqueness of the rookery and the importance of protecting it. These educational efforts will be off-site during the nesting season and on-site during the fall.*

Resource Protection

- *The island will continue to be closed to the public during the nesting season.*
- *The permit process, allowing some people onto the island during the nesting season for research purposes, will be more restrictive.*
- *It should be demonstrated that any proposed study would have minimal impact on the rookery and that the knowledge gained from such research would be worth the potential harm that could result from on-site field work.*

Resource Utilization

- *The waters around the island have been traditionally used for commercial shellfishing as well as for recreational shellfishing. These traditional uses will continue according to state regulations as long as these uses do not threaten to have a long-lasting impact on the resources.*
- *There has traditionally been a rabbit hunting season on Hope Island. This hunting season occurs in the fall and winter, so that there has been no impact on the rookery. This traditional use will continue according to state hunting regulations as long as hunting on Hope Island does not threaten to have a long-lasting impact on the rabbit population or on other Hope Island resources.*

3. Patience Island

a. Physiography

Patience Island, 204 acres in size, lies to the west of northern Prudence Island. At their closest point, the two islands are 900 feet apart. Patience has gentle topographic contours with a maximum elevation of 50 feet. The shoreline is primarily pebble beach, with a small sand beach and adjacent 13-acre salt marsh on the eastern side of the island.

b. Geology and Soils

The northeastern third of the island is overlaid with glacial outwash; most of the rest of the island is glacial till. The outwash soils are predominantly stratified sand and gravel, while the westerly side of the island with its till-derived soils is made up of silty, richer soils. The silt loam (Newport series) soils on the western side of the island helped to support the farming efforts that were carried on here for more than 200 years. The southern tip of the island is overlain with Popuonock loamy fine sand, which is primarily wind-blown sand that was deposited after the glacier receded. These are dry soils that have a depth of up to 4 feet, overlying the richer loam beneath.

c. Vegetation

Upland vegetation includes dense concentrations of tall shrubs interpersed with red cedar as overstory. Dominant shrubs include bayberry, black cherry, highbush blueberry, shadbush, poison ivy, and European bittersweet (Celastrus orbiculatus). Deciduous forest is gradually replacing the shrub habitat in some parts of the island.

The salt marsh contains the seablite (Suaeda maritima), a plant species common in other areas of the country, but rare in Rhode Island. There are only four other recorded sites for this species in the state. As a result, the plant is classified as "of special concern" by the Rhode Island Natural Heritage Program.

d. Wildlife

i. Upland

Since Patience island is within 900 feet of Prudence Island, white-tailed deer can easily swim back and forth between the two islands. Therefore, the Prudence Island deer and the Patience Island deer are actually one population. The low shrubs provide good browse and the dense vegetation serves as cover. The upland areas, with their early successional vegetation, also support red fox, eastern cottontail rabbit, and ring-necked pheasant (Phasianus colchicus).

There is limited hunting in upland areas. Deer can be hunted only with bow and arrow and hunters must obtain a special permit. This procedure allows DEM to limit the number of people hunting on the island. Small game cannot be hunted.

ii. Tidal Wetlands

Cove areas along the shore are used extensively as feeding areas by migrant and wintering waterfowl species. Common loons (Gavia immer), and horned grebes (Podiceps auritus) occur frequently, as do greater scaup (Aythya marila), great cormorants (Phalacrocorax carbo), canvas-backed ducks (Aythya valisineria), black duck (Anas rubripes), and scoters (Melanitta spp.). Ducks can be hunted in accordance with state and federal regulations. Quahogs are abundant in the sandy sediment and are harvested by commercial and recreational shellfishermen.

e. Cultural Sites

The Patience Island Farm covered an area of approximately 200 acres, nearly the entire island, and was a working farm as early as the mid-seventeenth century. The farm buildings were burned by the British during the Revolutionary War. After the war, the buildings were rebuilt and the farm remained in operation until the early twentieth century. During the 1960's, construction was undertaken to create a summer resort colony on the island. The colony was never completed; however, the construction did considerable damage to the sites of the early farm buildings.

There is another archaeological site, separate from the farm. This is the foundation of an oysterman's house along the northwest shore. The site probably dates back to the late eighteenth century when oyster-beds were leased in the upper bay. The small building was the home of a watchman for the oysterbeds located just off Patience Island. The foundation of the house remains in good condition with little apparent disturbance.

Management Actions

Research

- *Studies of the Prudence Island deer herd will include an analysis of the extent to which the deer utilize Patience Island.*

- *More archaeological work and documentary research will be done at the site of the oysterman's house.*

Resource Protection

- *Hunting is presently limited to deer hunting and duck hunting. Such limitations will continue.*

- *The stand of seablite will be protected from human impact. This stand is particularly vulnerable since it is growing near the Patience Island dock where many of the island visitors land. If a trail system is developed, it will avoid this stand of seablite.*

- *The site of the oysterman's house will be protected by designing a trail system that avoids the site. An educational program stressing the importance of the site will also help to protect the area.*

Resource Utilization

- *Hunting of deer and ducks will continue in accordance with state and federal regulations as long as hunting does not threaten to have long-lasting impacts on the species or unduly restrict other uses.*

- *Recreational and commercial shellfishing will continue in accordance with state regulations as long as such shellfishing does not threaten to have long-lasting impacts on the species, or unduly restrict other uses.*

Education

- *An education program will be developed to interpret the site of the oysterman's house. This program will show how the bay's resources have been utilized in different ways throughout Rhode Island's history.*

III. MANAGEMENT MEASURES

A. INTRODUCTION AND CONTEXT

The principal purposes for designating the Narragansett Bay National Estuarine Sanctuary are to encourage research, education, and low impact uses of the area through a comprehensive management plan that reflects the goals of the National Estuarine Sanctuary Program.

This section of the management plan presents the strategies for managing the area as part of the National Estuarine Sanctuary Program. These management measures include: Goals and Objectives, Sanctuary Administration and Operation, Resource Protection/Utilization Plan, Research Plan, and Education Plan. The strategies that are outlined in this section emphasize those uses that are consistent with long-term resource conservation. The plan is based on an analysis of biological, sociological, and economic aspects of the sanctuary and the upper bay as an ecological unit. The management strategies address the bay-related issues and problems discussed in Section II.

The sanctuary's management goals and objectives are long-term in nature. However, the management actions to achieve these goals and objectives span 7 years. The plan will be implemented in three stages: Stage I, II and III. Stage I will cover years 1, 2, and 3. Stage II will cover years 4 and 5, and Stage III will cover years 6 and 7. This phasing sequence provides orderly development of the sanctuary's programs, reflects management priorities and anticipated funding levels. Therefore, unanticipated changes in funding levels may require adjustments in the phasing sequence of sanctuary programs. Since the management plan was prepared during the third year of sanctuary operation, some of the Stage I programs have been completed or are in progress.

B. SANCTUARY GOALS AND OBJECTIVES

The goals that have been established for the sanctuary reflects the overall goals that have been set by NOAA for the entire national system of estuarine sanctuaries. The goals address the following: Research, Education, Resource Protection, and Resource Utilization.

1. Goal I - Research

PROMOTE AND COORDINATE RESEARCH TO EXPAND MAN'S KNOWLEDGE OF THE ESTUARINE SYSTEM AND PROVIDE INFORMATION USEFUL IN MANAGING THE ESTUARY.

Objectives

- Develop an annotated list of research that has been conducted within the estuary.
- Obtain baseline data for the sanctuary.

- Encourage appropriate research within the sanctuary through contacts with the scientific community.

- Promote opportunities for estuarine research by protecting natural resources, establishing a monitoring program, and providing support for research activities when possible.

- Screen applications for research within the sanctuary to determine the suitability of the proposed research.

- Review research findings to determine implications for management or for future research.

- Evaluate the impact of human uses on the sanctuary resources.

2. Goal II - Education

DEVELOP AN UNDERSTANDING OF ECOLOGICAL RELATIONSHIPS WITHIN THE ESTUARINE ENVIRONMENT AND THE PROBLEMS RESULTING FROM HUMAN IMPACT ON THE ENVIRONMENT.

DEVELOP AN AWARENESS OF HOW THESE PROBLEMS CAN BE SOLVED.

DEVELOP THE MOTIVATION TO ACT TOWARD THEIR SOLUTION.

Objectives

- Access the suitability of the sanctuary's natural and cultural resources for education programs.

- Design on-site and off-site education programs for a wide variety of audiences. On-site elements would include organized field walks led by a naturalist, self-guided trails with accompanying pamphlets, wayside exhibits, and interpretive display areas. Off-site elements would include interpretive brochures, press releases, and publicity about on-site programs.

- Develop an education program for local school classes.

- Train teachers to conduct field trips within the sanctuary and to conduct lessons in their classes on sanctuary subjects.

3. Goal III - Resource Protection

PROTECT THE NATURAL AND CULTURAL RESOURCES OF THE SANCTUARY.

Objectives

- Adopt regulations that minimize the impact on sensitive resources.

- Develop management strategies that protect these resources.

- Monitor ecological impacts from human activities.

- Adjust management strategies and regulations to respond to adverse environmental changes identified through the monitoring program.

- Maintain habitats so that they can support an abundance and diversity of wildlife.

- Maintain environmental conditions that enhance the survival of native species of plants and animals that are rare or endangered.

- Restore habitats that have deteriorated in their ability to support indigenous animal species due to past use of the land.

- Reintroduce indigenous species that have been exterpated due to overhunting or destruction of habitat.

4. Goal IV - Resource Utilization

PROVIDE FOR MAXIMUM COMPATIBLE USES OF THE SANCTUARY.

Objectives

- Arrange for convenient access to sanctuary sites including ferry service, dock construction, and a trail system.

- Develop a zone system that designates specific use areas .

- Manage the shellfish population so that this resource can be utilized by commercial and recreational fishermen.

- Allow hunting of some upland and wetland species in accordance with state and federal regulations.

C. ADMINISTRATION AND OPERATION

The sanctuary is owned by the State of Rhode Island and managed by the Rhode Island Department of Environmental Management (DEM). The sanctuary is managed as a part of the northern region of the Bay Islands Park, which includes South Prudence as well as the sanctuary. Sanctuary headquarters and the manager's residence are located at South Prudence. When the 27-acre parcel on North Prudence, now in private ownership, is purchased by the state, some administrative functions may be moved to one of the buildings on that site.

The sanctuary staff includes the manager, a maintenance crew, seasonal naturalists, and seasonal enforcement officers. The staff is employed by the Division of Parks and Recreation, except for the enforcement officers, who work for the Division of Enforcement. Both divisions as well as the Division of Fish & Wildlife, which manages hunting in the sanctuary, are responsible to the DEM Assistant Director for Operations. The Assistant

Director has general oversight and responsibility for the sanctuary and its programs. When conflicts arise between divisions, the Assistant Director for Operations shall make the final decision, based on the priorities established in this plan.

1. Sanctuary Manager

The sanctuary manager is the primary on-site contact. The manager's duties include:

a. Administration and Operation

° Prepare and administer sanctuary budget.

° Assist in the development of management policies with the advice of the Sanctuary Advisory Committee.

° Supervise sanctuary staff.

° Prepare financial assistance award applications and performance reports.

° Order equipment and supplies.

° Coordinate with other governments and organizations on issues that affect the sanctuary.

° Administer, review, and propose changes in management policies.

b. Education

° Participate with the Education Subcommittee in the development of education programs.

° Coordinate education programs for the sanctuary.

° Function as a naturalist.

c. Research

° Promote and coordinate research activities with the assistance of the Research Subcommittee.

° Coordinate and oversee the monitoring program.

° Explore funding possibilities for identified research priorities.

2. Other Sanctuary Staff

a. Naturalists

° Conduct education programs for organizations and the general public during the summer.

° Conduct education programs for school groups in the spring and fall.

b. Enforcement Personnel

° Enforce sanctuary regulations.

° Monitor human use of the sanctuary.

c. Maintenance Personnel

° Clean, maintain, and repair trails and sanctuary facilities.

3. DEM Off-Site Staff Support

Management of the sanctuary requires cooperative actions by other DEM divisions besides the Division of Parks and Recreation. A DEM organizational chart is presented in Figure 9. Division responsibilities in sanctuary management are provided in the brief description below. Division activities are coordinated with the sanctuary manager.

a. Office of Planning and Development

The division works in four areas--planning, recreation, and administration; land acquisition; facility development on state areas; and supervision of local projects utilizing federal land and water funds.

This office's involvement regarding sanctuary management includes acquiring land; designing and fabricating all site developments; and surveying sites for unique natural features as well as for rare and endangered flora and fauna.

b. Office of Information and Education

This office serves as a liaison between DEM and the people of Rhode Island. On a daily basis, the office is charged with the responsibility of keeping the public informed about DEM's programs and services.

Their involvement regarding sanctuary management includes planning interpretive programs for the sanctuary; developing education materials; supervising seasonal naturalists; and serving as a liaison with the Education Subcommittee.

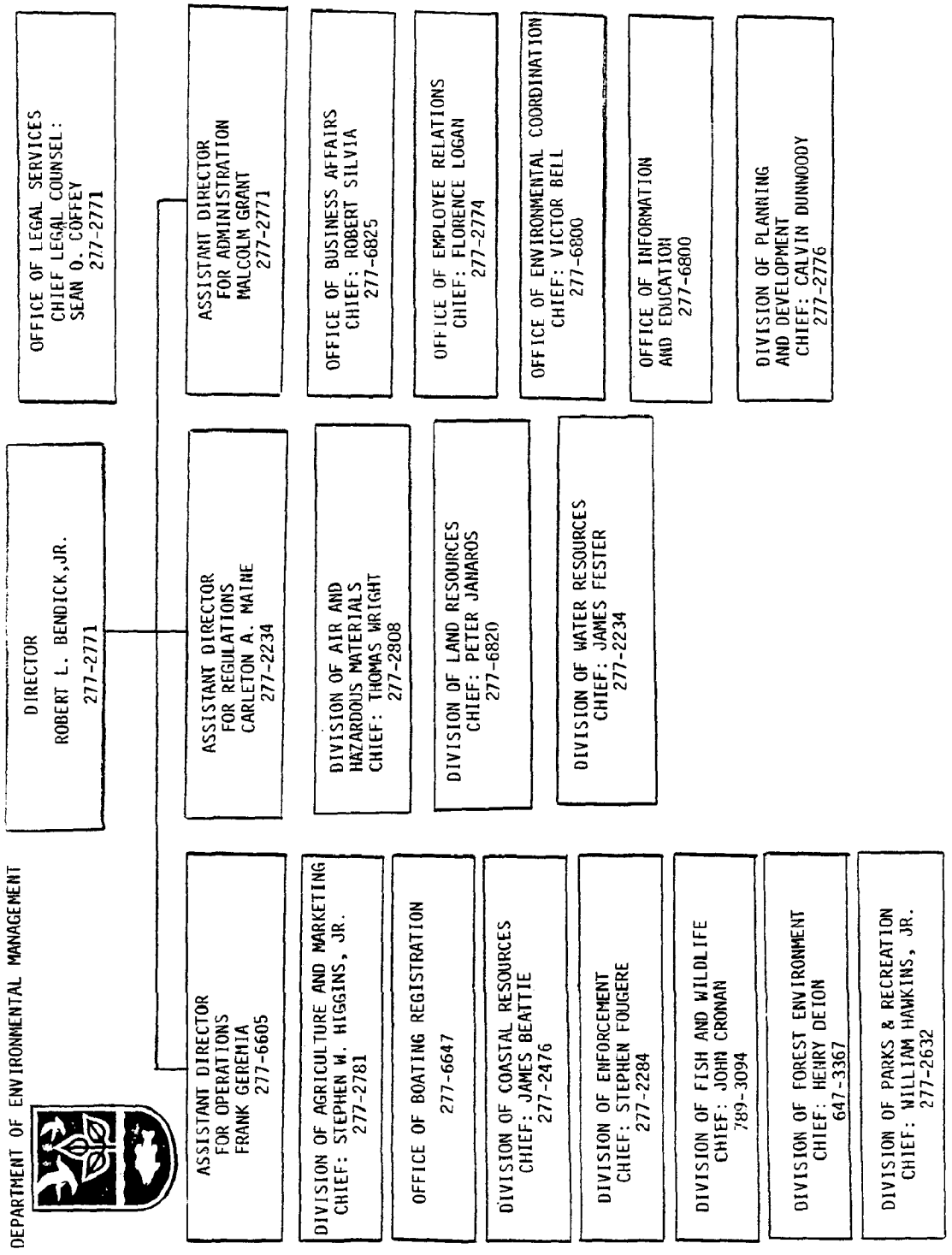

Figure 9 Organization Chart for the R. I. Department of Environmental Management

c. Division of Fish and Wildlife

This division is responsible for the proper utilization, management and human enjoyment of fishery and wildlife resources. These goals are achieved by the acquisition and management of fish and wildlife habitat; research activities to provide information for promulgating regulations and the conducting of proper use facilities.

Their involvement regarding sanctuary management includes providing expertise on natural resource protection for the sanctuary; managing hunting; monitoring the deer population, the Hope Island Rookery, and other wildlife populations as necessary; and conducting some research projects related to the wildlife populations.

d. Division of Enforcement

This division is charged with the responsibility of enforcing Rhode Island's conservation laws and maintaining security in recreational areas under the Department's jurisdiction. The division's Park Police Section enforces state laws and departmental regulations in 25 major parks and beaches and 50 picnic-grove areas. Conservation officers enforce fish and game laws.

Their involvement regarding sanctuary management includes enforcing shellfishing and hunting regulations within the sanctuary boundaries; enforcing other sanctuary regulations that have been established; and monitoring human use patterns of the area.

e. Division of Forest Environment

This division is charged with the responsibility of administering Rhode Island's forest and natural areas. It assists other agencies and local governments in urban programs relating to trees, forest green belts, and environmental enhancement. It is also responsible for forest management and fire protection on lands acquired by the State Water Resources Board until time of specific development.

Their involvement regarding sanctuary management includes assisting in the development of a fire suppression plan; providing fire fighting training to sanctuary staff; and providing equipment when feasible.

f. Office of Boating Safety

This office establishes and enforces Rhode Island's boating laws and regulations. It is responsible for accident reports and investigations, search and rescue services, educational programs, and boating safety on all fresh and salt waters throughout the state. Upon request, assistance is given to local fire and police departments, the State Fire Marshal's Office, and other state and federal agencies. Oil pollution control is also provided to the Rhode Island Port Authority when oil deliveries are made to the Quonset facility by ship. The office also works closely with and assists the local Coast Guard stations in all phases of search and rescue of disabled, sinking and overdue boats.

Their involvement regarding sanctuary management includes enforcing boating safety regulations within the sanctuary waters and assisting in rescues when necessary.

g. Division of Coastal Resources

This division is concerned with the development and improvement of the state's navigable waters and coastal zone, in cooperation with federal and local agencies, other state agencies, private concerns, organizations, and individuals. It is responsible for navigational and shore-front improvement, flood control, shore-erosion control, and hurricane protection.

Their involvement regarding sanctuary management includes providing expertise in managing the coastal resources of the sanctuary.

h. Division of Water Resources

The primary responsibility of the division is to control and abate sources of water pollution.

Their involvement regarding sanctuary management includes collecting and analyzing water samples from the tidal waters of the sanctuary.

i. Office of Business Affairs

This office manages the department's fiscal affairs which encompass budget maintenance, general accounting, federal grants accounting, fiscal reporting, and revenue accounting. Their involvement regarding sanctuary management includes managing the fiscal affairs of the sanctuary and preparing financial reports.

j. Office of Employee Relations

This office is responsible for initiating and coordinating personnel records. Their involvement regarding sanctuary management includes maintaining employee records for sanctuary personnel and preparing payroll for sanctuary personnel.

4. Sanctuary Advisory Committee

a. Function

A Sanctuary Advisory Committee (SAC) has been established to advise DEM on management and development of the sanctuary, and to provide expert advice and guidance on the development of the research and education programs.

The SAC's functions include:

-- Advising DEM and the sanctuary manager on sanctuary administration. The SAC assists DEM in developing guidelines for sanctuary management.

-- Reviewing proposals for research or education activities within the sanctuary.

b. Composition

The SAC is composed of representatives of the following groups:

-- Four representatives of DEM, including the Director's designee, who shall chair the committee, and one representative each from the Division of Enforcement, Division of Fish and Wildlife, and from the Division of Parks and Recreation.

-- One representative of the Coastal Resources Management Council.

-- Four representatives of conservation and recreation groups.

-- Two representatives of the Rhode Island Historical Preservation Commission.

-- One representative of shellfishing interests.

-- One representative from the Portsmouth town government.

-- Four representatives of Prudence and Patience Islands.

-- Three representatives of the scientific community.

-- Three representatives of the education community.

-- One representative from NOAA.

-- One representative from the U.S. Coast Guard.

-- One representative from the U.S. Environmental Protection Agency.

Members are appointed by the Director of DEM. Because of the large size of the committee, there are three subcommittees to deal with the following programs: (1) planning and management, (2) education, and (3) research. Each subcommittee elects its own chairman, and recommendations of the subcommittes are sent to the whole SAC for its review and action. The specific roles of each subcommittee are as follows:

i. Planning and Management Subcommittee

° To advise DEM on development and management proposals; and

° To help provide communication and cooperation among all sanctuary users and other affected public and private groups.

ii. Education Subcommittee

- To help in developing the goals and objectives for the education programs;
- To review plans and make recommendations on the development and operation of the education programs; and
- To provide the range of expertise necessary in the preparation of a comprehensive education plan.

iii. Research Subcommittee

- To provide general oversight and advice to DEM on use of the sanctuary for research;
- To make recommendations for establishing a long-term monitoring program;
- To review current research and monitoring programs and identify additional baseline information;
- To help DEM develop criteria for acceptable research projects in the sanctuary; and
- To review and make recommendations to DEM on proposed research.

D. RESOURCE PROTECTION/UTILIZATION

The Resource Protection/Utilization Plan is divided into three stages--Stage I, II and III. Stage I covers years 1, 2 and 3; Stage II covers years 4 and 5; and Stage III covers years 6 and 7. Activities have been identified in Table 1 to accomplish the resource protection goals of the sanctuary.

1. Management Zones

During Stage I, the sanctuary will be divided into different management zones to facilitate multiple use and protect sensitive resources of the sanctuary. Zones are based on the following factors:

Site Factors

- ecological sensitivity of the site (presence of rare species);
- ecological importance of the site (as a nesting, feeding, or nursery area);
- unique or significant geological, historical, archaeological or ecological factors; and
- visual qualities, climate, and hazards.

TABLE 1

RESOURCE PROTECTION/UTILIZATION PLAN

Implementation of the plan is divided into three stages--Stage I, II, and III. Stage I covers years 1, 2 and 3. Stage II covers years 4 and 5. Stage III covers years 6 and 7.

	Stage I	Stage II	Stage III
Establish management zones	X		
Adopt regulations	X (1981)*		
Develop enforcement procedures (patrols)	X (1981)*		
Design fire fighting plan	X (1981)*		
Clear fire roads	X (1981)*		
Develop comprehensive plan for managing Hope Island Rookery		X	
Develop comprehensive plan for managing Prudence/Patience deer herd		X	
Develop management strategy for minimizing deer tick/visitor contact		X	
Acquire Rossi property		Undetermined	
Acquire Johnson property		Undetermined	
Acquire Blount property	X		
Demolish unnecessary buildings (Patience)	X (1982)*		
Repair some buildings (Patience)	X	X	
Repair some Rossi buildings		Undetermined	
Build docks and floats (Patience/Prudence)	X (1982)*		
Construct raised walkway over marsh (Prudence)	X		
Develop trail system	X	X	
Clear sections within activity zone (Prudence)		X	
Provide primitive facilities in activity zone (Prudence)		X	
Provide ferry service (Prudence)	X (1981)*	X	
Create parking area in activity zone (Prudence)		X	
Develop and install signage (Prudence)	X	X	X

* Completion Date

Use Factors

- existing uses: need for support facilities such as docks, roads, and structures for sanctuary activities; and
- specific needs of research, education, recreation, and wildlife management.

After analyzing both site and use factors, three types of zones will be established: the Protected (P zone), the Conservation (C zone), and the Activity (A zone).

Protected zones will be limited to certain uses and access will be limited to sanctuary personnel and scientists who have been granted permits to conduct research within the area. A small percentage of the sanctuary's acreage will receive this most restrictive classification and it will be limited to those areas that are unique and fragile or have specific research demands that are incompatible with other uses. No facilities, alteration of the habitat, or activity other than monitoring or approved research will be permitted.

The major part of the sanctuary will receive the Conservation Zone classification. In the C zone, facilities will be limited to trails that would provide access to the general public. Activities will be those which have little environmental impact, such as hiking, hunting, wildlife observation, fishing, clamming, and interpretive programs. Most education programs will take place in this zone.

The third type of zone is the Activity Zone. This is the least restricted classification and will be applied to relatively few acres. The A zone will contain all the support facilities required for the sanctuary such as docks, roads, and buildings. It will accommodate large groups of people for education programs or recreational activities.

The three management zones just described can be applied to each of the four major ecological areas within the sanctuary (terrestial, freshwater, tidal wetlands, and tidal deepwater). As a result, there may be twelve distinct management zones within the sanctuary. Different policies have been established for each of the twelve zones to facilitate multiple use, and at the same time to protect the resources of the sanctuary. Activities that require a permit, prohibited and allowed are detailed in Appendix A.

Under certain circumstances it may be necessary to change the use restrictions for a particular zone, or to grant special exceptions to the regulations. Proposed exceptions or regulation changes will be reviewed by the SAC, who will make recommendations to the Assistant Director of Operations for a final determination.

2. Management Priorities for Each Zone

Protected Zone

° Research

Activity Zone

° Support facilities and uses necessary to manage sanctuary;

° Educational programs;

° Recreation (including hunting); and

° Research and monitoring.

Conservation Zone

° Education;

° Research and monitoring;

° Recreation (including hunting); and

° Support facilities.

3. Sanctuary Regulations

Since the sanctuary is part of the Bay Islands Park, its regulations apply within the sanctuary. Unless otherwise stated, the rules and regulations for state management areas apply within the sanctuary.

Additional regulations have been adopted specifically for the sanctuary. Listed below are the rules and regulations now in effect within the sanctuary. Before any other regulations are adopted they will be carefully reviewed by DEM and the Sanctuary Advisory Committee.

a. Seasons and Hours

North Prudence and Patience are open year-round. A permit is required from the sanctuary manager for educational groups of more than 12 people. From April 15 until July 31, landing or entering upon Hope Island is prohibited, except by special permission from the Department of Environmental Management. (DEM is currently considering extending the time during which Hope Island is closed. The proposed closure period is April 1 - August 31.)

Deer hunting season within state lands on Prudence and Patience Islands extends from November 1 until January 31. There is a small game season on North Prudence during February and on Hope from October through February. Hunting permits from DEM Division of Fish and Wildlife are required.

The sanctuary is open from 6 a.m. until one-half hour after sunset. The sanctuary is divided into three zones in which different restrictions apply. The specific regulations for each zone take precedence over these general rules when the zone regulations are adopted.

b. Vehicles

On North Prudence, parking areas will be designated near the entrance to the site for private vehicles. Vehicles are allowed on access roads to these parking areas.

In all other areas, no motor-powered vehicles will be allowed with the following exceptions: (1) vehicles operated by sanctuary employees, (2) vehicles used for emergencies, and (3) those operated by special permit issued by the sanctuary manager. The term moter-powered vehicles includes cars, miniscooters, minibikes, motor scooters, motor bikes, and snowmobiles. Bicycle riding is prohibited except on the access road where vehicles are permitted.

c. Private Boats

(1) Docking at piers and floats will be allowed at Patience and North Prudence for ten minutes to board and unboard passengers only.

(2) Beaching of small boats on Patience and North Prudence is allowed.

(3) Mooring and anchoring of boats will be allowed in sanctuary waters. Currently mooring and anchoring is allowed by right, but DEM may adopt a permit system for mooring and anchoring in certain areas.

(4) Overnight stays in moored and anchored boats is allowed; camping in unauthorized areas on shore is prohibited.

d. Fires

Charcoal fires are allowed on North Prudence and Patience only in designated fire sites on a first-come, first-serve basis. Taking of wood on the islands for fires is prohibited. Use of portable fuel stoves is allowed for cooking in designated areas. All other fires are prohibited.

e. Trash Disposal

Litter barrels will not be provided; a carry off trash policy will be in effect.

f. Fishing

Fishing and shellfishing are permitted in sanctuary waters in accordance with state shellfishing regulations.

g. Pets

No pets will be allowed within the terrestrial and intertidal areas of the sanctuary. (Hunting dogs can be brought to the sanctuary only during the month of January.)

h. Camping

Camping is not allowed except for groups taking part in an environmental education program. A camping permit is required.

i. Research

Research is allowed in the sanctuary with a permit.

E. RESEARCH AND MONITORING PLAN

The objectives for the research and monitoring program are:

- To gain a clearer understanding of the ecological relationships occurring within the estuarine environment through a coordinated program of baseline studies and related ecological research.
- To identify significant changes that may occur in this estuarine environment.
- To assess the effects of man's impact on this ecosystem and to forecast or mitigate environmental deterioration resulting from human activities.

The specific programs designed to achieve these objectives are outlined in this section of the plan. The programs are divided into three areas:

1. Developing Baseline Data
2. Long-Term Monitoring
3. Research Programs

Each of these programs is discussed in detail and the phased implementation outlined in Table 2.

1. Developing Baseline Data

a. Review of existing studies that have already been carried out within the sanctuary or in nearby estuarine waters.

Although relatively few studies have been conducted within the sanctuary boundaries, many studies have been carried out in the waters nearby. Since Narragansett Bay is one of the most intensively studied estuaries in the world, a review of this research will provide (1) a comprehensive understanding of the entire Narragansett Bay estuary, and (2) an indication of the environmental conditions that exist within the sanctuary.

Studies of Narragansett Bay are listed in The Bay Bib, a two-volume bibliography of research conducted in Rhode Island's coastal waters. This bibliography, completed in 1979 by the University of Rhode Island Graduate School of Oceanography, will be used to identify studies relating to upper Narragansett Bay. Researchers at the Graduate School of Oceanography and staff from the Coastal Resources Center will help find studies that have been conducted since 1979.

These studies will be reviewed and abstracts compiled and cross-referenced. Whenever possible, published reports of these studies will be obtained for a sanctuary library.

In addition, the estuarine sanctuary staff will compile a set of maps that indicates the locations of sampling stations used in past studies. This set of maps will be useful to scientists conducting research within the sanctuary.

b. Preliminary Site Analysis

Developing the baseline data also includes a preliminary site analysis. There are two aspects of this site analysis. The first involves general surveys which have wide focus. Large areas will be examined and many ecological factors noted. The second aspect of the site analysis will focus on specific areas, species, or relationships. These specific directed inquiries will answer some of the questions that arise as a result of the general surveys.

i. General Survey

In 1980, an archaeological survey was conducted throughout the sanctuary. This survey provided the baseline archaeological data leading to the protection of the Pine Hill site and to the interpretation of several other historical sites.

A general survey was conducted in 1982 by a team of scientists to identify unique or fragile areas and to determine which areas were best suited for research. In addition, the scientists explored possible research topics that should be investigated at the sanctuary. A second survey team including marine biologists will conduct another survey focusing on subtidal areas.

ii. Specific Directed Inquiries

The general survey resulted in a series of directed inquiries. Each inquiry focused on a specific geographical area or a particular species, animal group, ecological relationship, or environmental impact. The purpose of each inquiry is to gather information that will help to direct the focus of a later, more in-depth, research project or long-term monitoring program. The directed inquiries are designed to aid in selecting research areas, developing parameters, and determining sampling frequencies for the detailed studies that follow.

The inquiries may help to identify research subjects that should be given high priority because they are either important in obtaining an understanding of ecological relationships within the sanctuary, or of particular interest to DEM and the Coastal Resources Management Council in developing management strategies for the coastal zone.

Some of the initial directed inquiries include:

- o Conducting a preliminary survey of the subtidal environments of Potter Cove and Coggeshall Cove (completed 1981).
- o Determining the species of birds that feed on the salt marshes at Coggeshall and Sheep Pen Cove.
- o Surveying the extent to which seaside sparrows nest in the sanctuary's salt marshes. (This species is classified as "of special concern" by the RI Natural Heritage Program.)
- o Developing a list of the birds that breed within the sanctuary.
- o Compiling a vegetative map for North Prudence, Patience and Hope Islands (completed 1983).
- o Determining the existing human-use patterns through questionnaires and systematic observations.

2. Long-Term Monitoring Programs

Long-term monitoring programs within the sanctuary and in nearby waters are being carried out by both state and federal agencies. Currently, these programs are being carried out by the U.S. Environmental Protection Agency, the University of Rhode Island Graduate School of Oceanography, DEM's Division of Fish and Wildlife and Division of Water Resources.

Wide-ranging studies include the monitoring of:

- o heavy metals in shellfish;
- o coliform bacteria in shellfish;
- o stock assessment of shellfish;
- o coliform bacteria in surface waters;
- o chlorophyll concentrations in water;
- o stock assessment, species count, weight, length, frequency of finfish;
- o phytoplankton and zooplankton species count, abundance, and diversity;
- o waterfowl counts during fall and winter;
- o bird and nest counts at Hope Island Rookery during the summer;
- o aerial deer census at Patience and Prudence Islands during the winter; and
- o dead deer survey at Prudence Island during the spring.

Estuarine sanctuary personnel are compiling the data from these monitoring projects and assessing them with the help of the Research Subcommittee to determine changes occurring in the sanctuary. This process may indicate other proposed monitoring programs that should be undertaken within the sanctuary.

3. Research Programs

One of the primary goals of the sanctuary is to encourage estuarine research. DEM will take steps to facilitate research in the sanctuary and will regulate research through a permit process.

Several steps have already been taken to facilitate research. The most sensitive and unique areas will be set aside for research and monitoring only.

DEM will make available to researchers all files of past studies that have been conducted in the area. The files will include abstracts, reprints from professional journals, Masters and PhD theses, and a cross-referenced file of these research projects. Aerial photographs and detailed vegetative maps will also be available. Enlarged nautical charts with superimposed grids will be provided for use in the field.

Sanctuary personnel may be available to assist in research projects. They can gather data between the researcher's visits to the sanctuary, thereby providing additional data for the study. It is anticipated that an inholding, including buildings, will eventually be acquired. When this occurs, overnight accommodations will be made available to scientists who are conducting research. These buildings will contain laboratory space and house the collection of reprints and abstracts of past sanctuary studies.

a. Research Permit Process

Any researcher planning to conduct a study within the sanctuary must first obtain a research permit. These permits are issued by DEM based on recommendations from the Research Subcommittee.

b. Application

The applicant is required to state the focus of the proposed study, the research methods, research site and sampling location. All applicants must also state their college, university, or agency affiliation.

c. Review

Completed applications are sent to the sanctuary manager and reviewed by the Research Subcommittee. There are three options available to the Research Subcommittee. First, they can send the application to the DEM along with their recommendations that a permit be granted for the project as outlined. Second, the subcommittee can propose changes in the project's focus, methods, or sampling locations. Third, the subcommittee can suggest that the permit be denied, and inform DEM of the reasons for such a decision when they forward the application. DEM then makes a decision based on the suggestions of the Research Subcommittee and notifies the applicant.

d. Responsibilities of Researchers

It is the responsibility of the researcher to conduct the study as outlined in the approved application. In addition, the researcher must submit to the DEM at the completion of the study: a copy of whatever reports or publications resulted from the project, copies of all data that were gathered within the sanctuary, and an abstract which describes the project and includes a summarized discussion and conclusion. Annual reports must be submitted in the case of multi-year projects. All of this information will be made available to other researchers.

The permit process provides DEM a method for reviewing and coordinating research within the sanctuary and avoids potential conflicts between research and other activities. The permit process has additional benefits in that allows DEM to act as a clearinghouse for estuarine research and to encourage certain types of new research it deems to be useful.

TABLE 2

RESEARCH AND MONITORING PLAN

Implementation of the plan is divided into three stages: Stage I, II, and III. Stage I covers years 1, 2 and 3. Stage II covers years 4 and 5. Stage III covers years 6 and 7.

	Stage I	Stage II	Stage III
I. Developing Baseline Data			
Review existing studies		X	
Preliminary site analysis			
General archaeology survey	X (1980)*		
Scientists field day	X (1981)*		
Specific directed inquiries			
Subtidal survey of Potter Cove	X (1981)*		
Species of birds feeding - Coggeshall Cove	X		
Nesting of seaside sparrows	X		
Breeding bird survey	X (1982)*		
Vegetative map	X (1983)*		
Human use patterns	X (1982)*		
Marine biological sampling	X	X	
Documentary research - North End Farm	X (1983)*		
II. Long-Term Monitoring Programs			
Develop guidelines for monitoring program	X		
Monitor water quality in Potter Cove	X	X	X
Monitor coliform bacteria in shellfish	X	X	X
Conduct bird and nest counts (Hope Island)	X	X	X
Conduct aerial deer census (winter)	X	X	X
Conduct dead deer survey (spring)	X	X	X
Additional projects as indicated		X	X
III. Research Program			
Guideline for research program	X (1981)*		
Adopt permit process	X (1982)*		
Develop program for soliciting research proposals	X		
Develop research facility		Undetermined	
Specific Research Projects			
Study of deer tick (*Ixodes dammini*)	X (1983)		
Documentary research for North Farm	X (1983)		
Other appropriate research		X	X

* Completion Date

F. EDUCATION

1. Introduction

The goal of the sanctuary's education program is to enhance public awareness regarding the need to preserve, protect, and where possible, restore the quality of the Narragansett Bay estuary.

A site analysis of the sanctuary revealed that there is great potential for education programs. The site is rich with archaeological sites, dramatic biological interrelationships, and areas that are well-suited for field walks on such subjects as estuarine ecology and the management of estuarine resources.

A second study was conducted to determine the demand for education programs within the sanctuary; it indicated that both on-site and off-site programs would be well-attended. This demand analysis included a close examination of DEM's existing education programs. It also focused on estuarine educational services provided by other organizations and the level of public participation. The results show that increasing numbers of Rhode Islanders are involved in environmental and estuarine education programs offered throughout the state.

The sanctuary's education program complements existing programs. It covers many subjects currently not stressed in other programs that were surveyed. In addition, the audiences for sanctuary education programs are currently under-served by other similar programs.

An important feature of the education program is the link between public education and the research aspects of the sanctuary. Research will provide current knowledge about this estuarine environment. The results of this research will be incorporated into the interpretive programs and materials so that the public can share in the sense of discovery about the complex ecological systems within the sanctuary.

2. Objectives

The objectives of the sanctuary's education program are to help develop among Rhode Island citizens:

- an understanding of the ecological relationships within the estuarine environment;
- an understanding of the problems developing from man's impact on this environment;
- an awareness of means by which these problems can be solved; and
- the motivation to act toward their solution.

3. Site Analysis for Education Programs

An extensive site analysis was conducted within the sanctuary to determine the suitability of various areas for educational programs. The analysis included archaeological sites, coastal geologic formations, intertidal areas, upland regions, and freshwater wetlands. The presence of rare species and fragile archaeological and ecological areas are presented here as limitations to onsite programs. Accessibility of particular areas within the sanctuary was also considered when evaluating the educational potential of these sites.

The findings were reviewed by the research subcommittee to determine if there were any potential conflicts between research and educational uses of the areas. The following section summarizes the education subcommittee's analysis.

a. Hope Island

The extensive heron and egret rookery is a major theme to be developed in sanctuary education programs. Through learning about this rookery, people can obtain:

° a clearer understanding of the life histories of these birds;

° an appreciation of a rookery's sensitivity to human impact; and

° a commitment to protect the rookery and the salt marshes where these birds feed.

On-site interpretive programs would be permitted only in the fall after nesting is completed. These programs would require special transportation arrangements since there is no regular ferry service to the island. There are greater opportunities for off-site interpretation with printed materials and programs at Coggeshall Cove at North Prudence where the egrets go to feed. Interpretation of the rookery is an important management activity for increasing awareness in protecting the site.

b. North Prudence

Natural Features

° Salt Marshes

The two large salt marshes bordering the west side of the sanctuary will be used for interpreting a variety of themes. The education/interpretive program will focus on the ecology of the marsh and emphasize:

° The ways that man has historically used salt marshes. The extensive ditching serves as a good example of past use.

° The salt marsh as a food source for some species of wildlife.

° The productivity of salt marshes, as evidenced by the lush growth of salt marsh grass and the abundance of animal life in the channels, pools, and pannes.

° The importance of properly managing the uses of Narragansett Bay in order to protect such salt marshes.

Access to the various sections of the salt marsh becomes difficult when high tide waters flood the spartina meadow. A raised walkway over the marsh, now in the planning stage, will allow access even at high tide. This raised boardwalk will be part of a self-guided trail with wayside exhibits originating at Potter Cove.

° Kettlehole Pond

A kettlehole pond, located on North Prudence, is one of the few freshwater sources for the island's white-tailed deer herd. As a result, the pond is heavily used by deer. At such places where large numbers of deer gather, it is all too easy for humans to have a negative impact on the herd. An additional limitation on this site is the fact that an extremely uncommon plant (liverwort, Ricciocarpus sp.) has been found growing in the pond. Within Rhode Island, this plant has been found only in freshwater wetlands on Prudence Island. Still another limitation on visitor use of the site is the discovery of golden aster growing on the embankment overlooking the pond. This species is considered to be a "regionally significant" species by the Rhode Island Heritage Program. As a result of all these limitations, this kettlehold pond will not be used for on-site interpretation, but will be used in written educational materials.

° Shoreline

The shoreline of the sanctuary provides an excellent on-site teaching area for communicating many important concepts. Interpretive programs, led by the sanctuary naturalist, will be offered to the public on a regular basis and originate from Potter Cove. Special interpretive programs will be arranged for school groups.

From the shore, visitors see activities that illustrate the ways in which people utilize many of Narragansett Bay's resources. These activities include: commercial and recreational quahogging, purseseining for menhaden, recreational boating, and use of the East Passage as a commercial shipping channel to the Port of Providence. shoreline walks provide excellent opportunities for ranger-naturalists to discuss with visitors the many uses of the bay's resources and how those activities are managed to minimize the negative impact of a particular use on another. In addition, a group can learn about the ways in which these resources are managed in order to protect them for future generations.

The varied shoreline can also be used to communicate the diversity of life in this estuary. Many intertidal species can be found along the shore and shells of subtidal animals are often washed up.

There are interesting coastal geological formations along the shore as well. These features include: bay spits, recurved spits, eroding embankments, and drowned marshes that were flooded as sea level rose following the last ice age. Such features could be interpreted by a ranger-naturalist (or through a self-guided pamphlet) so that people better understand some of the bay's dynamic physical processes.

° Brackish Pond

A small brackish pond adjacent to Potter Cove serves as a feeding area for wading birds. This area is so close to Potter Cove, an area of heavy human use on weekends, that it would be a convenient instructional site. A wayside exhibit or a self-guided pamphlet will help people to identify and learn more about these large birds.

Historical Features

° Indian Campsites

There is an undisturbed Indian campsite of the Late Woodland period located on North Prudence. The site has middens containing the shells of oysters, quahogs, softshelled clams, scallops, and slipper limpets. Fire-cracked rocks in the area indicate that it was used for processing shellfish. This area will be used to interpret the historical use of the islands and the bay by Native Americans. On-site interpretive programs at this site are not planned because additional archaeologic study should precede any further disturbance, and the stand of golden asters discussed earlier grows directly over the Indian encampment. However, the information gathered by archeologists studying the site will provide valuable material that can be incorporated into educational pamphlets or brochures.

° North End Farm

A farm of historical value is located on North Prudence within the sanctuary. This farm has recently been nominated for the National Register. The North End Farm will be used for on-site interpretation by a naturalist and by means of wayside exhibits and self-guided pamphlets. Additional documentary research now being conducted on this site will furnish the background material necessary to provide in-depth interpretation of the changing relationship between the farmers and the bay. Since the farm was in use for about 200 years, the patterns of use should reflect many aspects of Rhode Island's history. Interpretation of the farm will actually be an integral part of the management strategy for this historic site. Through education programs concerning the farm's historic value, it is hoped that destruction of stonewalls and foundations will be minimized. Protecting the site by keeping people from the area is not possible since the farm is near the intersection of two dirt roads and is therefore quite visible and accessible.

° North End Schoolhouse

Another archeological site, the North End Schoolhouse, is located on North Prudence. This one-room school was established in 1854 and ceased operation in 1904. It remained standing until late 1930's. The foundation of the schoolhouse is near Potter Cove where many recreational boats moor on weekends and where the shuttle ferry docks. Therefore, the site is an ideal location for education programs conducted by a naturalist or as a stop on a self-guided walk where the interpretation is achieved through a wayside exhibit or a pamphlet. Further documentary research will indicate the focus of education programs at this site.

c. Patience Island

Natural Features

The shoreline of Patience Island varies from sandy, to rocky, to salt marsh. This area can be used for education programs describing historical uses of the bay, ecological relationships, and the area's geology.

Limitations

1. Sea blite, a plant rarely found growing in Rhode Island, has been located on the shore of Patience Island. Any shoreline education programs on Patience Island will avoid the area where sea blite grows.

2. The interior trails would encourage use of the area around the buildings and possibly result in greater management problems. After some of the buildings have been razed, and others repaired, interior trails could be improved, marked, and used for education programs.

Historical Features

The foundation of an oysterman's house has been found along the north shore of the island. It would be an ideal location for education programs dealing with the resources of Narragansett Bay, the way in which these resources have changed over the years, and the management of these resources. From this site, one can view an area of the bay that was once a productive oyster bed. Quahoggers now work these beds, taking their boats as near as they can to the imaginary line established by the state, separating SA water (clean water) from SB water (an area where shellfishing is prohibited). It is an excellent site for a discussion of pressures that are exerted on the bay's resources as a result of urbanization and industrialization near the shore of the upper bay.

Wayside exhibits at the foundation and a self-guided pamphlet keyed to the area would also be effective means of presenting these themes.

An archaeological study indicates that the area should be protected, but at the same time can be used for educational purposes. In fact, a carefully developed interpretive program that helps visitors to understand the importance of the site could be part of the management strategy to protect the area. Documentary research would further increase the value of the site for educational purposes.

4. Elements of the Sanctuary Education Program

Education of the public plays an important role in the successful operation of the Narragansett Bay National Estuarine Sanctuary. The following activities have been implemented or are in the planning stage to assist in enhancing public interpretation of the sanctuary. Table 3 outlines the activities that will be implemented during Stages I, II and III.

The Bay Islands Park Slide Show is a two-projector presentation with a taped narration that introduces audiences to the history and natural features of Narragansett Bay, the Bay Islands Park, and the Estuarine Sanctuary. A discussion that follows the showing further explains the purpose of the sanctuary and its unique natural features (completed 1981).

The Bay Islands Park Brochure describes the entire Bay Islands Park System presenting the nine distinct areas of the park. The brochure briefly discusses the sanctuary as part of the park and outlines the major uses of the sanctuary (completed 1981).

The Narragansett Bay National Estuarine Sanctuary Brochure gives visitors a more detailed look at the sanctuary. It describes the purpose of the National Estuarine Sanctuary Program and the place of the sanctuary within the national system. It stresses the research and education aspects of the sanctuary. It also discusses how these resources have been managed to protect them for future generations. Graphics and text present the natural features of each sanctuary site, placing particular emphasis on the research projects designed to learn more about these areas and management strategies to protect them. A section entitled Visitor Information explains the services provided at each of the sanctuary sites and describes the public access to these islands (completed 1982).

The Sanctuary Manager's Person-to-Person Awareness Program reaches many long-time users of the sanctuary. The traditional users are people with private boats who anchor in the sheltered areas and often go ashore to walk or dig shellfish. Throughout the summer, the sanctuary manager talks to people who are at anchor. He explains the establishment of the sanctuary, its purpose, and activities that will take place in the future. The manager also speaks to groups and organizations off-site using a slide/tape program to inform people about the sanctuary.

A Media Campaign will be coordinated by the DEM Office of Information and Education to enhance public awareness of the ecological importance of the sanctuary.

Curriculum Materials dealing with the Narragansett Bay subjects will be developed. The precise subject and grade level of these materials will be determined by an analysis of the curricula already in use, the scope of services being provided to schools by other RI marine education organizations, and the needs of classroom teachers as determined by a survey to be conducted.

In the past, very useful curriculum materials have been developed cooperatively by DEM, the RI Department of Education, and the Audubon Society of Rhode Island. Perhaps the proposed curriculum materials could be developed cooperatively as well.

In-Service Programs for Teachers - A recent survey of Rhode Island educators indicated that their greatest need in environmental education is for in-service programs dealing with curriculum material. During this phase of the sanctuary education program, the DEM will conduct in-service programs to help teachers use the new curriculum materials.

DEM environmental educators have had considerable experience in conducting in-service programs for teachers. In the past, these programs were co-sponsored by the Rhode Island Department of Education. Presently DEM is planning a series of programs with the Rhode Island Department of Education and the Environmental Education Association. Since in-service programs conducted for teachers by DEM personnel are consistently well-received and evaluated highly by participants, this outreach aspect of the sanctuary education program will be very productive.

Seminars - Scientists who conduct research within the sanctuary will be encouraged to speak at public programs where they will discuss the results and implications of their studies. Occasional seminars of this type will keep the public informed about recent research at the sanctuary.

Wayside Exhibits - Wayside exhibits will be designed and produced for several sites at North Prudence. Some of the wayside exhibits will be installed at important archeological sites, where they will describe life on the island as it existed during an earlier time and the influence that the estuary had on the island residents. Other wayside exhibits located along the shore will explain estuarine processes and how the resources of the sanctuary are used and managed.

Self-guided Pamphlets - Additional pamphlets will be developed to serve people using the sanctuary on their own. Such pamphlets will explain the different habitats that the visitor will encounter, describe the use of the bay's resources, and management strategies for protecting these resources.

Some of the self-guided pamphlets will direct people to a raised walkway that will be constructed over an extensive salt marsh at North Prudence. Along the walkway people will find wayside exhibits emphasizing the wildlife that use the marsh and the productivity of this estuarine environment. The pamphlet will further develop those ideas that are introduced through the exhibits.

Naturalist Programs - Naturalists lead interpretive walks at North Prudence. Ferry passengers are met by the naturalist who conducts a variety of walks. These programs are offered to the general public and to organized groups that have made prior arrangements for a walk specifically designed to suit their needs.

Use of Hope Island for on-site interpretation is restricted because of the rookery. The island is closed to visitors from April 15 to July 31. However, a pilot program indicated that there are a number of people who would like to visit this rookery after the nesting season. As a result, more programs of this type will be arranged.

Currently, programs on Patience Island are informal in nature, conducted by the ranger living on this island during the summer. The ranger's job is primarily that of a caretaker, but he/she also has the background necessary to conduct effective educational programs. These talks are not conducted according to a predetermined schedule, but instead occur as interested groups of people land on the island. In the future, more formal interpretive activities may occur on Patience Island.

On-site Education Programs Conducted by Non-Sanctuary Personnel - Use of the sanctuary by other educational organizations is being encouraged and facilitated by DEM. The Office of Information and Education is contacting schools, environmental education centers, and conservation groups throughout the state and New England region to inform them of the valuable education sites available within the sanctuary. The sanctuary provides naturalists to those groups that want this service, but there are groups that choose to conduct their own educational programs within the sanctuary. College professors teaching natural science courses, secondary schools with marine science teachers on their staffs, and the Audubon Society have already conducted such programs. In these cases, the sanctuary personnel provide background information about those sites that will be visited. Sanctuary personnel also help to arrange transportation to the sanctuary.

TABLE 3

EDUCATION PLAN

Implementation of the plan is divided into three stages: Stage I, II and III. Stage I covers years 1, 2 and 3. Stage II covers years 4 and 5. Stage III covers years 6 and 7.

	Stage I	Stage II	Stage III
Off-Site			
Develop Bay Island Park slide/tape show	X (1981)*		
Prepare Bay Islands Park Brochure	X (1981)*		
Prepare Estuarine Sanctuary Brochure	X (1982)*		
Conduct Speaker Program using Slide/Tape show	X	X	X
Distribute Bay Islands Park Brochure and Estuarine Sanctury Brochure	X	X	X
Conduct Media Campaign (newspaper/radio/television)	X	X	X
Develop Curriculum Materials		X	X
Develop Publications for sale to the general public			X
On-Site			
Conduct Comprehensive Site Analysis	X (1981)*		
Prepare and Conduct Interpretive Programs at Hope and Prudence	X	X	X
Conduct field trips for classes at North Prudence	X	X	X
Develop "North Farm Interpretive Site" (Prudence)	X	X	X
Develop "Oysterman's House Interpretive Site" (Patience Island)		X	X
Create Self-Guided Trails and Produce Associated Pamphlets (Prudence)		X	X
Conduct on-site workshops for teachers		X	X

APPENDIX A

REGULATED ZONE ACTIVITIES

REGULATED ZONE ACTIVITIES

A = allowed
P = permit only
N = not allowed

1. Terrestrial

A. Facilities, structures and other physical alterations	Protected Zone	Conservation Zone	Activity Zone
roads (new)	N	P[5]	A
parking lots	N	N	A
paths (new)	N	A	A
rest rooms	N	N	A
picnic tables	N	N	A
fireplaces	N	N	A
research field equipment	P[1]	P[1]	P[1]
observation blinds (public)	N	P[1]	P[1]
hunting blinds	N	P[1]	P[1]
wayside exhibits	N	A	A
habitat manipulation	N	P[5]	P[5]
filling and excavating	N	N	P[5]
structures	N	P[5]	A
B. Activities			
hiking	N	A	A
bicycling	N	N	A
hunting	N	P[2]	P[2]
camping	N	N	P[7]
education programs	N	P[3]	A
research and monitoring	P[1]	P[1]	P[1]
wood fires	N	N	N
charcoal fires (only in hibachis and permanent fireplaces est. by DEM)	N	N	A
use of motorized vehicles	N	N	A
archaeological investigation	P[6]	P[6]	P[6]

[1] Permits must be obtained from DEM, Sanctuary Manager.

[2] Permits for deer hunting must be obtained from DEM, Division of Fish and Wildlife.

[3] If group consists of more than 12 people, a permit must be obtained from DEM, Sanctuary Manager.

[4] Only sanctuary vehicles and vehicles with special permits are allowed within the sanctuary.

[5] Permits must be obtained from DEM Assistant Director of Operations.

[6] Permits must be obtained from RI Historic Preservation Committee.

[7] Permits will be granted only to groups participating in educational programs which are organized and conducted by DEM staff. Permits will be granted for camping on Patience Island only.

2. Freshwater Wetlands

A. Facilities, structures, and other physical alterations[1]	Protected Zone	Conservation Zone	Activity Zone
research field equipment	P[2]	P[2]	P[2]
observation blinds (public)	N	P[2]	P[2]
hunting blinds	N	P[2]	P[2]
wayside exhibits	N	A	A
habitat manipulation	P[3]	P[3]	P[3]
docks	N	N	P[3]
pilings	N	N	P[3]
raised walkways	N	P[3]	P[3]
other structures	P[3]	P[3]	P[3]
B. Activities			
fishing	N	N	A
swimming	N	N	N
boating	N	N	N
research and monitoring	P[2]	P[2]	P[2]
education programs	N	P[4]	A
camping	N	N	N
wood fires	N	N	N
charcoal fires	N	N	N

[1] Most alterations in freshwater wetlands require a permit from DEM, Division of Land Resources in addition to other permits that may be required.

[2] Permits must be obtained from DEM, Sanctuary Manager.

[3] Permits must be obtained from DEM, Assistant Director of Operations.

[4] If group consists of more than 12 people, a permit must be obtained from DEM, Sanctuary Manager.

3. Tidal Wetlands

A. Facilities, structures, and other physical alterations*	Protected Zone	Conservation Zone	Activity Zone
docks	N	P[1]	P[1]
riprap	N	P[1]	P[1]
bulkheads	N	P[1]	P[1]
groins	N	P[1]	P[1]
jetties	N	P[1]	P[1]
pilings	N	P[2]	P[2]
dredging	N	N	P[3]
filling	N	N	P[3]
raised walkways	N	P[3]	P[3]
hunting blinds	N	P[4]	P[4]
B. Activities			
fishing	N	A	A
shellfishing	N	A	A
wood fires	N	N	N
charcoal fires (in hibachis only)	N	N	N
research and monitoring	P[4]	P[4]	P[4]
education programs	N	P[5]	A
hunting blinds	N	P[4]	P[4]

*Any alteration below mean high water or up to 200 feet inland from the mean high water line requires a permit from the Coastal Resources Management Council.

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[1] Permits must be obtained from U.S. Army Corps of Engineers; RI Coastal Resources Management Council; and DEM, Assistant Director of Operations.

[2] Permits for pilings must be obtained from all of the federal and state agencies listed in footnote #1. In addition, permits must be obtained from the U.S. Coast Guard if the proposed piling is in a navigable channel or may interfere with a navigable channel.

[3] Permits for raised walkways must be obtained from RI Coastal Resources Management Council; and DEM, Assistant Director of Operations.

[4] Permits must be obtained from DEM, Sanctuary Manager.

[5] If group consists of more than 12 people, a permit must be obtained from DEM, Sanctuary Manager.

4. Tidal Deepwater

A. Facilities, structures, and other physical alterations	Protected Zone	Conservation Zone	Activity Zone
docks	N	P1	P1
groins	N	P1	P1
jetties	N	P1	P1
pilings	N	P2	P2
moorings	N	N	P5
aquaculture	N	P3	N
navigational aids	P4	P4	P4
dredging	N	N	N
B. Activities			
shellfishing	N	A	A *
fishing	N	A	A *
mooring	N	N	P
anchoring	N	A	A
boating	N	A	A
research	P5	P5	P5

*subject to water quality

[1] Permits must be obtained from U.S. Army Corps of Engineers (Section 404); RI Coastal Resources Management Council; DEM, Assistant Director of Operations.

[2] Permits to erect pilings must be obtained from all of the federal and state agencies listed in footnote #1. In addition, permits must be obtained from the U.S. Coast Guard if the proposed piling is in a navigable channel, or may interfere with a navigable channel.

[3] Permits for aquaculture projects must be obtained from RI Coastal Resources Management Council, and DEM, Assistant Director of Operations.

[4] Permits for navigational aids must be obtained from U.S. Coast Guard.

[5] Permits must be obtained from DEM, Sanctuary Manager.

Proposed activities, facilities, and structures that are not listed in this Appendix will be reviewed by the Sanctuary Advisory Committee and submitted to DEM, Assistant Director of Operations, who will make the final determination on all proposals.

APPENDIX B

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LITERATURE CITED

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