

RIU-Q-97-002



# Narragansett Bay National Estuarine Research Reserve

## *Revised Management Plan 1998*

*Prepared by*

State of Rhode Island and Providence Plantations  
Department of Environmental Management  
Narragansett Bay National Estuarine Research Reserve  
55 South Reserve Drive, Prudence Island, RI 02872

U.S. Department of Commerce, NOAA  
Office of Ocean and Coastal Resource Management  
Sanctuaries and Reserves Division  
1305 East West Highway, Silver Spring, MD 20910

Rhode Island Sea Grant  
University of Rhode Island  
Narragansett Bay Campus  
Narragansett, RI 02882





# Narragansett Bay National Estuarine Research Reserve

## *Revised Management Plan 1998*

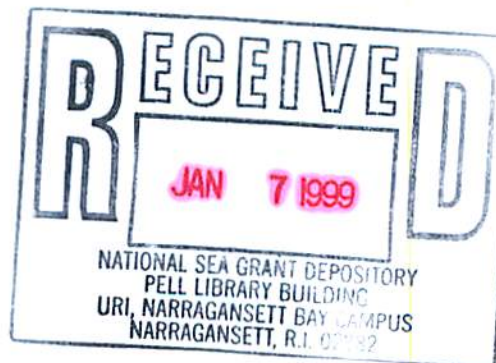
*Prepared by*  
State of Rhode Island and Providence Plantations  
Department of Environmental Management  
Narragansett Bay National Estuarine Research Reserve  
55 South Reserve Drive, Prudence Island, RI 02872



U.S. Dept. of Commerce, NOAA  
Office of Ocean and Coastal Resource Management  
Sanctuaries and Reserves Division  
1305 East West Highway, Silver Spring, MD 20910



Rhode Island Sea Grant  
University of Rhode Island  
Narragansett Bay Campus  
Narragansett, RI 02882



1. 1998

NOV 1998

RECEIVED  
NOV 1998  
NARRAGANSETT BAY NATIONAL ESTUARINE RESEARCH RESERVE

**NARRAGANSETT BAY  
NATIONAL ESTUARINE RESEARCH RESERVE  
REVISED MANAGEMENT PLAN 1998**



**TABLE OF  
CONTENTS**

ACKNOWLEDGMENTS ..... 6

EXECUTIVE SUMMARY ..... 7

ACRONYMS AND ABBREVIATIONS ..... 9

LIST OF FIGURES ..... 9

LIST OF TABLES ..... 9

**I. THE NATIONAL ESTUARINE RESEARCH RESERVE SYSTEM**

    A. Need for Preserving Estuaries ..... 13

        1. Definition ..... 13

        2. Estuarine Productivity ..... 13

        3. Modification of Estuaries ..... 13

    B. Creation of the National Estuarine Research Reserve System ..... 14

        1. Coasts in Crisis: The Coastal Zone Management Act ..... 14

        2. National Estuarine Research Reserve System ..... 14

        3. NERR Strategic Plan ..... 15

        4. NERR System Administrative Framework ..... 15

    C. NERR National Program ..... 17

**II. NARRAGANSETT BAY: NERR SETTING**

    A. Narragansett Bay Region ..... 21

        1. Introduction ..... 21

        2. Physical Aspects of the Bay ..... 21

        3. Hydrology ..... 21

        4. Geology ..... 24

        5. Soils ..... 24

        6. Groundwater ..... 25

        7. Climate ..... 25

        8. Life in the Bay ..... 25

        9. Commercial Shellfishing and Fishing ..... 26

        10. Shipping ..... 26

        11. Recreation ..... 27

        12. Water Quality ..... 27

    B. Reserve Setting ..... 33

        1. Physical Setting ..... 33

        2. Habitats & Biota ..... 36

        3. Cultural Aspects ..... 45

**III. NARRAGANSETT BAY NERR: MISSION AND GOALS**

    A. Statutory Basis ..... 49

        1. Federal Regulations: NERR Program Goals ..... 49

        2. State Management Policy ..... 49

    B. Mission ..... 49

    C. Goals ..... 49

        1. Administrative Goal ..... 50

        2. Stewardship Goal ..... 50

        3. Boundary and Acquisition Goal ..... 50

        4. Research and Monitoring Goal ..... 50

        5. Education, Information, and Interpretation Goal ..... 50

        6. Public Involvement Goal ..... 50

        7. Facilities Goal ..... 50



D. Goal Interaction Policies .....	50
1. Prioritize Stewardship .....	50
2. Mutual Reinforcement Regarding Goal-Specific Plans and Staff .....	50
3. Inter-Plan Consistency .....	51
<b>IV. ADMINISTRATIVE FRAMEWORK AND PLAN</b>	
A. Mission .....	55
B. Relationship to Federal Government .....	55
1. Federal Law .....	55
2. Federal Agency Relationship .....	55
C. Narragansett Bay NERR and the State .....	56
1. The Coastal Zone Management Program .....	56
2. Office of the Assistant Director for Natural Resources .....	57
3. Other Divisions Within the Department of Environmental Management .....	57
4. Other Federal and State Agencies .....	59
5. Non-Regulatory Agencies .....	61
D. Narragansett Bay NERR Internal Administration .....	62
1. Narragansett Bay NERR Management Council .....	62
2. Staff .....	63
3. Volunteers .....	65
4. Advisory Groups .....	65
E. Plan of Action .....	67
1. Goal and Objectives .....	67
<b>V. STEWARDSHIP PLAN: MANAGING THE ECOSYSTEM</b>	
A. Mission .....	71
B. Goals .....	71
C. General Policy .....	71
1. Rules and Regulations .....	71
2. Implementation and Enforcement .....	72
D. Stewardship Action Plan .....	72
1. Land and Estuary Use .....	72
2. Biota .....	75
3. Freshwater Resources .....	76
4. Uplands Management .....	77
5. Archeological Resources .....	77
6. Controlling Visitor Usage .....	78
E. Habitat Manipulation Plan .....	79
1. Background .....	79
2. Policy .....	79
3. Actions .....	80
F. Joint Stewardship of the Narragansett Bay Region .....	84
1. Need for Joint Stewardship .....	84
2. Joint Planning .....	84
<b>VI. BOUNDARY AND ACQUISITION PLAN</b>	
A. Goals and Objectives .....	89
B. Key Land and Water Areas of the Reserve .....	90
C. Acquisition Strategy .....	91
D. Proposed Acquisitions .....	93
E. Boundary Expansion .....	94
F. Action .....	95
<b>VII. PUBLIC INVOLVEMENT AND ACCESS PLAN</b>	
A. Mission .....	97



B. Policy .....	99
C. Goals .....	99
D. Background .....	99
E. Action .....	101
<b>VIII. FACILITIES/CONSTRUCTION PLAN</b>	
A. Goals .....	105
B. Objectives .....	105
C. Policies .....	105
D. Existing Facilities .....	106
E. Facility Needs .....	107
F. Action Plan .....	107
1. Phases .....	107
G. Estimated Schedule and Costs .....	109
<b>IX. EDUCATION, INTERPRETATION AND OUTREACH PLAN</b>	
A. Introduction .....	113
B. Mission .....	113
C. Goals .....	113
D. Guidelines and Policies .....	114
E. Existing Program .....	115
1. Introduction .....	115
2. Education Opportunities .....	115
3. Site Accessibility .....	116
4. Off-Site Programs .....	117
5. Additional Elements of the Education Program .....	117
F. New Course .....	118
G. Action Plan .....	119
1. Goals and Objectives .....	119
<b>X. RESEARCH AND MONITORING PLAN</b>	
A. Introduction .....	123
B. Research Plan .....	123
1. Mission .....	123
2. Goals .....	123
3. Guidelines and Policies for Research .....	123
4. Research Implementation Strategy .....	127
C. Action Plan – Research .....	129
1. Goals and Objectives .....	129
D. Monitoring Plan .....	132
1. Mission .....	132
2. Policy .....	132
3. Goals .....	133
4. Existing Program Status .....	134
E. Action Plan – Monitoring .....	135
1. Goals and Objectives .....	135
<b>APPENDICES</b> .....	<b>137</b>
A. Memorandum of Understanding Between RIDEM and NOAA, SRD Concerning the Management of the NBNERR .....	141
B. RIDEM Organizational Chart .....	145

## **Acknowledgments**

The Revised Management Plan was based on the idea and thoughts of the Narragansett Bay National Estuarine Research Reserve Advisory Committee; Roger Greene, assistant to the director, Rhode Island Department of Environmental Management; and Allan Beck, reserve manager. The plan's organization was based somewhat on the South Slough Reserve Management Plan and guidance from Randall Schneider of the National Oceanic and Atmospheric Administration Sanctuaries and Reserves Division. It was written by Allan Beck and produced by Margaret Beck. Publication production and layout were provided by Carole Jaworski and Malia Schwartz, Rhode Island Sea Grant, and Wendy Andrews-Bolster, Puffin Enterprises.

DEM contributors and reviewers included Jim Meyers, Chris Reithel, and a host of others from the various RIDEM Divisions.

Much of the text for the chapter *Narragansett Bay: NERR Setting* was adopted from the Narragansett Bay Project (NBP) Comprehensive Conservation and Management Plan and other reports published by the NBP.

Loan copies of this publication are available from the National Sea Grant Depository, Pell Library Building, University of Rhode Island Bay Campus, Narragansett, RI 02882-1197. Order RIU-Q-97-002.

This publication is sponsored in part by Rhode Island Sea Grant, under NOAA Grant No. NA36RG0503. The views expressed herein are those of the author and do not necessarily reflect the views of NOAA or any of its sub-agencies or of the R.I. Department of Environmental Management. The U.S. Government is authorized to produce and distribute reprints for governmental purposes notwithstanding any copyright notation that may appear hereon.

### **The proper citation for this report is:**

Beck, Allan and Margaret Beck. 1998. *Narragansett Bay National Estuarine Research Reserve Revised Management Plan 1998*. R.I. DEM Narragansett Bay National Estuarine Research Reserve Program and NOAA Sanctuaries and Reserves Division (preparers). Rhode Island Sea Grant, Narragansett, R.I. 145 pp.

### **Photo Credits:**

Cover: Mil Kinsella-Sullivan; p. 11: Allan Beck; p. 14: Mil Kinsella-Sullivan; p. 19: Chris Damon, URI (from NOAA chart); p. 24: Puffin Enterprises; pp. 26, 32, 34: Allan Beck; pp. 36, 38, 40: Puffin Enterprises; p. 42: Pau I Dix, U.S. EPA; p. 44: *Newport (R.I.) Daily News* staff photo; p. 46: Deborah DiQuinzio, College of Natural Resources, URI; pp. 47, 53, 56, 58, 64, 69: Allan Beck; pp. 72, 74: Puffin Enterprises; p.p. 76, 78: Allan Beck; p. 80: Puffin Enterprises; pp. 87, 90, 97, 102, 103, 111: Allan Beck; pp. 114, 116: Victoria Belmont; p. 118: Puffin Enterprises; pp. 121, 126, 128, 132: Allan Beck.

### **Map Credits:**

Figure 1: NOAA Sanctuaries & Reserves Division; Figures 2-7: Lynn Carlson, DEM and RIGIS.



## Executive Summary

In response to intense pressures on the coastal resources of the United States, Congress enacted the Coastal Zone Management Act (CZMA or Act) in 1972. Four years later, the Act was amended to establish the National Estuarine Sanctuary program. As stated in the Act,

... the purpose of the estuarine sanctuary program is to create natural field laboratories in which to gather data and accomplish studies of the natural and human processes occurring within the estuaries of the coastal zone. This shall be accomplished by the establishment of a series of estuarine sanctuaries which will be designated so that at least one representative of each type of estuarine ecosystem will endure into the future for scientific and educational purposes. The primary use of estuarine sanctuaries shall be for research and educational purposes, especially to provide some of the management information essential to the coastal management decision-making process.

The 1990 amendments to the CZMA established the National Estuarine Research Reserve System (NERRS) and renamed the sites as research reserves to stress the promotion and coordination of estuarine research on a national level as a high priority for establishing the system. Also emphasized was the use of a Reserve's natural resources to enhance public awareness and understanding of estuarine areas.

Nationwide, the NERRS consists of 22 sites and protects nearly 550,000 acres of estuarine waters, marshes, shoreline, and adjacent uplands for research, education, and resource protection. The goals of the NERRS is to establish and manage a system of Reserves representing different coastal regions and estuarine types that exist in the United States, and provide scientific, management, and educational information to coastal zone managers.

Established in 1980, the Narragansett Bay National Estuarine Research Reserve (NBNERR) is located in the geographic center of Narragansett Bay and originally consisted of 1,035 acres of land on Prudence, Patience, and Hope islands and 1,591 acres of water adjoining the islands out to a depth of 18 feet. These islands contain diverse sites for numerous species. The islands are essentially undeveloped, and their distance from urban centers reduces their exposure to chronic pollution associated with urban development. However, the islands' proximity to the mainland makes public access and coordination of educational and recreational activities relatively easy.

The NBNERR has operated under a 1983 Management Plan. Recently, the NBNERR boundaries were expanded in 1993 and its programs revitalized to meet the new goals and objectives under the amended CZMA. This plan reflects the greater commitment of the state of Rhode Island to fully meet or exceed NERRS program regulations and guidelines. More importantly, it protects critical estuarine resources in Narragansett Bay.

Major elements of this revised plan include:

- Developing a stewardship program for core and buffer areas to encompass all state-owned and private land trust properties on Prudence Island, a 3,500-acre island located in the geographic center of Narragansett Bay and all of two small adjoining islands, Hope and Patience.

The Reserve boundaries are to be extended Bayward and defined by physiographic and geodetic features which include an additional 1,500 acres of water adjoining the land.

- The recent acquisition of additional properties has brought the total land under the Reserve's jurisdiction to 2,353 acres. The remaining properties are small, privately owned, and support a summer population up to 2,000 people and a winter population of 200 individuals. The residential parcels are excluded from the Reserve and will remain so.
- Improving the infrastructure by repair and upgrading the caretaker's and visitor's cottages and constructing a new 2,500-square-foot multi-purpose facility to support research, education, and provide a functional office.
- A long-term (inter-decadal) research plan focuses on understanding the structure and function of key habitats, such as the Reserve's five major marsh systems. A comparative ecology approach provides the basis for research project design and priority setting. Collaborative studies with federal, state, and institutional researchers are encouraged.



- An associated long-term monitoring program will characterize the environmental quality and the occurrence and abundance of living resources. Monitoring is designed to determine baseline status and trends in habitat quality and the health of important resource species.
- The education program will emphasize cooperative efforts with existing educational organizations.

A number of management issues are dealt with, ranging from protection of natural resources to prevention of Lyme Disease in island residents and visitors.

Other management initiatives planned are restoration of Nag Creek Marsh impacted by a previous landfill encroaching on the marsh features, controlling boater waste pollution in Potter Cove and Coggeshall Cove, and protecting the watershed and wellhead providing for the Prudence Island water supply.

The Reserve is administered and supported by the R.I. Department of Environmental Management (DEM) Associate Director for Natural Resource Management. The existing staff includes an administrator in the Director's Office, an on-site manager, facilities caretaker, seasonal graduate students and research assistants, seasonal laborer and a seasonal naturalist. Future staff additions could include a research coordinator, education coordinator, part-time naturalists, and maintenance personnel as funding permits. Support arrangements are received from other elements of DEM including the Division of Forestry Environment, Division of Water Resources, and the Division of Enforcement.

This plan is consistent with the Portsmouth Comprehensive Community Plan approved in October 1992 (the town has legal jurisdiction over Prudence Island) and is a blueprint for development and success of the NBNERR over the next 10 years. It is dynamic in the sense that new management and scientific information may support revisions in program direction and Reserve management over the life of this document.

The overall philosophy is to accomplish the development and implementation of a rational, detailed, flexible and coordinated plan for research, monitoring, education and resource management. Achieving the goals and objectives of this plan will firmly establish the NBNERR in its role of stewardship for the valuable and fragile estuarine areas located within the land and Bay boundaries.



## **Acronyms and Abbreviations**

ASRI	Audubon Society of Rhode Island
CCMP	Comprehensive Conservation and Management Plan
CRMC	Coastal Resources Management Council
CFR	Code of Federal Regulations
CZMA	Coastal Zone Management Act
CSO	Combined sewer overflow
DEM	Rhode Island Department of Environmental Management
DFW	Division of Fish, Wildlife and Estuarine Resources
DOH	Rhode Island Department of Health
OCRM	Office of Ocean & Coastal Resources Management, NOAA
OMWM	Open Marsh Water Management
PIUC	Prudence Island Utility Corporation
RAC	Research Advisory Committee
MGD	Million gallons per day
RC&D	Resource Conservation and Development Program
PC	Prudence Conservancy
TNC	The Nature Conservancy
NBNERR	Narragansett Bay National Estuarine Research Reserve
NBP	Narragansett Bay Project
NERRS	National Estuarine Research Reserve System
NOAA	National Oceanic and Atmospheric Administration
RICRMP	Rhode Island Coastal Resources Management Program
RIGIS	Rhode Island Geographical Information System
SAM	Special Area Management Plan
SCS	Soil Conservation Service
SRD	Sanctuaries and Reserves Division
SPP	R.I. Department of Administration Statewide Planning Program
USC	United States Code (Federal statutes)
WWTF	Wastewater Treatment Facility

## **List of Figures**

	<i>Page</i>
1. National Estuarine Research Reserve System as of January 1998 .....	17
2. Narragansett Bay Watershed Map and Location of NBNERR .....	22
3. Property in the NBNERR .....	23
4. Narragansett Bay Water Quality Classifications .....	29
5. Shellfish Closure Areas in Narragansett Bay .....	31
6. Hydrography in the Narragansett Bay Research Reserve .....	35
7. NBNERR Trail Map .....	100

## **List of Tables**

1. NOAA'S National Estuarine Research Reserve System .....	18
2. Rhode Island Water Quality Criteria - Sea Water .....	28
3. Common and Scientific Names of Marine Finfish in the NBNERR .....	44
4. Representation of Bioregional Estuarine Ecosystem Types Within the NBNERR .....	90
5. Criteria to Be Considered in NBNERR Land Acquisitions .....	92
6. SRD-Funded Research Priorities, 1993-1998 .....	125
7. NBNERR Research Priorities, 1995-2005 .....	126





# The National Estuarine Research Reserve System

## CHAPTER I



Air particulates sampler for assessing atmospheric deposition of contaminants to Narragansett Bay.







# I. THE NATIONAL ESTUARINE RESEARCH RESERVE SYSTEM

## A. Need For Preserving Estuaries

### 1. Definition

Estuaries are a hydrologic and biological crossroads, defined as the portion of the earth's coastal zone where there is interaction of ocean water, fresh water, land, and atmosphere.

The specific plant and animal habitats which may be supported by an estuarine system are determined by conditions in the estuarine watershed and in the adjacent marine realm. The rate at which fresh water enters the estuary, the amount and type of waterborne and bottom sediments, the degree of tidal flushing, water depth (and hence temperature and degree of sunlight), all combine to produce habitat and food at interwoven micro- and macroscopic scales. Different combinations of these factors can produce several estuarine habitats within a single estuary. A significant physical change in any of those factors can trigger dramatic changes in the estuarine biologic community, greatly enlarging or reducing the size of various species populations.

### 2. Estuarine Productivity

In a healthy estuarine system, the interaction of tides, unpolluted fresh water, and sediments concentrates nutrients more densely than in any other natural system on the planet. Sheltered shallow waters and soft mud or sand flats, regularly flooded by the tides, provide ideal conditions for abundant life.

Among the most important, but least understood, estuarine species are microscopic plants—phytoplankton. Phytoplankton, like other green plants, make the energy of sunlight available to animals as food. Though rarely noticed by the casual observer, phytoplankton are a critical element in the complex estuarine food web.

Phytoplankton are consumed by microscopic and minute animals, called zooplankton. These tiny animals include the larvae of fish, crabs, clams, and other species, and are themselves part of the food supply for adults of their own or other species.

Marsh plants and eelgrass growing in shallow estuarine waters are critically important to estuarine animal life. Marsh vegetation not only provides cover for many animals, but also, as it dies back each season, creates detritus that feeds and houses the minute species on which larger species depend. The blades of eelgrass provide shelter for algae, snails, and other food for larger animals. Juveniles of many commercially valuable species reach adulthood by hiding among estuarine vegetation.

In an undisturbed estuary, the wealth of food can support huge populations of immature and adult fish, crabs, shrimp, and other species. Those animals provide essential food for populations of birds and mammals, including people.

Some species spend their entire life cycle in estuaries. For other species, including waterfowl and several kinds of flounder, growth and reproduction depend entirely on the availability of an estuarine system. Many commercially valuable species need the shelter of an estuary for only some seasons of the year or for a part of their life cycle (typically egg-laying and juvenile stages).

### 3. Modification of Estuaries

Estuaries' profusion of fish and other seafood, characteristically flat land, and sheltered access to the sea, offer almost ideal conditions for human habitation, agricultural production, and transportation. For thousands of years, estuaries on the East Coast of the United States supported native peoples and, more recently, settlers from other parts of the globe.

In the Northeast, as population, shipping, and industrial demands grew, estuarine tidelands were perceived as "wastes" of potential flat land. Marshes were also viewed as barriers to open water vital for transportation. Estuarine lands were diked, drained, and in some cases filled to create pastures or sites for port-related construction.

Those portions of an estuary that escaped diking were highly vulnerable to other development pressures: Some were invaded by industrial and agricultural pollution, some were dredged for shipping channels, while others were smothered by sediments carried in runoff from roads and farm field erosion.



*"The habitat areas of the coastal zone, and the fish, shellfish, other living marine resources, and wildlife therein, are ecologically fragile and consequently extremely vulnerable to destruction by man's alteration."*

By the 1970s, it had become apparent that estuaries were not isolated and valueless, but integrally related to ecological and human well-being. Destruction of estuaries was disastrously affecting water quality, commercial and recreational fisheries, and overall ecosystem health. Estuary-dependent plant and animal populations began to dwindle with lost habitat, food sources, reproductive sites, and overfishing. Affected species included not only winter flounder, scallop, crabs, and clams, but also birds, such as the osprey, which feeds on the tide flats. Increasing awareness of the value of estuaries triggered current efforts to preserve, conserve, and restore these fragile systems. Among the most significant of these efforts was passage of the Coastal Zone Management Act in 1972.

## **B. Creation of the National Estuarine Research Reserve System**

### **1. Coasts in Crisis and the Coastal Zone Management Act**

In 1972, Congress passed the Coastal Zone Management Act (CZMA). In the CZMA, and in subsequent reauthorizations, Congress officially recognizes that resources of the coastal zone are of national significance, and are rapidly disappearing. The CZMA also recognizes the interrelationships between uplands and tidelands: the "coastal zone" was defined in the Act as including all uplands "to the extent necessary to control shorelands." A portion of the 1990 reauthorization of the CZMA states:

*"Competing demands upon the lands and waters of our coastal zone. . . have resulted in the loss of living marine resources, wildlife, nutrient-rich areas, permanent and adverse changes to ecological systems, decreasing open space for public use, and shoreline erosion."*

*"The habitat areas of the coastal zone, and the fish, shellfish, other living marine resources, and wildlife therein, are ecologically fragile and consequently extremely vulnerable to destruction by man's alteration."*

In recognition of these growing problems, the CZMA established a national goal:

*"To preserve, protect, develop, and where possible, to restore and enhance the resources of the Nation's coastal zone for this and succeeding generations."*

The CZMA also recognized that coastal waters are significantly affected by land uses:

*"Land uses in the coastal zone, and the uses of adjacent lands which drain into the coastal zone, may significantly affect the quality of coastal waters and habitats, and efforts to control coastal water pollution from land use activities must be improved."*

Under the CZMA, coastal states can receive grant money to develop and administer plans for coastal management. The CZMA also authorizes the provision of Federal technical and financial assistance to support states' coastal zone management planning and plan implementation. A state's National Oceanic and Atmospheric Administration (NOAA)-approved coastal management plan governs Federal actions affecting the state's coastal zone, including actions proposed by any Federal agency, or which require Federal approval. Rhode Island's Coastal Management Plan was approved in 1977.

### **2. National Estuarine Research Reserve System**

#### **a. Mission**

Section 315 of the CZMA established the National Estuarine Research Reserve System (Appendix A). Under the system, healthy estuaries which typify different regions of the United States are designated and managed as sites for long-term research and used as a base for estuarine education and interpretation programs. The system also provides a framework through which research results and techniques for estuarine education and interpretation can be shared throughout the region and across the nation.



The mission of the National Estuarine Research Reserve System is:

“the establishment and management, through Federal-state cooperation, of a national system of Estuarine Research Reserves representative of the various regions and estuarine types in the United States. Estuarine Research Reserves are established to provide opportunities for long-term research, education, and interpretation.”

(For this and additional text of the Coastal Zone Management Act, see Federal Register, Part V, 15 CFR Part 921 [7/15/93].)

Prior to establishment of the NERR System, scientific understanding of estuarine processes was increasing slowly and without national coordination. There was no ready mechanism for the detection and measurement of local, regional, or national trends in estuarine conditions. Resource managers, governments, and the public did not always have access to information about the significance and ecology of their estuaries, could not assess the full impact of past activities, and could not readily anticipate the damaging effects of proposed management and development policies.

Some communities and policy makers either were unaware that certain activities would destroy their estuaries or did not fully appreciate the long-term consequences of that destruction. Governmental leaders and policy makers who promoted healthy estuaries could not always find political support because information about estuarine values was not readily available to the general population. Communities that appreciated the economic and environmental significance of their estuaries found that previously damaged estuarine habitats were slow to recover, and that there was little scientific knowledge about how to assist in that recovery. NERR System research and education can help to fill those gaps in knowledge and guide estuarine management for sustained support of commercial and recreational fisheries, tourism, aquaculture, and other activities.

#### **b. Goals of the National Estuarine Research Reserve System**

The goals of the NERR System are established by Federal Regulation, 15 CFR Part 921.1(b) as follows:

- Ensure a stable environment for research through long-term protection of National Estuarine Research Reserve resources
- Address coastal management issues identified as significant through coordinated estuarine research within the System
- Enhance public awareness and understanding of estuarine areas and provide suitable opportunities for public education and interpretation
- Promote Federal, state, public, and private use of one or more Reserves within the System when entities conduct estuarine research
- Conduct and coordinate estuarine research within the System, gathering and making available information necessary for improved understanding and management of estuarine areas

### **3. NERR System Strategic Plan**

The NERR System, the NOAA OCRM, and the individual reserves incorporate into their planning and implementation the January 1995 document titled: *Conserving the Nation's Coasts and Estuaries—A Strategic Plan for the National Estuarine Research Reserve System: A State and Federal Partnership*.

### **4. NERR System Administrative Framework**

#### **a. State-Federal Relationship**

Each NERR is jointly operated by a state and the Federal government. The Federal interest is represented by the Sanctuaries and Reserves Division (SRD) of the NOAA. NOAA's mission includes management of the nation's coastal resources, and promotion of global stewardship of the world's oceans and atmosphere through science and service. The SRD coordinates the NERR System nationally and administers Federal grant funds to individual Reserves.

The state interest is usually represented through one or more state agencies, typically agencies



charged with environmental or wildlife or coastal management responsibilities. States usually administer Reserve personnel and day-to-day Reserve management.

#### **b. Biogeographic Regions**

NOAA has identified 11 distinct biogeographic regions in the United States, each of which contains several types of estuarine ecosystems. When complete, the NERR System will contain examples of estuarine hydrological and biological types characteristic of each bioregion, with each Reserve responsible for conducting research, monitoring, and providing educational and interpretive services to its bioregion. As of January 1998, the NERR System contained 22 reserves, preserving nearly 550,000 acres, with at least four more in development (Figure 1; Table 1). Appropriate representatives of some regions are still being sought (Figure 1).

#### **c. Reserve Establishment and Maintenance**

Under Federal law (16 U.S.C. sec. 1461), a state can nominate any estuary for Research Reserve status so long as the site meets the following conditions:

- The area is a bioregionally representative estuarine ecosystem that is suitable for long-term research and contributes to the biogeographical and typological balance of the System
- The law of the coastal state provides long-term protection for the proposed Reserve's resources to ensure a stable environment for research
- Designation of the site as a Reserve will serve to enhance public awareness and understanding of estuarine areas and will provide suitable opportunities for public education and interpretation
- The coastal state has complied with the requirements of any regulations issued by the Secretary [of Commerce]

Reserve boundaries must include an adequate portion of the key land and water areas of the natural system to approximate an ecological unit and to ensure effective conservation.

If the proposed site is accepted into the NERR System, NOAA provides financial assistance for acquisition of property, and shares administrative costs with the state. The state exercises administrative and management control consistent with its obligations to NOAA. After establishment, a Reserve may apply to SRD for funds to support operations, research, monitoring, facility construction, and education/interpretation development.

#### **d. Reserve Management Planning**

Every Reserve is required by Federal regulation to have a NOAA-approved management plan. The plan must describe the Reserve's goals, objectives, and management issues, and must identify the Reserve's intended strategies or actions for research, education/interpretation, public access, construction, acquisition, and resource protection, restoration, and manipulation. Staff roles in each of these areas must also be addressed.

A Reserve's initial plan, and any major proposed changes to a plan, are made available for public comment at national and local levels before receiving NOAA's final approval.

#### **e. Reserve Oversight**

Under Federal statute, a NOAA team periodically evaluates a Reserve's management and operations. The Reserve's education, research, and land management must be in compliance with NERR System objectives and with the Reserve's Management Plan. The NOAA team may identify areas needing improvement or increased emphasis, or may make suggestions regarding any aspect of Reserve management.

### **C. NERR National Programs**

The two major elements of the NERR System are (1) research and monitoring on estuarine habitats and processes, and (2) education and interpretation of estuarine habitats.



# National Estuarine Research Reserve System

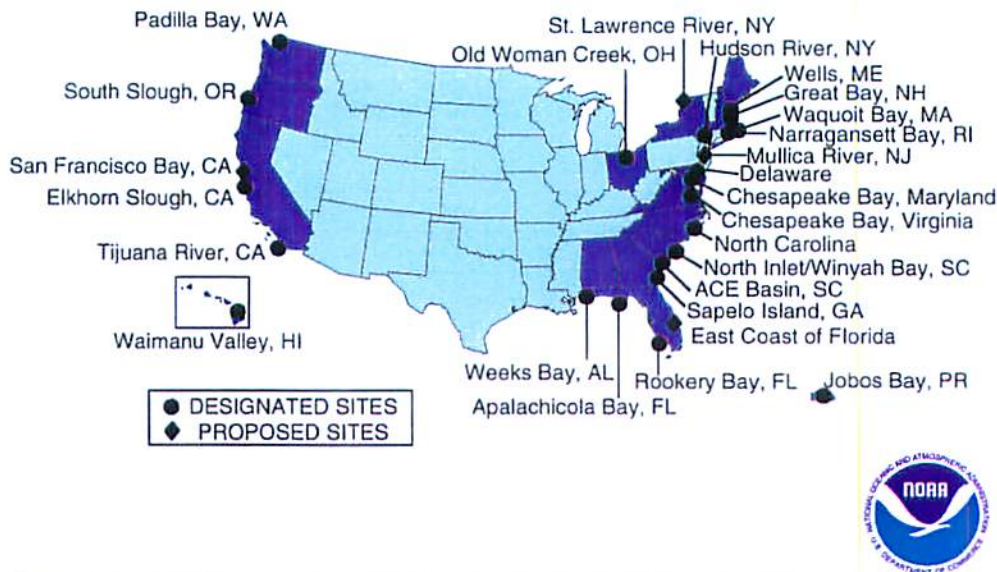


Figure 1. National Estuarine Research Reserve System as of January 1998.

## 1. NERR Research and Monitoring Program

The NERR research and monitoring program is designed to facilitate and coordinate scientific understanding of estuarine systems, and to establish and regularly monitor the baseline conditions of estuaries in the NERR System. In creating the NERR System, Congress indicated that research priorities, objectives, and methodologies should be nationally coordinated for the broadest application of research results and maximum use of the system. The NERR System has developed a strategic plan to address both research and monitoring activities on a national scale (for details of national coordination of research priorities among Reserves, see "Research and Monitoring Plan (Priorities for Research Funding), Chapter X of this document).

The NERR research and monitoring program is intended to generate and supply information to state and local governments, including wildlife management and land use permitting agencies, and to other entities involved in coastal management. Coastal governments and policymakers should be able to use research results and implications to make land use and estuary management decisions, to gauge the effects of past activities, and to restore estuarine habitat.

## 2. NERR Education and Interpretation Program

The NERR education and interpretation program represents a national network for the dissemination of information about, and appreciation of, estuarine processes. The NERR education and interpretive program also supports development of new educational and interpretive techniques and approaches. Programs and techniques developed by one Reserve may be shared with other NERRs and other educators and interpreters through the national coordination of the NERR System.

Each Reserve may develop an educational and interpretation plan tailored to its site and region and to its region's educational system. The NERR System has begun work on a national strategic plan which will provide additional guidance to individual Reserves.

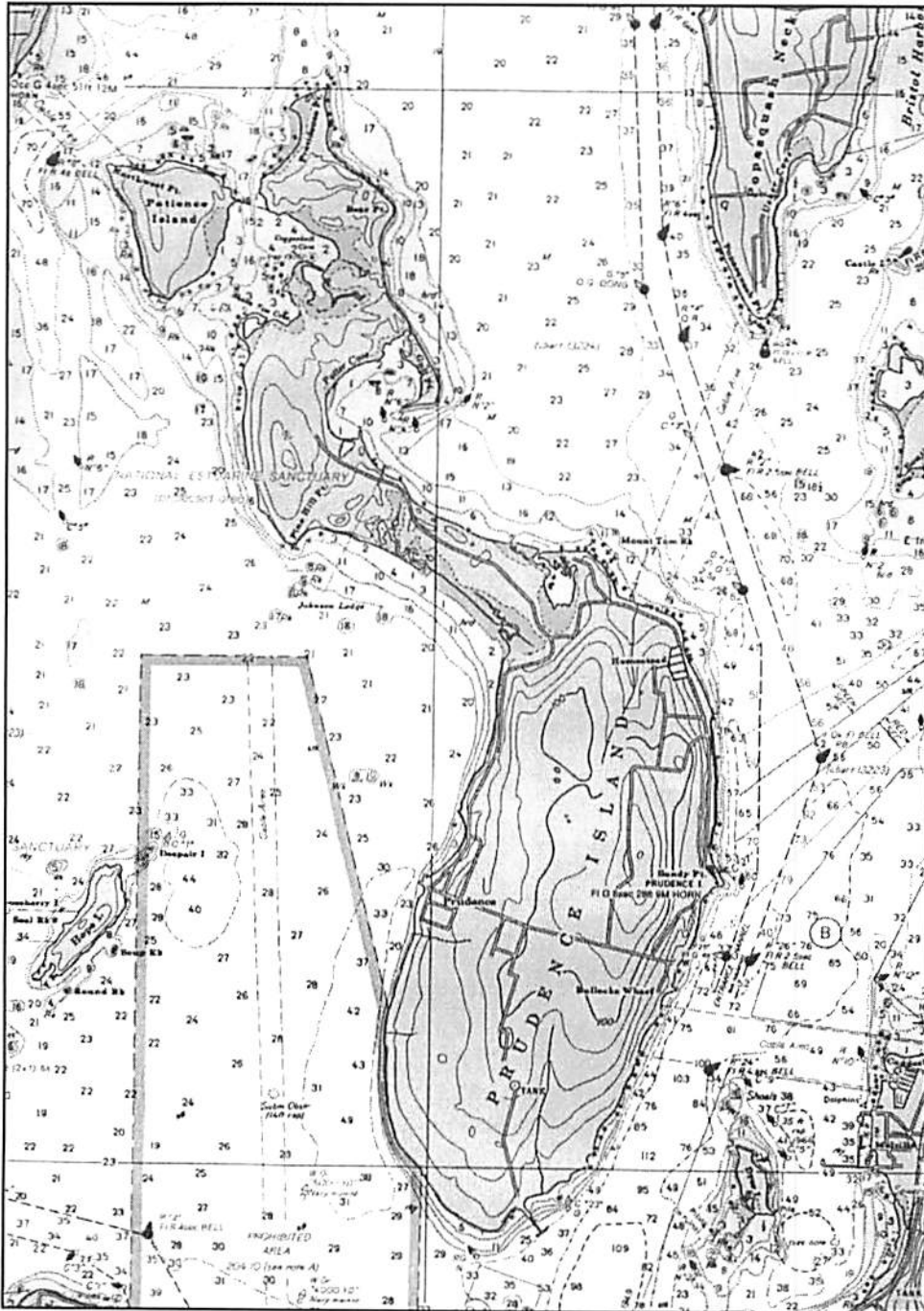
**Table 1. NOAA's National Estuarine Research Reserve System, January 1998.**

Name & Location	Year Designated	Acres (Land & Water)	Square Kilometers	Biogeographic Region' (Sub-Region)
1. South Slough, OR	1974	4,700	19.0	Columbian (17)
2. Sapelo Island, GA	1976	6,111	24.7	Carolinian (7)
3. Rookery Bay, FL	1978	12,550	50.8	West Indian (10)
4. Apalachicola, FL	1979	193,758	784.1	Louisianian (11)
5. Elkhorn Slough, CA	1980	1,400	5.7	Californian (15)
6. Padilla Bay, WA	1980	10,700	43.3	Columbian (19)
7. Narragansett Bay, RI	1980	4,950	19.9	Virginian (3)
8. Old Woman Creek, OH	1980	571	2.3	Great Lakes (21)
9. Chesapeake Bay, MD (3 components)	1981	4,848	19.6	Virginian (5)
10. Jobos Bay, PR	1981	2,800	11.3	West Indian (9)
11. North Carolina (4 components)	1982	10,000	40.4	Carolinian (6)
12. Tijuana River, CA	1982	2,500	10.1	Californian (14)
13. Hudson River, NY	1982	4,838	19.7	Virginian (5)
14. Wells, ME	1984	1,600	6.5	Acadian (2)
15. Weeks Bay, AL	1986	3,028	12.3	Louisianian (11)
16. Waquoit Bay, MA	1988	2,250	9.1	Acadian (3)
17. Great Bay, NH	1989	5,280	21.5	Acadian (2)
18. Chesapeake Bay, VA (4 components)	1991	4,434	17.9	Virginian (5)
19. A.C.E. Basin, SC	1992	136,600	552.7	Carolinian (6)
20. North Inlet, SC	1992	9,080	36.7	Carolinian (7)
21. Delaware Bay, DE	1993	8,600	34.7	Virginian (4)
22. Mullica River, NJ	1997	114,000	461.3	Virginian (4)
<b>TOTAL DESIGNATED</b>		<b>544,598</b>	<b>2,203.6</b>	
<b>RESERVES IN DEVELOPMENT</b>				
23. St. Lawrence, NY	TBD*	6,000	24.3	Virginian (4)
24. San Francisco Bay, CA	TBD	TBD	----	Californian (16)
25. East Florida, FL	TBD	TBD	----	Carolinian (8)
26. Kachemak Bay, AK	TBD	365,000	1,477.1	Aleutian Is. (25)
<b>ESTIMATED TOTALS</b>		<b>371,000</b>	<b>1,501.4</b>	
*TBD=To be determined      1 square mile = 640 acres = 2.59 kilometers				
'NERRS biogeographic classification scheme (Federal Register 57:138 Friday July 17, 1992. P31937)				



# Narragansett Bay: NERR Setting

## CHAPTER II









## II. NARRAGANSETT BAY: NERR SETTING

### A. Narragansett Bay Region

#### 1. Introduction

In October 1980, the NBNERR became the ninth Reserve in the country and first in the Virginian Biogeographic region, which extends over 1,000 miles of Atlantic coastline from Cape Hatteras to Cape Cod. The Reserve is representative of the Southern New England Subregion of the Virginian region. Sites in this region reflect lowland streams, coastal marshes, and muddy bottoms. Biota is primarily temperate with some boreal representatives.

The Reserve is located in the geographic center of Narragansett Bay and consists of over 2,300 acres of land on Prudence, Patience, and Hope islands and approximately 2,000 acres of water adjoining the islands. (See Figures 2 and 3). These islands contain diverse aquatic and terrestrial habitats and support numerous species. Hope Island and Patience Island have had human occupation in the past but are not developed. Prudence is sparsely populated with pockets of development mainly along its eastern coast. Their distance from urban centers reduces their exposure to chronic pollution associated with urban development. However, the islands are close enough to the mainland to make public access and coordination of educational and recreational activities relatively easy.

#### 2. Physical Aspects of the Bay

Prudence, Patience, and Hope islands lie in the approximate center of Narragansett Bay. Narragansett Bay is a medium-sized, relatively deep, high salinity, temperate zone estuary. The Bay is exceedingly productive and hosts a high diversity of marine life, including many migratory species. It is often referred to as, "Rhode Island's most valuable natural resource." Narragansett Bay covers 147 square miles of water surface (Figure 2).

The Bay's three largest islands are Aquidneck (the Indian name means "longest island"), Conanicut, and Prudence. Approximately 30 smaller islands also dot the Bay, many of them little more than large rocks.

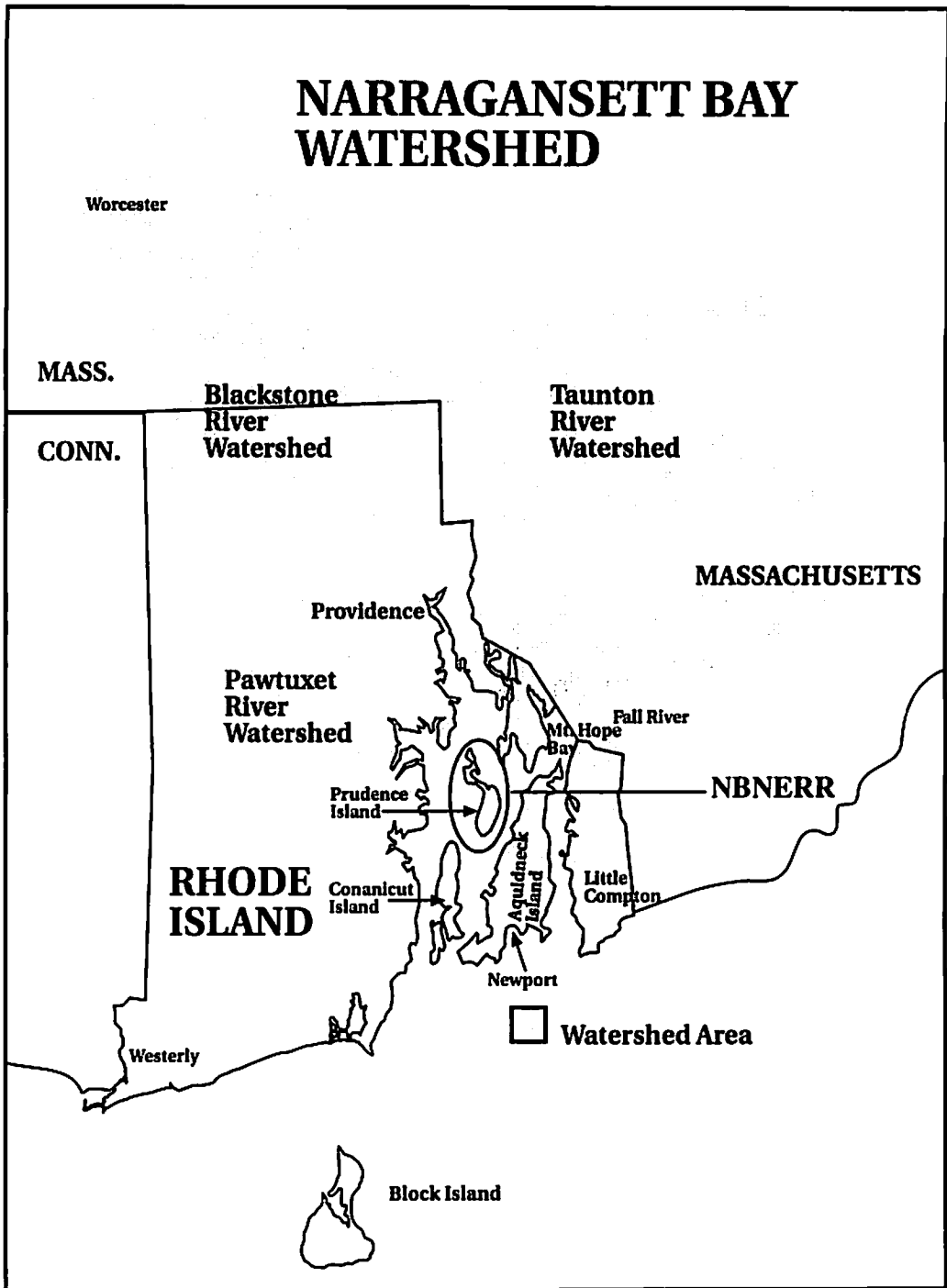
Its watershed comprises 1,657 square miles, 61 percent of which is in Massachusetts and 39 percent in Rhode Island. Major cities within the watershed include Worcester, Fall River, Taunton, and Brockton, Mass.; and Providence, Woonsocket, Cranston, Warwick, and Newport, R.I. (Figure 2).

Narragansett Bay connects with Rhode Island Sound through the three ancient, drowned river valleys, the East and West passages and the Sakonnet River. East Passage is the deepest valley, averaging 50 feet (15.3 meters). In contrast, the average depth of the Bay is 27 feet (8.3 meters), and West Passage averages 25 feet (7.6 meters). East Passage provides deep water access for large vessels as far as Prudence Island, and dredged channels allow further passage to ports on the Providence and Taunton rivers.

Total freshwater input to the Bay has been estimated to be approximately 2,400 million gallons per day (MGD). Most of the fresh water entering the Bay, about 80 percent of the total flow, comes from Bay tributaries which are recharged by approximately 46 inches of annual precipitation. Other freshwater sources include direct precipitation on the Bay (310 MGD), wastewater treatment facilities (WWTFs) (248 MGD or 98 billion gallons per year), and combined sewer over flows (CSOs) (4 billion gallons per year). Groundwater and suburban stormdrains also contribute an unknown volume of freshwater. The Blackstone, Taunton, and Pawtuxet rivers account for 63 percent of the total measured input of fresh water. Smaller rivers and streams, including the Woonasquatucket, Moshassuck, Ten Mile, Palmer, and Hunt Rivers account for the rest of the riverine flow, but do not contribute substantially to the total flow of water.

#### 3. Hydrology

Circulation of water within the Bay is complex, but important to understand because these circulation patterns affect the distribution of sediments, nutrients, pollutants, and microscopic floating plants and animals in the Bay. Because most freshwater sources are at the head of the Bay, there is a salinity gradient, with fresher waters in the Upper Bay and more saline water in the Lower Bay. Since fresh water is less dense than salt water, fresh water from the rivers tends to float on top



**Figure 2. Narragansett Bay watershed map and location of NBNERR.**

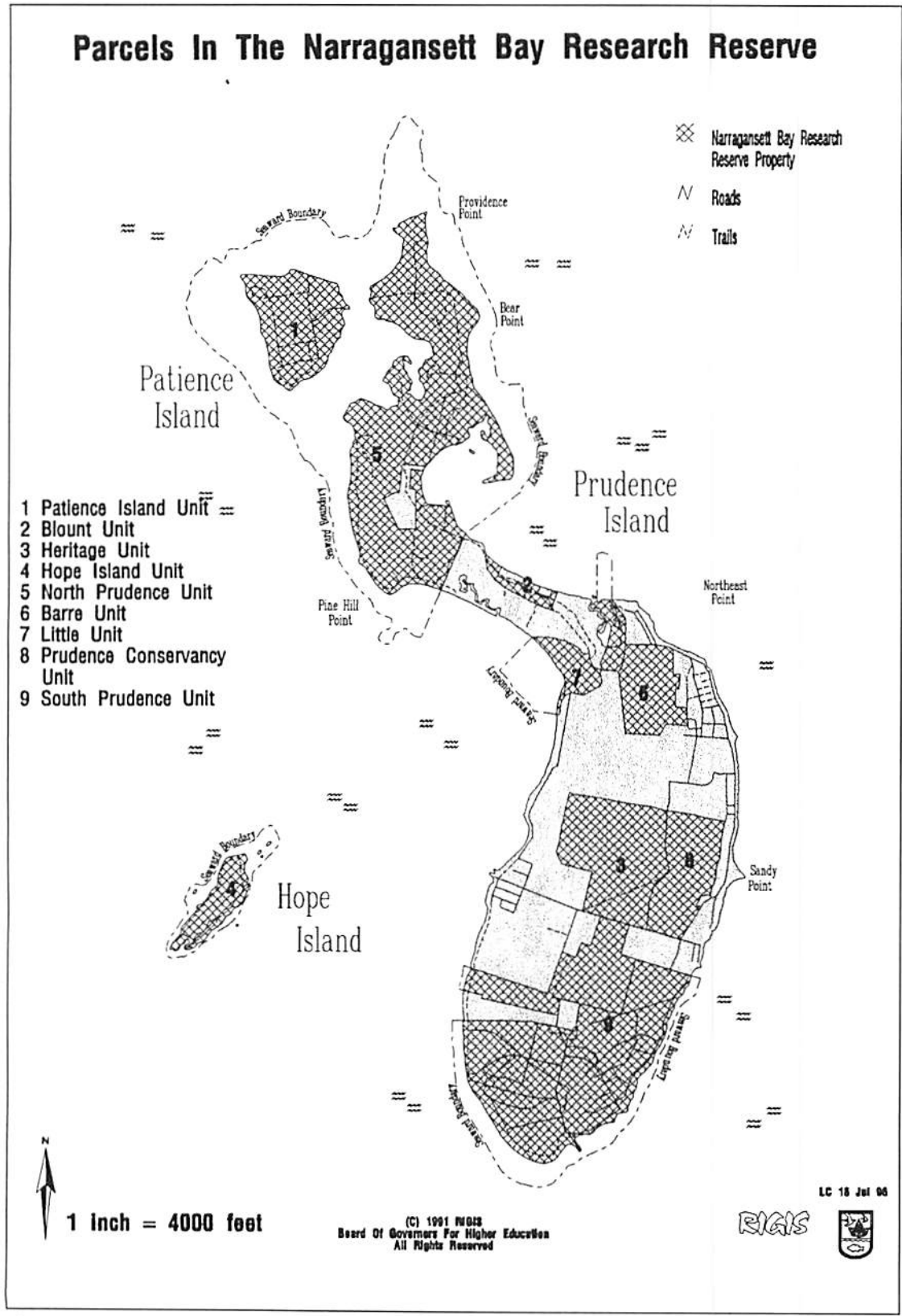


Figure 3. Property in the NBNERR.



*Sandy beaches are found along the ocean shores at the mouth of the Bay and, in a few areas, such as Prudence Island, in the Bay's interior.*

of the salt water, gradually mixing as it moves seaward. The currents, produced by this seaward flow, called nontidal currents, move at speeds of less than one-half knot. They are, in part, responsible for moving water out of the Bay and into Rhode Island Sound, a process that takes between 10 and 40 days. The average residence time of a molecule of water in the Bay is 26 days.

Although the net movement of water in Narragansett Bay is downstream from the rivers to Rhode Island Sound, tidal currents also mix Bay waters. Tidal currents are the most important force mixing Bay waters and also help to move water in and out of the Bay. Tides cause the waters of the Bay to rise and fall 3 to 4 feet every 12-and-a-half hours. Tides travel up the Bay like a wave, so high tide in Providence is about 20 minutes later than high tide in Newport. Tidal currents average one-and-a-half knots, and are even faster in certain areas.

Winds also play an important, although sporadic, role in circulation. During the summer, southwesterly winds dominate in the Bay. In the winter, most winds are northwesterly. Average wind speeds are highest in December and January, and result in accelerated movement of water out of the estuary and into Rhode Island Sound.

#### **4. Geology**

All of what is now Rhode Island was covered by glacial ice sheets several thousand feet thick during the Pleistocene epoch, which began 2.5 to 3 million years ago. As the glacier moved south, it scoured and picked up older glacial deposits, bedrock, and soil. The final deposition of glacial material occurred during the Wisconsin glaciation 10,000 to 12,000 years ago. As the glacier melted and receded, it deposited unconsolidated material consisting mainly of unsorted glacial till and beds of meltwater-sorted sand, gravel, and silt. Glacial till is the most extensive of these deposits. The meltwater and the eroded material it carried caused a landscape of kames, eskers, terraces, and outwash plains, all of which contain stratified outwash and fluvial deposits.

The Narragansett till plains make up the area immediately bordering Narragansett Bay. This area is covered by glacial till derived from sedimentary rock, shale, sandstone, conglomerate, and, in a few places, coal. The till is generally compacted, dark gray to olive-colored, and finer textured than the till derived from granitic rock. The area has few bedrock outcrops, and most of the landforms are drumloidal and have been smoothed by glacial action. The Newport soils formed in these deposits.

The bedrock formation in the Narragansett Bay region is the Pennsylvanian (coal-age) sedimentary rock of an ancient sequence of rocks over 200 million years old. These rocks range from coarse-grained sandstone to a black, fine-grained shale.

#### **5. Soils**

The glacial deposits of Narragansett Bay are overlain by a layer of material that has washed down into the Bay from its rivers. Rivers and the erosion of coastal bluffs provide most sedimentary material to the Bay. In general, there are finer-grained materials in the Upper Bay than there are at the mouth. The Providence River and protected harbors and coves of the Bay also contain finer-grained sediments. Areas with fine-grained sediments are likely sinks for particle-associated toxic pollutants in the Bay.

The cobble shore along most of Narragansett Bay is a reminder of the glacial deposits that helped form the area. The most common type of shoreline found around the Bay is a narrow beach of gravel and cobble that backs up to a scarp or bluff composed of glacial till. Sandy beaches are found along the ocean shores at the mouth of the Bay and in a few areas such as Prudence Island in the Bay's interior. Rocky shorelines are found at Beavertail, Common Fence and Brenton points, Hope Island, and the southeast and southwest shores of Prudence Island.

The predominant soils in the east Bay region and the Reserve are the Newport silt-loam series which are formed in compact glacial till derived mainly from dark sandstone, conglomerate, argillite and phyllite; and the Stissing silt-loam, a poorly drained coarse-loamy soil formed in a compact glacial till from dark gray phyllite, slate, shale, and schist. Many of the marshes are underlain by Matunuck mucky peat. The beaches in the region range from zero to 8 percent slope and are comprised of fine sand to cobbles, depending on wave energy and natural slope of the beach.



## 6. Groundwater

Groundwater provides the domestic water supply for approximately 25 percent of the state's population. Groundwater is generally abundant and of high quality in the East Bay region. The source of replenishment to groundwater on Prudence, Patience and Hope islands is local precipitation. The rain or snow leaves the islands as flowing surface water, evaporates, transpires, and the remainder infiltrates the ground to provide the available water supply. The principal aquifer on Prudence Island and the source of 90 percent of the supply is located in the center of the island emanating from Schoolhouse Swamp and the Mill Creek valley. The water is withdrawn primarily at Indian Spring and distributed throughout the Island. This aquifer is being exploited to the maximum allowable extent. Approximately 12 million gallons per year are withdrawn. Any further pumping will result in a decline in depth of groundwater which could lead to salt intrusion and adverse ecological impact.

There are several "rock" wells on Prudence. Typically these are drilled 600 to 800 feet deep into the bedrock. The sustained yield is limited by a slow rate of recharge or saline water encroachment.

## 7. Climate

Rhode Island is in the north temperate zone and the climate in the Narragansett Bay region is moderated by the Bay waters and Atlantic Ocean. The average annual temperature is 50.6°F with an average minimum of 20°F. In summer the average temperature is 70°F with an average daily maximum of 80°F. Extreme temperatures range from minus 10°F in winter to 102°F in summer.

Precipitation in the Bay region averages 38.10 inches. Monthly rainfall is generally uniform but ranges from a high of 3.53 inches in January to 2.58 inches in July. Average seasonal snowfall is approximately 32 inches.

Average relative humidity is 55 percent, highest at night. The percentage of possible sunshine is 60 percent in summer and 55 percent in winter. The prevailing wind is southwest in summer and northwest in winter. Average wind speed is highest in April at 13 miles per hour. Storms generally have winds from the easterly direction. The region receives an occasional hurricane with winds to 120 miles per hour. The last major hurricanes were in 1991, 1954, 1944, and 1938.

## 8. Life in the Bay

The basis of the Bay's food chain — or, more accurately, food web — are one-celled floating algae called phytoplankton. Like land plants, these tiny plants use photosynthesis to convert carbon dioxide into organic material that ultimately nourishes all other life in the Bay. The phytoplankton population rises and falls several times each year, with an explosive growth period called a "bloom" occurring in late winter or early spring.

- During the winter/spring bloom, Narragansett Bay's phytoplankton population can double in a single day, and one drop of water may contain up to 4,500 individual cells.
- More than 250 species of phytoplankton have been identified in the Bay.

Narragansett Bay, like any estuary, provides a variety of different habitats for living things. Certain plants and animals are concentrated in particular areas where salinity and other conditions are best suited to their needs. For example, the most productive quahaug (hard clam) beds are in the less salty, more nutrient-rich waters of the upper Bay. On the other hand, lobster and blue mussel prefer the more oceanlike conditions of the lower Bay, near Rhode Island Sound.

Since 1959, researchers at the University of Rhode Island have been collecting weekly samples of the Bay's benthic (bottom-dwelling) fish by dragging a conical net, called an otter trawl, across the bottom. Among their findings:

- The winter, or blackback, flounder has been the dominant bottom-dwelling fish species in Narragansett Bay, until a significant decline in numbers in recent years.
- There are large year-to-year variations in the winter flounder population, ranging from a high of 75 percent of the total yearly sample in 1968 to a low of 5 percent in 1994.



*A 17-mile-long, 40-foot-deep dredged channel from the southeast side of Prudence Island up to Providence enables large ships to reach the Port of Providence.*

- Three species (winter flounder, scup, and sand flounder) account for 90 percent of the total bottom-fish sample.

The Bay's commercially important species of pelagic fish (fish that feed in the water column, as opposed to bottom-fish like flounder) include the bluefish, striped bass, tautog (blackfish), squeteague (weakfish), and menhaden. Most of these migrate to Narragansett Bay in May or June. Each year, representatives of about 100 different fish species may visit the Bay at one time or another.

## **9. Commercial Shellfishing and Fishing**

At the beginning of the century, the Narragansett Bay oyster, highly prized by gourmets, was the most important commercial species in the Bay. The oyster industry started shortly after the Civil War, peaked in 1908, and continued to flourish through the 1920s. But subsequently, the oyster business declined for a variety of reasons: pollution, poaching, hurricane damage, predators, and overfishing have all been blamed. The last Narragansett Bay oyster company closed its doors in 1952. Today oyster beds are again found in some parts of the Bay including the NBNERR.

In terms of both economic value and employment, quahaugs are by far the most important resource harvested from Narragansett Bay. Each year the state of Rhode Island issues commercial quahauging licenses to approximately 3,000 people who make all or part of their living from this physically demanding job. Working from small open boats, the quahauggers harvest the clams by hand, using a heavy bullrake whose handle can be up to 70 feet long.

- From 1985 to 1993, commercial landings (gross weight) of quahaugs diminished from 25 to 10 million pounds of quahaug meat. In 1985, 4.4 million pounds of quahaug meat, with a value of \$15.7 million at the dock, were harvested from the Bay.
- Since 1980, Rhode Island's yearly quahaug catch has accounted for about 20 percent of the U.S. total.

Lobstering is the Bay's second most important commercial fishery. Annually, about 1 million pounds of lobsters, worth about \$3 million at the dock, are caught in the lower Bay.

The Bay's finfishing industry ranks third in economic terms. (The majority of Rhode Island's commercial finfish catch comes from outside the Bay, in Rhode Island Sound and the Atlantic Ocean.) Currently, about 30 small commercial trawlers fish in the Bay, primarily for scup, squid, and butterfish. Between 10 and 30 million pounds of menhaden, most of it sold for use as lobster bait, are taken from the Bay annually by purse seiners, and approximately 700 rod-and-reel fishermen are licensed to sell their catches commercially.

Because of Narragansett Bay's small size and its crucial role both as a feeding area for the young of many species and as a spawning ground, the Bay's resources need to be carefully managed. Restrictions govern fishing methods, size of fish or shellfish that may be kept, amount of catch, and where and when fishing is permitted.

## **10. Shipping**

Rhode Island's first major commercial enterprise was maritime commerce, based on the infamous rum-slave-sugar "triangle trade" and centered in Newport. By the early 19th century, manufacturing along the Bay's major rivers had replaced shipping as the basis of Rhode Island's economy. To accommodate the manufacturers, the shipping industry followed them up the Bay to Providence and Fall River.

Today, the Rhode Island ports of Providence and Quonset Point/Davisville are major importers of petroleum products (fuel oil, gasoline, and kerosene) and automobiles. A 17-mile-long, 40-foot-deep dredged channel from the southeast side of Prudence Island up to Providence enables large ships to reach the Port of Providence.

- The total cargo brought into Rhode Island ports exceeds 8 million tons annually.





- Over \$1 billion worth of foreign automobiles, mainly Japanese and Scandinavian, have been brought into Rhode Island each year since 1985.

## 11. Recreation

Narragansett Bay is considered one of the best sailing locations in the world. Its safe, sheltered waters, with few shoal areas, are rarely too rough for small boats during the summer months. Sailors can generally count on an afternoon sea breeze of 12 to 15 knots.

Recreational boating exceeds all other uses of the Bay (swimming, commercial fishing and shellfishing, and shipping) in terms of number of people participating and economic impact. The biggest problem confronting the Bay's sailors and motorboaters is the serious shortage of marina space.

- According to a recent survey, 32 percent of Rhode Island's population goes boating on Narragansett Bay one or more times per year.
- There are an estimated 35,000 to 40,000 recreational boats in Rhode Island, with the majority using Narragansett Bay.
- Ninety-one percent of all boating facilities (marinas, boat yards, and yacht clubs) in Rhode Island are located on the Bay.

Recreational fishing on the Bay, whether from a boat, a dock, a bridge, or the shore, is very popular. Bluefish and striped bass are especially prized as sport fish.

Near shore, the Bay's water can reach a surface temperature of 74°F, ideal for swimmers at town and state beaches along the Bay and island shores.

## 12. Water Quality

The states of Rhode Island and Massachusetts classify the state's waters according to the condition and goals for water uses. Seawaters are classified as follows:

Class SA	Suitable for bathing and contact recreation, shellfish harvesting for direct human consumption, and fish and wildlife habitat.
Class SB	Suitable for bathing and contact recreation, for shellfish harvesting for human consumption after depuration, and fish and wildlife habitat.
Class SC	Suitable for boating and secondary contact recreation, fish and wildlife habitat, industrial cooling, and aesthetic value.

Discharges into the waters must meet limitations necessary to ensure compliance with specific state water quality standards, which limit concentrations of specific pollutants in order to protect aquatic life and human health.

Table 2 enumerates the specific criteria for the three marine water quality standards. Figure 4 indicates the Narragansett Bay water quality conditions based on dissolved oxygen and chemical constituents. Figure 5 illustrates the shellfish closure areas based on fecal coliform bacteria per 100 milliliters (ml).

The NBNERR waters are Class SA except for a seasonal closure of Potter Cove on Prudence Island due to high coliform bacteria levels during peak boating activity from June through October.

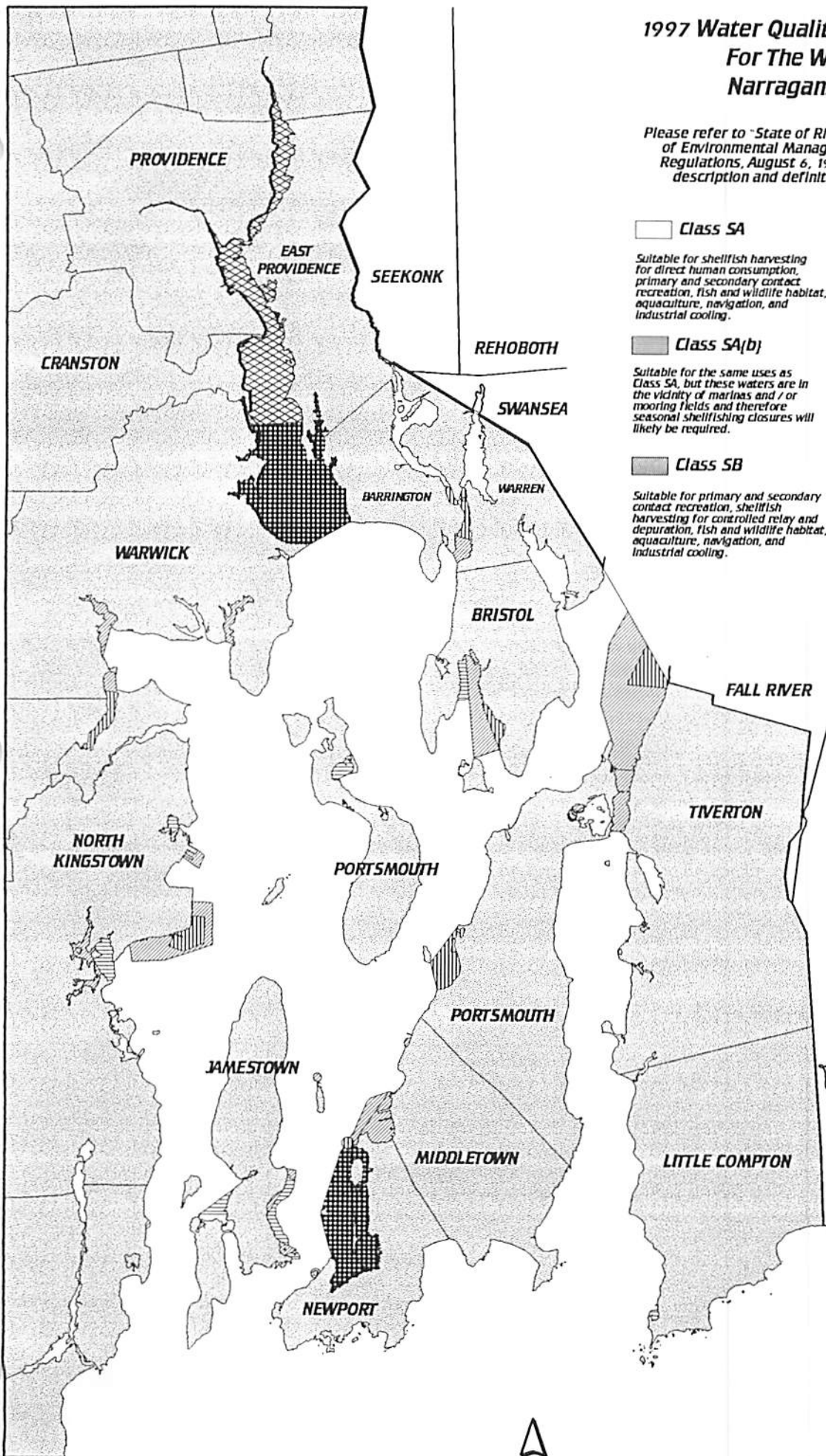
In 1793, the opening of America's first water-powered textile mill on the Blackstone River in

**Table 2. Rhode Island water quality criteria for sea water.**

Criterion	Water Quality Standard		
	Class SA	Class SB & SB1	Class SC
Dissolved Oxygen	Not less than 6.0 mg/L at any place or time, except as naturally occurs. Normal seasonal and diurnal variations that result in <i>in situ</i> concentrations above 6.0 mg/L not associated with cultural eutrophication will be maintained in accordance with the Antidegradation Implementation Policy.	Not less than 5.0 mg/L at any place or time, except as naturally occurs. Normal seasonal and diurnal variations that result in <i>in situ</i> concentrations above 5.0 mg/L not associated with cultural eutrophication will be maintained in accordance with the Antidegradation Implementation Policy.	
Fecal Coliform Bacteria (MPN/100 ml)	Not to exceed a geometric mean MPH value of 14 and not more than 10% of the samples shall exceed an MPN value of 49 for a three-tube decimal dilution.	Not to exceed a median geometric mean MPN value of 50 and not more than 10% of the samples shall exceed a value of 500.	None in such concentrations that would impair any usages specifically assigned to this class.
<b>Chemical Constituents</b>	<b>Acute (mg/L)</b>		<b>Chronic (mg/L)</b>
Nitrogen	N.S.		N.S.
Phosphorous	N.S.		N.S.
Cadmium	43		9.3
Chromium VI	1100		50
Copper	2.9		2.9
Lead	140		5.6
Mercury	2.1		0.025
Nickel	75		8.3
Selenium	410		54
Gold	2.3		---
Zinc	95		85
Carbon/Nitrogen	1.0		1.0
Polychlorinated Biphenols (PCBs)	10		0.03
Polyaromatic Hydrocarbons (PAHs)	N.S.		N.S.
<i>(N.S. = No standard)</i>			

# 1997 Water Quality Classifications For The Waters Of Narragansett Bay

Please refer to "State of Rhode Island, Department of Environmental Management, Water Quality Regulations, August 6, 1997", for the complete description and definition of these waters.



**Class SA**

Suitable for shellfish harvesting for direct human consumption, primary and secondary contact recreation, fish and wildlife habitat, aquaculture, navigation, and industrial cooling.

**Class SA(b)**

Suitable for the same uses as Class SA, but these waters are in the vicinity of marinas and / or mooring fields and therefore seasonal shellfishing closures will likely be required.

**Class SB**

Suitable for primary and secondary contact recreation, shellfish harvesting for controlled relay and depuration, fish and wildlife habitat, aquaculture, navigation, and industrial cooling.

**Class SB1**

Suitable for primary and secondary contact recreation, fish and wildlife habitat, aquaculture, navigation, and industrial cooling. Primary contact recreation may be impacted due to pathogens from wastewater treatment facilities.

**Class SB(a)**

Suitable for the same uses as Class SB, but these waters will likely be impacted by combined sewer overflows. Therefore, primary contact recreation, shellfishing, and fish and wildlife habitat will likely be restricted.

**Class SB1(a)**

Suitable for the same uses as Class SB1, but these waters will likely be impacted by combined sewer overflows. Therefore, primary contact recreation, shellfishing, and fish and wildlife habitat will likely be restricted.



Figure 4. Narragansett Bay water quality classifications.



Rhode Island marked the beginning of the Industrial Revolution in the United States. This event also gave Narragansett Bay a head start over the nation's other estuaries in serving as a receptacle for industrial waste. By 1860, Rhode Island was the nation's most heavily industrialized state.

For over two centuries, a variety of pollutants from many sources have entered, and continue to enter, the Bay. Toxic chemicals and metals arrive in industrial waste discharges from jewelry factories, chemical companies, and textile mills. Rainwater washes oil and gasoline from streets and parking lots, as well as fertilizers and pesticides from farms and gardens, into storm sewers. Antiquated "combined sewage" systems in Providence and other towns channel storm drain runoff into the same water treatment facilities as domestic sewage, overloading the treatment plants so that inadequately treated sewage runs into the Bay during heavy rainfalls.

- Twenty-nine municipalities and 145 industrial users discharge wastes into Narragansett Bay.
- About 10 percent of the Bay's total freshwater input consists of treated sewage, which flows in at the rate of 310 million gallons per day.
- Levels of copper and nickel in the Providence River periodically exceed EPA water quality standards.

Sewage contamination of Narragansett Bay hurts the shellfishing industry. Shellfishing is prohibited in the most polluted waters because clams taken from these waters can carry bacteria and viruses, including those that cause gastroenteritis and hepatitis. About one-fourth of the Bay's total area, including the Providence River, all of Mount Hope Bay, and a number of small areas in the immediate vicinity of sewage treatment plants or marinas, is permanently closed to shellfishing, and an additional portion of the upper Bay is closed after heavy rains (Figure 5).

Pollutants can also overfertilize the Bay and cause eutrophication, a high nutrient/low oxygen condition that can kill seagrasses, fish, and shellfish. Inlets of the Bay where oxygen circulation is poor are particularly at risk for eutrophication.

It is no wonder that, after serving for so many years as a disposal site, the upper portion of Narragansett Bay is polluted with bacteria and chemicals. But there may be grounds for cautious optimism. Rhode Island Sea Grant researchers have found that the level of dissolved oxygen in the Providence River is increasing due to improvements to water treatment plants. Also, metal inputs at the Field's Point wastewater treatment plant, the largest facility discharging into Narragansett Bay, have decreased substantially since 1980. The levels of cadmium, chromium, copper, mercury, nickel, silver, zinc, and lead coming into the plant have all decreased because of waste pretreatment by industries, and, in the case of lead, the increasing use of unleaded gasoline.

#### **a. Oxygen**

Narragansett Bay Project research cruises demonstrated that the Providence area had the lowest levels of oxygen. During a fall Bay-wide cruise (1985-1986), oxygen fell below a critical level in the Fox Point area and immediately downstream of the Field's Point wastewater treatment facility. At all other times, the oxygen levels in the surface and bottom waters were above this critical level. Data from the 1986-1987 Providence River seasonal cruises showed the lowest average bottom water oxygen concentrations were again in the Fox Point area and may be partially attributable to discharges from the Field's Point wastewater treatment facility. The lowest seasonal oxygen levels occurred during the warmer months, and at times, the bottom waters were nearly depleted of oxygen.

#### **b. Nutrients**

Results from the 1985-1986 Bay-wide research cruises revealed that the majority of nutrients entering the Bay appear to do so via the Providence River. In fact, the Providence River area contributed 78 percent of the total nitrogen and 71 percent of the total phosphorus inputs to the Bay. Within the Providence River area (Figure 5), the Field's Point wastewater treatment facility was the

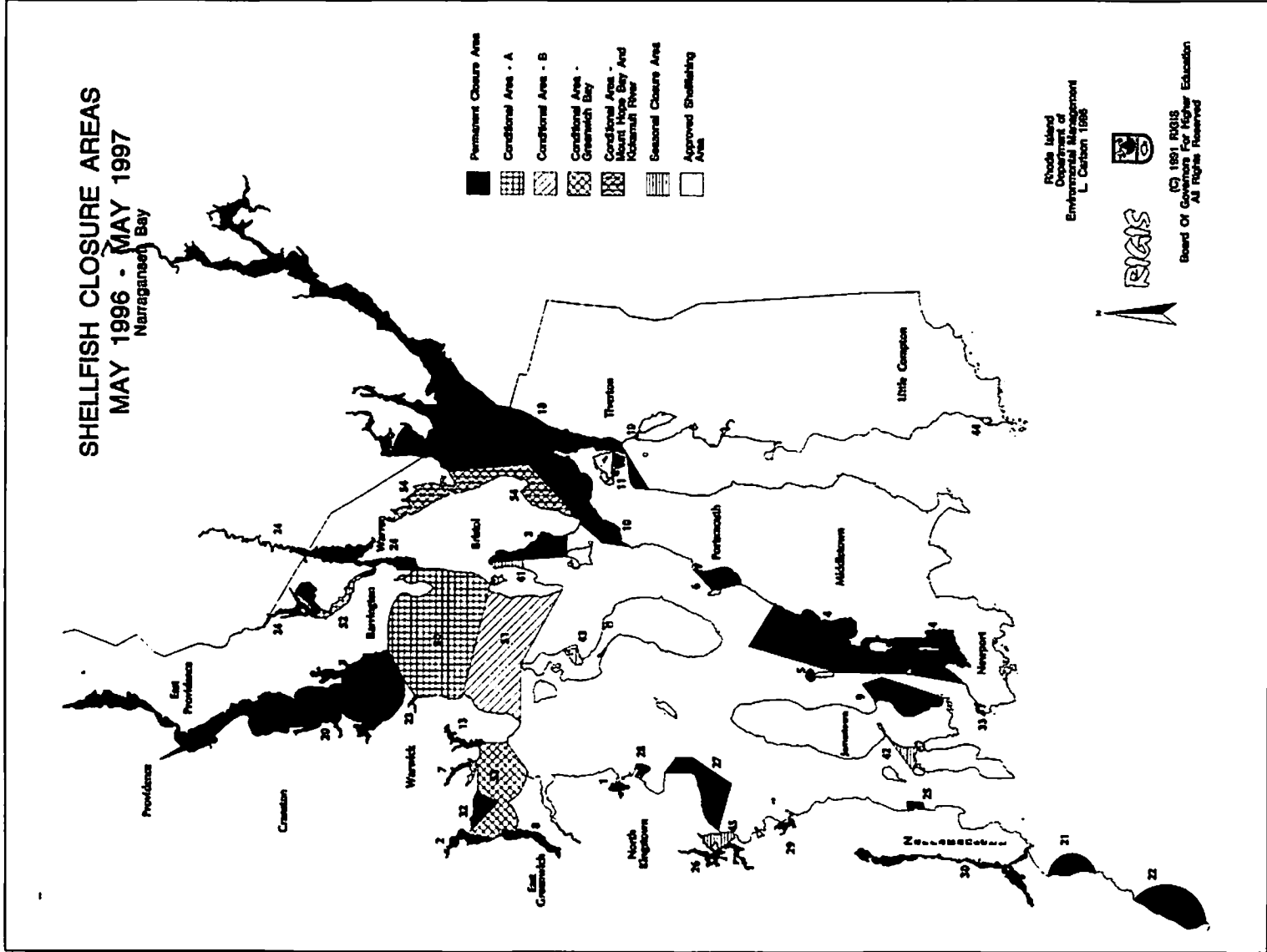


Figure 5. Shellfish closure areas in Narragansett Bay.



*Atmosphere deposition is also a significant source of organic pollutants to the estuary.*

major nitrogen source, while the Blackstone River was the major contributor of phosphorus. The surveys also showed that in addition to Field's Point, both the Blackstone and Pawtuxet rivers were sources of nitrogen to the Bay. The nitrogen levels in the Providence River area were high enough to indicate that eutrophic conditions could occur there, particularly in the summer months.

### **c. Suspended Solids**

Suspended solids are discharged into wastewater treatment facility effluents; many originate as soil particles transported by overland runoff. The bacterial breakdown of the organic matter associated with suspended solids may also lead to low oxygen levels in water. These particles may be a source of trace metals and organic pollutants, such as lead and PCBs, respectively. In addition, high amounts of suspended solids can lead to cloudy waters that can interfere with plant growth and oxygen production.

In general, Bay-wide research cruises showed that point sources contributed the greatest amounts of suspended solids to Narragansett Bay, with the Field's Point wastewater treatment facility being the largest contributor. Many wastewater treatment facilities exceeded the EPA suspended solids limit (although they were not in violation of their Rhode Island DEM permit levels), including the Newport, East Greenwich, Blackstone Valley, and Bristol facilities. The Blackstone River was another major contributor of suspended solids. Wastewater treatment facilities along the Blackstone River were the primary sources of suspended solids.

### **d. Trace Metals**

The Providence River and its tributaries were the major sources of metal entry into Narragansett Bay during dry weather periods. The major source of copper, nickel and chromium was the Providence Field's Point wastewater treatment facility, while the Blackstone River appeared to be the primary source of lead and cadmium. The high Field's Point pollutant contribution can be traced to the metal finishing industries it serves. High levels of lead and cadmium in the upper Bay appeared to be from nonpoint sources such as stormwater runoff.

Pollutants in the Blackstone River originate in both Rhode Island and Massachusetts. The Woonsocket wastewater treatment facility was the major Rhode Island point source of trace metals to this river. However, riverine inputs from waste originating in Massachusetts were significantly higher. Calculations showed that the Upper Blackstone wastewater treatment facility, serving Worcester, Mass., was responsible for 79 to 96 percent of the metals entering the Blackstone River from point sources in Massachusetts.

### **e. Organic Compounds**

The origin of organic pollutants in the Bay was attributable to both point and nonpoint sources. In the Providence River area, the amount and sources were found to fluctuate on a seasonal basis. Major point source contributors included Field's Point, Blackstone Valley, and Newport wastewater treatment facilities. The Blackstone River was the major source for various organic pollutants to Narragansett Bay. The largest amounts of point source organic compounds within the Blackstone River were from the Woonsocket wastewater treatment facility. However, in most cases, the organic pollutant loading from Massachusetts sources, like the trace metal inputs, were significantly greater than the Woonsocket wastewater treatment facility. In addition to the Blackstone River, the Taunton and Pawtuxet rivers were also major sources of organic contaminants to Narragansett Bay. Atmosphere deposition is also a significant source of organic pollutants to the estuary.





## **B. Reserve Setting**

### **1. Physical Setting**

#### **a. General Description**

Prudence Island is located in the center of Narragansett Bay. The closest mainland to the Island is Warwick Neck which lies 1.5 miles to the west of the northern tip of Prudence. Aquidneck Island, including the Town of Portsmouth, which has political jurisdiction over Prudence, Patience, and Hope islands, lies approximately 1.5 miles to the east.

The three islands within the Reserve total over 3,800 acres. The Reserve's holdings include 2,353 acres of upland and approximately 2,000 acres of surrounding waters. The remainder is in private ownership. The Reserve property is shown in Figure 3.

Prudence Island is just over 7 miles long and 1.39 miles at its greatest width. It is shaped somewhat like a whale. The main body of the Island is essentially a rocky spine with a thin overburden of unconsolidated rock and soil. The northern end, or tail, is primarily sand and gravel glacio-fluvial deposits. The highest point of land is 180 feet above sea level and is located 0.5 mile west of Sand Point on the eastern shore.

Prudence is home to upwards of 2,000 residents and visitors on a mid-summer weekend. This seasonal peak diminishes to as few as 200 in winter.

#### **b. Meteorology**

Rhode Island is in the north temperate zone with a climate moderated by the waters of Narragansett Bay and the Atlantic Ocean. The average annual temperature, measured at the T.F. Green Airport in Warwick, R.I., is 50.6°F. The coldest month is January at 29.5°F and 72.5°F in July being the highest average monthly temperature.

Prudence (as determined from a 24-year record for Bristol) has an annual rainfall of 38.10 inches. Monthly rainfall is generally uniform, but ranges from a high of 3.53 inches in January to 2.58 inches in July. Snowfall averages about 31 inches per year.

Winds are predominantly southwest in summer and northwest in winter. Major storms generally have winds from the easterly direction.

Hurricanes and tidal waves sometimes visit the coast. The most notable of these storms occurred in 1815, 1938, 1944, 1954, and 1991. These catastrophic events can be major agents of change to shoreline and living resources of the Reserve.

#### **c. Geology**

The general geology of Prudence Island is described in the U.S. Geological Survey Geologic Bulletin No. 7, U.S. Geological Survey Bulletin 1295, *Bedrock Geology of Rhode Island* and U.S. Geological Survey Ground Water Map 20 (1925). Prudence Island is underlain by bedrock of the Rhode Island Formation classified as pre-Pennsylvanian and Pennsylvanian, an ancient sedimentary sequence of rocks over 200 million years old. These rocks include gray to dark gray, fine to coarse-grained sandstone and lithic graywacke, dark to black shale, conglomerate and meta-anthracite coal. The bedrock has cross-bedding and irregular discontinuous beds with plant fossils in some places. The rock surface is very irregular and displays considerable folding and foliation. Outcrops are seen along the coastline.

The rock is covered by a thin discontinuous blanket of unconsolidated glacial deposits from the last Ice Age, known as the Wisconsin Glaciation. This period of ice cover ended in southern New England about 12,000 years ago. At that time, sea level was 300 to 400 feet lower than present and Prudence Island was part of the mainland. However, sea level rose rapidly after the departure of the ice and by 3,500 years before present it was within 10 to 20 feet of where it is today. As the ice melted, the soil and rock contained in the ice was deposited on the bedrock as a highly heterogeneous mixture known as till. In some instances the meltwater from the glacier carried the soil and rock with it and deposited it as glacio-fluvial deposits, a relatively well-sorted and permeable deposit of sand and gravel. On Prudence Island the dominant ground cover is till, generally a much less permeable material. There are some deposits of glacio-fluvial material identified on the north end of Prudence Island.





*Prudence Island lighthouse at Sand Point overlooks the east passage of Narragansett Bay.*

The topography of Prudence Island is shown on U.S. Geological Survey topographic maps of the Prudence Island Quadrangle (photo revised 1975) and the Bristol Quadrangle which was photo revised in 1970. Prudence Island is composed of two parts, a main south part of about 350 acres and a smaller north part of about 150 acres connected by a low-lying strip dominated by salt marsh. Both the north and south parts of the island are rugged terrain marked with well-defined drainage depressions and swamps. The area is largely forested.

Hope Island is 94 acres in size and is located south of Patience Island and west of south Prudence. The topography is very irregular with frequent ledges and bedrock outcrops. The maximum elevation is 60 feet. The shoreline is steep and rocky. The bedrock is part of the Rhode Island Formation. It is Pennsylvania-age slate, siltstone sandstone and conglomerate, highly metamorphosed rock. The thin soils are extremely rocky, fine grained, sandy loam derived from glacial till. The island was occupied in World War II by the U.S. Navy as an ammunition depot. There was much construction activity that disturbed the original environments. Even today, remnants can be found of roads, bunkers, docks, electrical lines, and other facilities left by the Navy when the state acquired title in 1975.

Patience Island, by contrast, is primarily second-growth with only several small areas previously occupied. The island is 204 acres and lies immediately to the west of Coggeshall Cove on Prudence. It is separated from Prudence by a narrow channel approximately 200 to 500 feet wide and a maximum of 13 feet deep at low tide, though most of the waters are shallow, less than 4 feet in depth.

The northeastern third of Prudence 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 deposited after the glacier receded. These are dry soils with a depth of up to 4 feet overlying the richer loam beneath.

#### **d. Hydrology**

The source of fresh water on Prudence Island (also on Hope and Patience islands) is local precipitation. The rain or snow leaves the Island as flowing surface water, evaporates, or infiltrates into the ground to provide the available water supply for the Island's population. The Mill Creek watershed comprises about 332 acres and is withdrawn for public use by the Prudence Island Utility Corporation at Indian Spring. This spring currently provides approximately 80 percent of all the domestic water used over the annual cycle. Two small streams, Mill Creek and South Creek, empty into the Bay throughout the year. There are numerous other seasonal streams which cease to flow in the dry summer months.

There is little surface fresh water, other than streams and swamps, with only four permanent ponds, the largest being several acres in size.

Two major freshwater swamps are Crow's Swamp southeast of Prudence Park and Schoolhouse Swamp in the center of the Island, which contains the origin of Mill Creek. The hydrography of the Reserve is given in Figure 6.



## Surface And Groundwater Resources In The Narragansett Bay Research Reserve

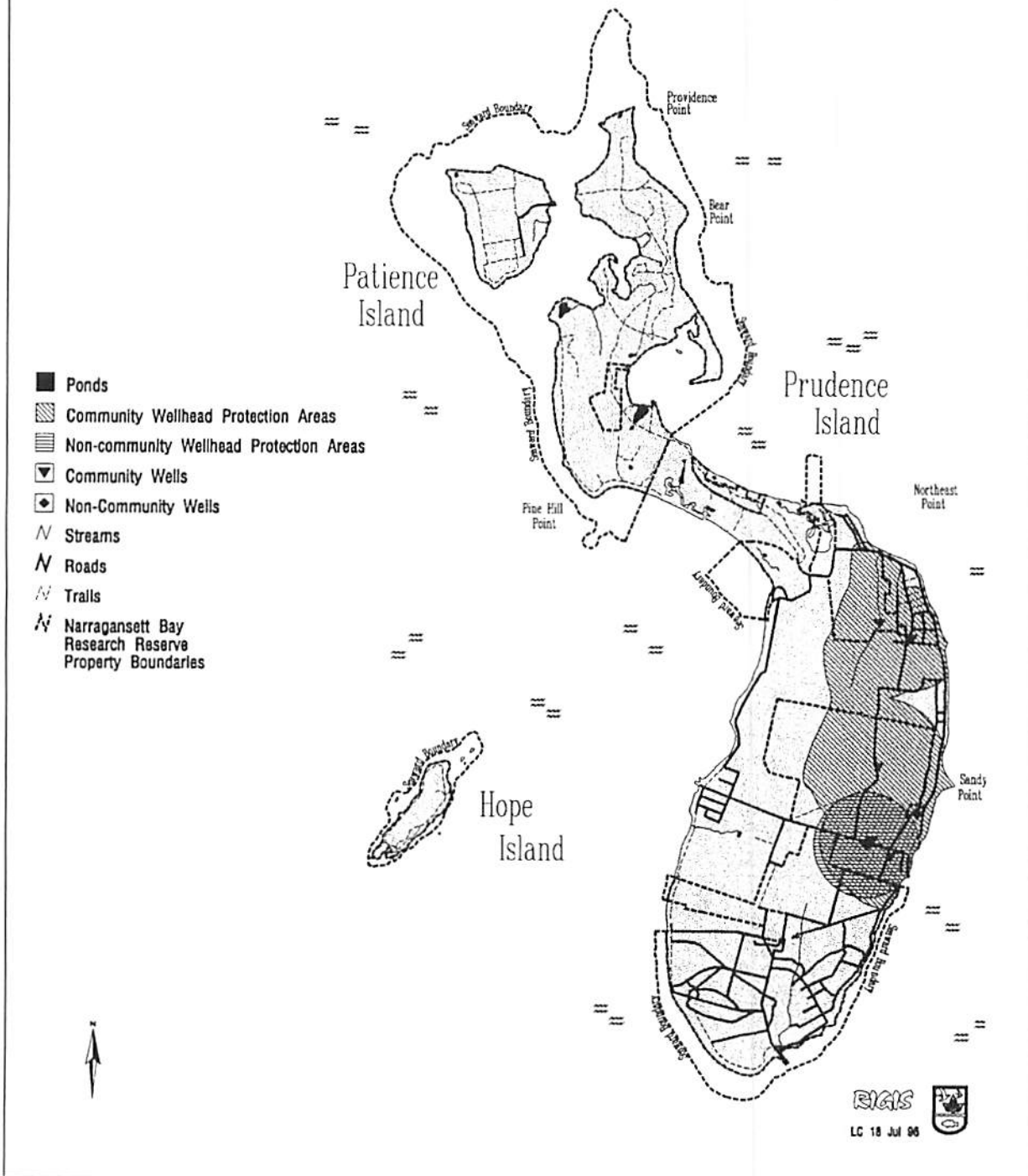


Figure 6. Hydrography in the Narragansett Bay Research Reserve.



The estuarine intertidal shore supports a population of soft clams (*Mya arenaria*), other small worms, molluscs, and crabs.

## 2. Habitats & Biota

The Narragansett Bay NERR is totally within the mid-Bay subsystem of the Narragansett Bay estuarine polyhaline ecosystem. It contains a wide diversity of habitats within the subsystem and includes estuarine, palustrine, and upland areas. There is a variety of wetland types, both palustrine (buffer areas) and estuarine (core areas). It is emphasized that these habitats are components of the larger Narragansett Bay ecosystem and strongly influenced by the dynamic, open system through which many species migrate or reside.

### a. Representative Ecosystems

The NBNERR site consists of a variety of ecosystems and habitat types based on the NERR System ecosystem typology classification scheme. These include:

- Group IA3 Shorelands  
Maritime forest - woodland  
Temperature deciduous forest biome  
*Example:* Prudence Island Heritage unit
- Group IB1 Shorelands  
Coast shrublands  
Northern species  
*Example:* Patience Island, North Prudence unit
- Group IE Shorelands  
Coastal cliffs  
*Example:* South Prudence unit, Hope Island
- Group IIA Transition areas  
Coastal marshes  
*Example:* Prudence Island, Little unit
- Group IID Intertidal beaches  
*Example:* North Prudence unit
- Group IIE Intertidal mud and sand flats  
*Example:* North Prudence unit
- Group IIF1 Intertidal algal beds  
Northern latitude rocky shores  
*Example:* South Prudence unit, Little unit
- Group IIIB Submerged bottoms  
Subtidal soft bottoms  
*Example:* North Prudence unit
- Group IIIC Submerged bottoms  
Subtidal plants  
*Example:* South Prudence unit

### b. Estuarine

The surrounding Narragansett Bay ecosystem is polyhaline with salinity ranging from 16 to 32 parts per thousand. The Reserve ecosystem is divided into two parts; the estuarine sub-tidal and estuarine intertidal.



The estuarine sub-tidal system supports a rich and varied flora and fauna. It consists of the waters below mean low water surrounding the Prudence, Patience, and Hope islands totaling approximately 2,000 acres as shown in Figure 3. Narragansett Bay is considered to be a phytoplankton dominated system. The waters adjoining the Reserve are relatively deep and phytoplankton is the major contributor to primary production. However, microphytobenthos, macroalgae, and halophytes (*Spartina* community) are also significant producers. There are two small eelgrass (*Zostera marina*) beds in Reserve waters.

The zooplankton community in the subtidal zone is similar to other open water coastal areas in the Northeast and is comprised mainly of two species of copepods, *Acartia tonsa* and *Acartia hudsonica*.

The subtidal waters also support a diverse benthic community of indwelling molluscs, crabs, and worms. The northern quahaug (*Mercenaria mercenaria*) is the most commercially important species with a smaller fishery for the American lobster (*Homarus americanus*). Mussels (*Mytilus edulis*) are abundant in shallows along the east shore of Prudence Island and along the Hope Island and Patience Island shores with subtidal hard substrates.

The estuarine intertidal sandy shore supports a population of soft clams (*Mya arenaria*), other small worms, molluscs, and crabs.

Salt marshes are found in the North Prudence, Barre and Little units and on the east shore of Patience Island. There are extensive monotypic stands of smooth cordgrass (*Spartina alterniflora* and *Spartina patens*). These emergent wetlands are influenced by the adjoining Bay rather than landward processes. They are laced with irregular creeks, ponds, potholes, and man-made drainage ditches.

Prudence Island has five major marshes totaling 600 acres. A small marsh area of about 10 acres is found on the east shore of Patience. These salt marshes are characterized by two general vegetative zones based on differences in tidal flooding: (1) regularly flooded low marsh, and (2) irregularly flooded high marsh.

In the low marsh, vegetation is dominated by a single plant, the tall form of the smooth cordgrass (*Spartina alterniflora*) typically 3 to 6 feet high. The high marsh by contrast is a mosaic of species, the occurrence of each being precisely determined by the elevation and resultant periodic flooding. These marshes are characterized by the short form of the smooth cordgrass (*Spartina patens*) spike grass (*Distichlis spicata*), glassworts (*Salicornia* spp.), sea lavender (*Limonium nashii*), salt marsh aster (*Aster tenuifolius*), black grass (*Juncus gerardii*) and hightide bush (*Iva frutescens*).

Pools and tidal creeks of the salt marsh are vegetated with widgeon grass (*Ruppia maritima*), with sea lettuce (*Ulva lactuca*), and other macroalgae.

The major values of the marshes are both in providing a beneficial, sheltered habitat for key resource species and as a major food source. This food is in the form of decomposing plant material, or detritus. Detritus is the base of an aquatic food web supporting higher consumers and commercial species. Animals such as shrimp, snails, clams, worms, and killifish consume the plant breakdown products or graze upon bacteria, fungi, diatoms, or protozoa growing on the surfaces of detritus. Forage fish (anchovies, silversides, sticklebacks) and small invertebrates (grass shrimp, worms) then are consumed by commercial and recreational fish species, including winter flounder, striped bass, and bluefish.

### c. Palustrine

A diversity of palustrine wetland communities is represented in the South Prudence, Heritage, and Barre units. There are large areas of deciduous forested wetlands, numerous small creeks, and several small ponds. The forested wetlands are dominated by red maple (*Acer rubrum*) and swamp white oak (*Quercus bicolor*) with an undergrowth of high bush blueberry (*Vaccinium corymbosum*), winterberry (*Ilex* spp.), skunk cabbage (*Symplocarpus foetidus*), and various mosses and grasses.

### d. Uplands

Most of Prudence Island, Hope Island, and Patience Island were extensively farmed in the 1700s and early 1800s. The land has since reverted to second-growth except for residential areas along the eastern shore, Prudence Park on the Island's west side, and larger sections of the former



The most ubiquitous bird species are the herring and great black-backed gulls.

U.S. Navy Base which occupied what is now the southern portion of the Reserve. These areas have been repeatedly disturbed by man's activities, including residential and recreational use.

The Prudence Island upland habitats are divided equally between scrub-shrub and forested areas.

The scrub-shrub habitats are dominated by woody vegetation less than 18 feet tall including sapling trees, tree shrubs, brambles, briars, and vines. Common species of saplings are red maple (*Acer rubrum*), black cherry (*Prunus serotina*), and staghorn sumac (*Rhus typhina*). Shrubs include northern arrowwood (*Viburnum recognitum*), Bayberry (*Myrica pennsylvanica*), highbush blueberry (*Vaccinium corybosum*) with common subordinates including greenbrier (*Smilax rotundifolia*), sumacs (*Rhus* spp.), blackberry (*Rubus allegheniensis*), and poison ivy (*Toxicodendron radicans*). The scrub-shrub habitats are found at Hope Island (90 percent of the vegetated cover), Patience Island along the shore and the interior except for several small forested patches, and the North Prudence, Heritage, Prudence Conservancy and South Prudence units.

Forested uplands on Prudence Island are found covering most of the Barre, Heritage, and Prudence Conservancy units on Prudence Island and several large areas at South Prudence. Patience Island has only several small patches of forest. Hope Island has none. The forests consist of old second growth forests, dominated by oaks (*Quercus* spp.) and black cherry (*Prunus serotina*), with occasional red maple (*Acer rubrum*), locust (*Robinia pseudo-acacia*), and apple trees (*Pyrus malus*). Some areas are characterized by a dense undergrowth of arrowwood (*Viburnum* spp.), Bayberry (*Myrica pennsylvanica*), and bittersweet (*Cylosterus orbiculatus*), crisscrossed by the remnants of old stone walls. Areas that have more recently regrown from cleared land often have a growth of sumac (*Rhus* spp.) and greenbrier (*Smilax* spp.).

#### e. Biota

##### 1) Threatened and Endangered Plants

Uncommon species include the golden aster (*Pityopsis falcata*) which has been found growing on a sandy embankment overlooking the kettlehole pond at North Prudence. 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 (*Hudsonia tomentosa*). This is only the fifth recorded site for golden aster in Rhode Island and 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 Reserve that is of particular interest. A liverwort (*Ricciocarpus* sp.) was found during a preliminary survey of the freshwater wetlands at North Prudence.

##### 2) Amphibians and Reptiles

There are two amphibian species of special concern within the Reserve. The four-toed salamander (*Hemidactylium scutatum*; "Concern," Massachusetts and Rhode Island) possibly may be found in brackish marshes. It is recorded from Conanicut Island and Prudence Island (Raithel, personal communication). The northern leopard frog (*Rana pipiens*; "State Interest," Rhode Island) has been found in Narragansett Bay salt marshes. Other amphibians include: Fowler's toad (*Bufo woodhousii*), which has been found on Prudence Island (Enser, personal communication); the common northern spring peeper (*Pseudacris crucifer*), which has been found in brackish waters, and can be found anywhere on the Bay islands where there is fresh water; and the bullfrog (*Rana catesbeiana*), which also can be found in brackish marshes (Raithel, personal communication). All the above amphibians species are more common in freshwater or terrestrial habitats.

Some reptiles are tolerant to salt water; several species of turtles may be found in Bay waters. The only truly marine reptiles recorded from Narragansett Bay are the sea turtles: the loggerhead (*Caretta caretta*; "Federally Threatened"), the leatherback (*Dermodochelys coriacea*; "Federally Endangered"), the Kemp's ridley (*Lepidochelys kempii*; "Federally Endangered"), and the green turtle (*Chelonia mydas*; "Federally Threatened") may be found very rarely as wanderers into the Bay. The diamondback terrapin (*Malaclemys terrapin*; "State Threatened," Rhode Island and Massachusetts)





breeds in protected salt or brackish waters in the upper Bay. The spotted turtle (*Clemmys guttata*; "Concern," Massachusetts) may be found in both salt and brackish marshes of the Bay (Raithel, personal communication), but is not common in these habitats, being found more frequently in acid bogs (Shoop, personal communication). The common snapping turtle (*Chelydra serpentina*) is common in Bay waters.

Several species of snakes may be found hunting for prey on the upper edges of salt and brackish marshes, and the eggs of one species, the eastern green smooth snake (*Opheodrys vernalis*), have been found in the *Iva* zone of a salt marsh on Prudence Island (Raithel, personal communication). The eastern hognose snake (*Heterodon platyrhinos*; "Concern," Rhode Island) is also considered possible in the upper marsh (Raithel, personal communication).

### 3) Mammals

The largest mammal on Prudence Island is the white-tailed deer (*Odocoileus virginiana*). The Island supports the densest white-tailed deer herd in New England, numbering approximately 600 at fawning time in the spring. The early successional vegetation at the north and south ends 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 4 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. The Rhode Island Wild Plant Society conducted a qualitative survey of the flora on the Prudence Conservancy unit. The conclusion was that deer browsing had resulted in a significant reduction of plant species observed.

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

The deer tick (*Ixodes dammini*) has been found on Prudence Island's white-tailed deer, raccoon, eastern cottontail rabbit, white-footed mouse (*Peromyscus leucopus*), domestic dog (*Canis familiaris*), and humans. These ticks can carry Lyme Disease, and in fact, some people on the Island have contracted this disease. People leaving the trails to go through brushy areas are more likely to come into contact with the deer tick.

Mammals that visit the marshes to feed on shellfish, bird eggs, vertebrates and invertebrates are red fox, raccoon, and skunk (*Mephitis mephitis*). Feral cats are abundant bordering human populated areas.

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

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

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*).

### 4) Birds

Surveys of primarily maritime birds have been conducted for many years on the islands that comprise the Narragansett Bay Research Reserve. A publication documenting the colony and beach-nesting maritime birds of Rhode Island is in preparation. In 1990, a survey of upland breeding birds on Prudence and Patience islands was completed and is part of the Breeding Bird Atlas published by the Rhode Island Natural Heritage Program.



The marshes of North  
Prudence provide  
opportunities for hunting  
water fowl over a two week  
period during the fall.

The maritime bird group includes the species listed below. The listing includes species and nest counts for 1992 (II B.2b Section 4 Prepared by: James E. Myers, DFW, Wildlife Section).

#### Nest Count–Hope Island

Herring gull	237
Black-backed gull	72
Glossy ibis	31
Great egret	22
Snowy egret	5
Little blue heron	0
Cattle egret	0
Black-crowned night heron	280
Oystercatcher	2 pr
Canada goose	12 pr
Double-crested cormorant	72

#### Nest Count–Little Gooseberry

Cormorant	138
Black-backed gull	12

#### Nest Count–Despair Island

Common tern	5
-------------	---

#### Nest Count–Prudence Island

Least tern	0
------------	---

Most of these species utilize islands adjacent to Prudence, which are Hope, Despair, and Little Gooseberry, for nesting. The adjacent fresh water, salt marshes, and upland fields in the towns of Portsmouth, Middletown and Jamestown are used for feeding.

All the species except for some species of *Anatinae* (mallards and black ducks) are migratory.

The most ubiquitous species are the herring and great black-backed gulls. Presently the fastest expanding species is the double-crested cormorant.

The cormorant numbers on Little Gooseberry, adjacent to Hope Island, have increased over 450 percent from 1988. These birds have since colonized Hope Island which has experienced almost a 900 percent increase between 1991 and 1993. Cormorants not only compete for nesting space of most other colonial species, but also through their highly acidic excreta, cause the death of the soil protecting plant rootlets. Once the roots holding the soil on these island rocks are rendered useless, sloughing through weathering will occur and result in a rock island habitat suitable for cormorant and gull nesting only.

Hope Island, by the late 1970s, was home to one of the largest and most diverse wading bird colonies in the Northeast. A major decline occurred in the early 1980s (823 percent reduction in colony bird nests, 1978 to 1987) when a family of red fox was placed on the island. Documentation of the effect of predation on this colony is in preparation.

The Hope Island habitat classes are composed of 62 acres scrub-shrub, 8 acres forest, 12 acres herbaceous, and 8 acres unvegetated. The island had been burned periodically in the 1970s to improve the rabbit habitat. Burning has not occurred recently and increases in shrub and woody vegetation has caused a decline in gull nesting habitat while not affecting the colonial nesting areas.





Despair Island is a low-lying island about 2 meters above high tide and 50 square yards. Common terns have been recorded nesting here (one to 20 nests since 1983).

Prudence Island and Patience, although good nesting habitat, have not proven good sites for either ground or tree nesting colonial birds since the 1930s. The number of raccoon, fox, mink, stray cats, and dogs have generally precluded any colony formation.

The Potter Cove point of Prudence has been a nesting site for the least tern and a loafing site for the oystercatcher; however, the accessibility for raccoon and mink to this sand spit have rendered this site unsuitable for ground nesting species.

The Prudence Island habitat has been described in other portions of the text. A survey of birds conducted by Enser in 1990 indicated that there were 69 species of birds considered breeding during the period June 5-8 of that year.

Patience is a 205-acre island approximately 200 yards to the west of Prudence and therefore shares the same avifauna as Prudence. Raccoons appear to be the limiting factor to colonial nesters and, although the habitat is suitable, no major nesting of other than passerine birds has been noted in the last 20 years.

Nesting sites for osprey are available on Hope, Patience and Prudence islands. Their nesting has not been reported since the late 1950s. It was reported that, in 1748, the species may have been as numerous as any time in the 20th century and closely protected by the farmers. Three nests near Potters Cove were found on Prudence in 1891 and again in 1894. This indicated continued nesting but at greatly reduced numbers. There were 13 and 18 nests respectively, again in the Potters Cove area of Prudence in 1942 and 1946. These appear to be the last records prior to the Northeast population crash in the 1950s (from R.L. Ferren, *Birds of Rhode Island*, in preparation).

## **5) Aquatic Components**

### **a) Eelgrass**

Eelgrass is considered a critical habitat species in the estuarine ecosystem. Eelgrass detritus can be a significant component of the food web. The underwater fronds slow down the water flow and provide a breeding ground and nursery for associated fishes and invertebrates. The root system stabilizes sediments, and eelgrass beds are extremely valuable to the health and productivity of the estuary. Unfortunately, declining water quality and disease have decimated the once extensive East Coast beds.

In Narragansett Bay, eelgrass beds have dramatically declined. Major beds have been lost along the east and north shores of Prudence Island and also in the Potter Cove area. A remnant of a once extensive bed persists west of the Sheephead Marsh along the Prudence shore. The largest bed in the mid-Bay region is found along a 0.25 mile stretch at the southeast end of Prudence. Improving water quality may support the restoration of lost, once lush beds.

### **b) Macroalgae**

Narragansett Bay is considered a plankton-based system relative to primary production. However, macroalgae in the Reserve waters is a significant contributor to primary production. The marshes, shallow nutrient-rich waters, and stable substratum for macroalgal attachment provide a system where a significant percentage of primary production can be attributed to macrophytes.

The first comprehensive study of seaweeds in Narragansett Bay was done in 1991. The study was funded by the Narragansett Bay Project as part of a habitat survey and resources inventory. In general, the Bay is typical of the north temperate, Virginian province estuary. In comparison to estuaries north of Cape Cod, there are fewer species but a larger proportion of tropical species. In this study, seasonal sampling was done at intertidal and subtidal stations throughout the Bay. Permanent stations were established at 10 locations and another 54 stations were covered in a June 1990 broad scale survey. Two of the permanent stations, Dyer Island and Colt State park, are in the mid-Bay region in close proximity to Prudence Island. At Colt State park, 23 species in four phyla were found in the intertidal zone with 23 species in three phyla in the subtidal region. Dyer Island, by contrast, had 44 species in four phyla intertidally and 26 species in four phyla in the subtidal areas. The difference can be attributed to the presence of sandy beaches, as well as cobble and rocky shores, providing more diverse habitats for the macroalgae. Of the Dyer Island species,



The blue shell crab is a frequent visitor in the summer months.

probably quite similar to Prudence Island in habitat types, most species were ephemeral in occurrence with only seven found in all four seasons of the year. These perennial species included *Codium fragile*, *Ulva lactuca*, *Enteromorpha intestinalis*, *Fucus vesiculosus*, *Ralfsia verrucosa*, *Chondrus crispus*, and *Hildenbrandia rubra*.

### c) Phytoplankton

Narragansett Bay as a whole is considered to be a phytoplankton-based ecosystem. There are exceptions to this rule in discrete embayments and other shallow segments of the Bay where macrophytes play a more important role.

The annual abundance pattern of phytoplankton is quite variable from year to year. This inter-annual variability makes it statistically difficult to discern long-term patterns in abundance data available for the past 35 years.

Data do not show any major species shifts in phytoplankton within the last 35 years. However, the number of minor species has increased over that period. The occurrence of a "brown tide" in 1985 where a single picoplankton heterotrophic species dominated the Bay-wide flora over a six-week period is cause for concern as a possible manifestation of stress and instability of the natural system.

The annual cycle in phytoplankton is divided into four natural phases:

1. Winter and early spring — diatoms dominant
2. Late spring to early summer — flagellates dominant
3. Late summer — diatoms dominant
4. Fall — flagellates dominant

This general pattern is quite variable, however, with the time of seasonal occurrence, species composition, and abundance differing greatly from year to year and by regions within the Bay.

*Skeletonema costatum* is the dominant diatom with *Detonula confervacea*, *Asterionella glacialis*, and *Thalassiosira nordenskiöldi* also important. Flagellate species of importance include *Olisthodiscus luteus*, *Katodinium rotundatum*, and *Prorocentrum redfieldii*, along with smaller species such as *Gymnodinium* spp.

The yearly integrated phytoplankton primary production in the mid-Bay region averages 323 grams carbon per square meter per year. This is within the range found for the Hudson River and Delaware Bay but lower than Chesapeake Bay primary production.

### d) Zooplankton

Previous studies of the zooplankton community over the time span 1950-1987 have indicated a basic pattern over the years, changing seasonally in response to temperature, food availability, and predation. The range of Narragansett Bay temperatures varies widely from 0 C to 24 C resulting in a strong seasonality in the occurrence and abundance of species. Two copepods dominate numerically and in biomass, *Acartia hudsonica* which is present in the colder months and *Acartia tensa* found in late spring to early fall. These two species contribute about 50 percent of the mean annual total zooplankton biomass in Bay waters of the Reserve. Other copepod species, with the exception of *Oithona* sp., never reached more than 1 percent of the mean zooplankton numbers. Additional numerically important seasonal members of the zooplankton community were bivalve and polychaete larvae, rotifers and the cladoceran, *Podon polyphemoides*.

Zooplankton biomass in dry weight was found to be somewhat higher at mid-Bay stations than those in the upper and lower regions. The most productive station sampled in the Bay was in the Reserve area about mid-way between Patience Island and Hope Island, with a biomass of 58.2 mg/m<sup>3</sup>.

Predators have a major role in controlling zooplankton abundance in the Bay, especially during the summer and fall. The large ctenophore, *Mnemiopsis leidyi*, is a voracious feeder on zooplankton and has the greatest impact during peak summer temperatures in July and early August. Other predators are the planktivorous fishes, notably the Menhaden, *Brevoortia tyrannus*.

There is a strong linkage between the occurrence and abundance of zooplankton and phytoplankton availability. Both undergo strong seasonal patterns, with the survival of the zooplankters also dependent on the abundance of phytoplankton in specific size ranges suitable as food.



### e) Benthos

The distribution of benthic communities in Narragansett Bay is influenced by a north-south salinity gradient and waterborne contaminants largely originating in the upper Bay urbanized areas.

In the mid-Bay region two major communities are found. In deeper waters with fine grained, loose sediments and higher salinities, a deposit feeding assemblage is found dominated by two clams, *Yoldia limatula* and *Nucula proxima*, and *Nephtys incisa*, a small worm of up to 8 cm (3 inches) long. Average densities are reported as 7,000 to 9,000 individuals per square meter with a standing crop of approximately 8 grams per square meter. The second major community is found at shallower depths in sand and silt sediments. This assemblage is dominated by a small tube dwelling crustacean, *Ampelisca* sp. These animals exist in soft, gummy, grey-brown tubes several centimeters long and carpet the bottom at densities up to 30,000 per square meter.

There are extensive intertidal and shallow water blue mussel (*Mytilus edulis*) beds around Prudence Island with the greatest concentration along the entire eastern coast. Mussel beds are also found along the west side areas with rocky shores. The mussels grow to such densities that they crowd in on one another and deplete the overlying water column of food and dissolved oxygen during periods of the highest annual water temperatures in the Bay. The subsequent die-off results in windrows of dead and dying mussels lining the beaches in late summer.

Another prolific species in intertidal and shallow areas is the slipper shell or decker, *Crepidula fornicata*. Individuals settle on hard substrate and on the original colonizers. These stacks of *Crepidula* often carpet every available hard surface on the bottom, forming extremely dense patches.

The quahaug, *Mercenaria mercenaria*, is the most prolific shellfish throughout the Bay. Harvesting of quahaugs is the most important commercial fishery in Rhode Island waters. This filter-feeding organism is found in virtually every part of the Bay, even in the heavily polluted waters of the upper Bay. The total harvest reached a peak of 5 million pounds of meat in 1955. The harvest has declined in recent years and there is concern about over harvesting this once limitless resource.

Another commercial benthic species is the American lobster, *Homarus americanus*. In the late 1970s, this species was cause for concern with sharply declining stocks. Presently, this fishery is in good shape, producing historic high catches. The species is found mainly in the lower Bay region and inhabits the benthic community around the south end of Prudence in both the east and west passages.

### f) Finfish

Narragansett Bay is a valuable spawning and nursery ground for many species of fish. The high primary productivity and rich benthos provides ample food. The diversity of fishes in the Bay is enhanced by the seasonal changes typical of north temperate estuaries. Populations of many species migrate in and out of the Bay according to well-established seasonal cycles, while others are year-round residents. In total, over 100 species may occur in any given year, half of which are occasional visitors.

A year-long Bay-wide survey indicated a standing crop of 117 individuals or 28.5 pounds per acre. This is equivalent to 1.9 million pounds of bottom fish and is comparable with estimates in other New England estuaries.

Until recently, the bottom dwelling fish community was dominated by the winter flounder, *Pleuronectes americanus*, representing approximately 36 percent of the total catch. This was the most valuable commercial finfish in Narragansett Bay. Important spawning and nursery grounds for the flounder are found in the waters around north Prudence and Patience islands. However, the population of winter flounder in Narragansett Bay has declined dramatically Bay-wide as a result of overfishing. It will take years of careful management to re-establish this species at high levels. Nursery areas within the Reserve may be important for the recovery of this species. Other benthic fish in Narragansett Bay include scup, tautog, cunner, sea robin, and sculpin.

There are fewer pelagic species of fish compared to bottom dwellers. These mid-water fishes are more seasonal in occurrence and several important species migrate over a large area of the East Coast. Commercially and recreationally important species include the bluefish, *Pomatomus saltatrix*, and the striped bass, *Morone saxatilis*. Menhaden occur sporadically in the Bay, being absent in



A white-tail deer bow hunting program has been conducted in designated areas on Prudence Island since the 1970s.

some years and incredibly abundant in others. The annual commercial catch in the Bay has reached as high as 23 million pounds.

The Bay is a valuable spawning, nursery, and feeding ground for a diverse array of estuarine fishes. The sheltered, shallow embayment and productive marshes of the Reserve are critical habitats for the survival and well being of the major commercial and sport species dependent on the Bay. Despite the protected habitats and improving water quality, especially in the upper Bay, recent years have seen a cataclysmic decline in winter flounder and a disturbing decrease in tautog. This is being attributed to overfishing.

Commonly occurring species in the shallow waters and marshes of the NBNERR are indicated in Table 3.

**TABLE 3**

**Common and Scientific Names of Marine Finfish in the Narragansett Bay National Estuarine Research Reserve**

(from Satchwill, Turano, and Sisson, DFW)

Dogfish Uncl.	
Blueback Herring	<i>Alosa aestivalis</i>
Atlantic Menhaden	<i>Brevoortia tyrannus</i>
American Plaice	<i>Hippoglossoides platessoides</i>
Summer Flounder	<i>Paralichthys dentatus</i>
Winter Flounder	<i>Pseudopleuronectes americanus</i>
Atlantic Silverside (and Waxen)	<i>Menidia spp.</i>
Three Spine Stickleback	<i>Gasterosteus aculeatus</i>
Northern Pipefish	<i>Syngnathus fuscus</i>
Hogchoker	<i>Trinectes maculatus</i>
Atlantic Bonito	<i>Sarda sarda</i>
Butterfish	<i>Peprilus triacanthus</i>
Bluefish	<i>Pomatomus saltatrix</i>
Striped Bass	<i>Morone saxatilis</i>
Scup	<i>Stenotomus chrysops</i>
Weakfish	<i>Cynoscion regalis</i>
Tautog	<i>Tautoga onitis</i>
Oyster Toadfish	<i>Opsanus tau</i>
Northern Puffer	<i>Sphaeroides maculatus</i>
Bigeye Scad	<i>Selar crumenophthalmus</i>
American Eel	<i>Anguilla rostrata</i>
Atlantic Tomcod	<i>Microgadus tomcod</i>
Striped Killifish	<i>Fundulus majalis</i>
Four-Spine Stickleback	<i>Apeltes quadracus</i>
Lined Seahorse	<i>Hippocampus erectus</i>
Crevalle Jack	<i>Caranx hippos</i>
Common Mummichog	<i>Fundulus heteroclitus</i>





### 3. Cultural Aspects

#### a. Early Historic Occupation

Archeological evidence suggests that Native Americans frequently visited Prudence and nearby Patience and Hope islands for some 8,000 years prior to white settlement of the islands. These pre-colonial occupants probably utilized the island on a seasonal basis taking advantage of the rich natural resources for fishing, hunting, farming, and the gathering of nuts and berries. The Indians named the large island (Prudence) as Chippaquissett and it was occupied by the Wampanoags from nearby Massachusetts, then the Narragansetts from the west Bay. Chippaquissett was home to 400 to 500 natives before colonial occupation. The first white men with claims to Prudence were Roger Williams and then Massachusetts Governor John Winthrop, who purchased the island in 1637 from the Narragansetts.

The settlement of Prudence began with the establishment by Roger Williams of a stock farm for goats and pigs. The Island had rich soil and was well situated in the middle of Narragansett Bay. Nearby markets on the mainland could be easily reached by a journey of a mile or less by water. The settlement and farming became the primary use of the island. At the start of the Revolutionary War, the island was divided into 15 owner-occupied farms and over 50 percent of the land was under cultivation or in pasture. The British dealt harshly with the island inhabitants and by war's end all but one of 15 farms had been burned and crops and cattle stolen. Most people fled the island during the British invasions and few returned thereafter. There was a resurgence of farming during the following period of peace and calm. However, most farms were operated by tenant farmers. These tenants were careless about the use of the land and eventually depleted the goodness of the soil. The water bridge to the mainland now became more of a barrier as land transportation superseded water transport for people and products. Eventually, by the mid-1800s, farming had declined to only several working farms.

In the late 1800s, Prudence was being promoted as a summer resort for Providence merchants and other well-to-do individuals. This started a new industry of tourism that resulted in several summer colonies and room and board inns scattered across the island. A period of prosperity and intense summer use continued until the economic crash of the 1930s.

Tourism remains as the principal industry on Prudence. There are approximately 450 dwellings on the Island. Summertime population can reach over 2,000 on a weekend including seasonal residents and day-trippers. There are 200 year-round residents. There are mostly retirees with about 20 commuters to jobs on the mainland and an equal number working on the island.

Prudence Island is served by a car-passenger ferry with a capacity of 150 people and nine vehicles. The ferry runs a minimum of four trips daily with additional trips on summer weekends when the boat is often at capacity.

Patience Island is virtually uninhabited with one seasonal residence. Hope Island has no human inhabitants.

Today tourism is strong with an average of three new cottages constructed each year. This slow growth will likely continue but will be eventually limited by the short supply of groundwater for domestic use and the acquisition and preservation of open space by Federal, state and local groups which presently totals over 2,300 acres out of the 3,500 acres of land on Prudence. The Narragansett Bay National Estuarine Research Reserve protects two-thirds of Prudence Island. Environmental stewardship is now the major use of island land.

#### b. Archeological and Historic Landmarks

An archeological survey of Prudence and Patience islands was conducted in 1980. Both historic and prehistoric surveys were accomplished. A large seasonal native American campsite was found on north Prudence. The site has been preserved for further investigation. Two sites on Patience and 13 sites on Prudence were studied. On Patience, evidence of a ferry site dating back to 1742 was discovered and the remnants of an oysterman's house was uncovered. The house probably dates back to the late 1700s when extensive oyster beds were farmed off the island shores.

On Prudence Island, the best preserved historic site on Reserve land is the North End Farm. This farm included house, barn and at least six other out buildings. Most of the foundations are still



The sharp-tailed sparrow is a resident of healthy salt marsh systems. Population studies of this species are being conducted at the NBNERR.

intact with some walls visible above grade. A 3-acre area of the former farm has been cleared and a multi-panel educational display maintained to acquaint the public with the historic uses of the north end. The site is on the National Register of Historic Places. Another Prudence historical asset is the John Brown Farm located west of Sand Point on the Prudence Conservancy unit. This site contains the ruins of a large farm complex dating back to the early 1700s and the remains of the Prudence Inn built in 1894.

Hope Island was the site of a working farm dating back to the early 1800s and still used as a summer home until taken over by the U.S. Navy in 1940. The island was heavily disturbed for the construction of an ammunition depot and no traces are left of the farm.

The lighthouse at Sand Point is a unique historic landmark. This is the oldest lighthouse in Rhode Island. It was built on Goat Island, off Newport, in 1823 and relocated to Prudence Island in 1851. The white, octagonal tower stands 28 feet above the Bay and the green flashing light still warns boaters of the sand spit protruding several hundred feet into the navigable water.

### c. Contemporary Uses

#### 1) Economics

The Prudence Island economy is tied to the east Bay region of southern Rhode Island. The major economic activity on the Island is seasonal tourism supporting the Prudence Ferry, Inc., a modest construction industry, and several small convenience stores with milk, bread, and other staples. There is no commercial zone on Prudence and little potential for new or expanded business. Most commodities and services are provided by Bristol, Portsmouth, and other east Bay vendors who access the Island via the ferry.

There are no farms, other agricultural activities, commercial forestry, or other industries active on Prudence, Patience, or Hope islands.

#### 2) Fisheries

The marshes/estuarine system of the Reserve provides important habitat to numerous commercial species for spawning, nursery, and harvesting of finfish and shellfish.

The major commercially caught finfish in Reserve waters are the winter flounder, tautog, scup, and menhaden. Overfishing has become a problem for some species and trawling for winter flounder is now greatly restricted.

Shellfishing is the principle fishery with Narragansett Bay providing the majority of the harvest of the northern quahaug (*Mercenaria mercenaria*) on the entire East Coast. Commercial landings in 1989 was 2 million pounds worth \$13 million.

Saltwater sport fishing is a popular recreational activity in the Bay. Shoreside and small boat anglers land large numbers of striped bass and bluefish.

#### 3) Other Marine Uses

Narragansett Bay is heavily utilized for recreational boating during the summer months from May through September. The north Prudence areas of Potter Cove and Coggeshall Cove are favorite mooring sites for visiting boaters. The large T-wharf and small boat dock at the South Prudence unit also attract significant boating activity.

The main navigable channel from the ocean to the Port of Providence is through the east passage off the west shore of Prudence. Tankers, freighters, barges, excursion vessels, and other large watercraft use the channel.

The Reserve and adjacent waters have supported a significant estuarine research program over the years. Current research activities focus on fisheries management, comparative ecology of salt marshes, habitat mapping, resource inventory, and water quality impacts.

Wildlife management is an important land-use practice on Prudence Island. A white-tailed deer bow hunting program has been conducted since the 1970s. In 1993, approximately 1,600 acres of Reserve uplands were hunted and an additional 400 acres of private land was open to hunting. The season is generally from early November through mid-January. In 1993, 230 deer were harvested.

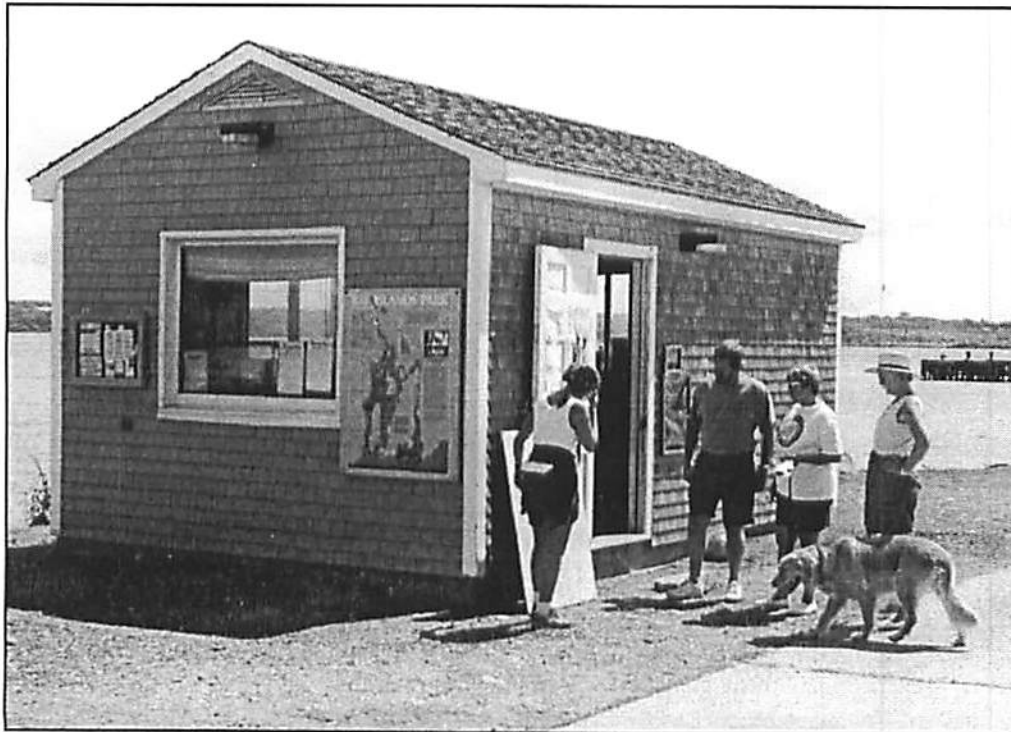
The marshes of north Prudence provide opportunities for hunting water fowl over a two week period during the fall. Another short season is provided for fall hunting of pheasant, quail, and other upland birds.





# Narragansett Bay NERR: Mission and Goals

## CHAPTER III



A summer naturalist program is operated from the south Prudence beach and boating area.





### **III. NARRAGANSETT BAY NERR: MISSION AND GOALS**

#### **A. Statutory Basis**

Narragansett Bay NERR operates under NOAA regulations and guidance as one of 22 units of the NERR System and is administered by a state agency with bioregional and state responsibilities. Accordingly, the Reserve's core mission is determined by NERR System program goals, and by policy established in state law. Management issues and strategies are elaborated in the various sections of this revised management plan.

#### **1. Federal Regulations: NERR Program Goals**

Federal regulations provide five specific goals for the NERR System:

- a) Ensure a stable environment for research through long-term protection of National Estuarine Research Reserve resources;
- b) Address coastal management issues identified as significant through coordinated estuarine research within the System;
- c) Enhance public awareness and understanding of estuarine areas and provide suitable opportunities for public education and interpretation;
- d) Promote Federal, state, public, and private use of one or more Reserves within the System when such entities conduct estuarine research; and
- e) Conduct and coordinate estuarine research within the System, gathering and making available information necessary for improved understanding and management of estuarine areas.

#### **2. State Management Policy**

The DEM policy complements and reinforces the Federal NERR regulations. Basic Reserve management policy is set by an internal management council consisting of division chiefs from the various divisions of DEM (see Section IV.C.).

#### **B. Mission**

The core mission of the Narragansett Bay NERR is:

To preserve a representative estuarine area of the Virginian—southern New England—biogeographical region and provide opportunities for long-term estuarine research, education, and interpretation.

#### **C. Goals**

Goals for operation of the NBNERR are developed from Federal statutes and state requirements considering the geographic, biological, and cultural setting.

The goals established for the Reserve are as follows:

### **1. Administrative Goal**

To provide administrative relationships and staff necessary to fulfill the Reserve's mission as established in state and Federal law, administrative rules, and interagency agreements.

### **2. Stewardship Goal**

To preserve and restore the integrity and natural dynamic processes of an estuarine ecosystem representative of the Virginian biogeographic region; and

To provide Reserve stewardship of estuarine ecosystem types of the Virginian—southern New England—biogeographic region, for long-term scientific and educational use.

### **3. Boundary and Acquisition Goal**

To encompass key land and water areas (core areas) and a protective buffer zone to thus provide adequate control of the site, by the managing entity, over programs and activities occurring within the Reserve.

### **4. Research and Monitoring Goal**

To expand scientific knowledge of estuarine processes by addressing significant gaps in the understanding of dynamic change within estuarine ecosystems; and

To develop information for improved coastal zone decision making.

### **5. Education, Information, and Interpretation Goal**

To increase awareness, understanding, and appreciation of estuarine systems and estuarine stewardship by developing and disseminating information about estuarine systems, and by providing opportunities for personal experiences with them.

### **6. Public Involvement Goal**

To create opportunities for members of the public to benefit from and contribute to the Narragansett Bay NERR.

### **7. Facilities Goal**

To provide accessible facilities necessary to fulfill the Reserve's mission as established in state and Federal law, administrative rules, and interagency agreements.

## **D. Goal Interaction Policies**

The NBNERR Advisory Council recognizes that progress toward several goals may be affected by a single action. The Council has developed the following policies concerning interaction among goal-specific plans:

### **1. Prioritize Stewardship**

The Federal laws that govern the Narragansett Bay NERR emphasize stewardship as a preeminent obligation because continuing availability of an accessible, healthy estuarine ecosystem is a prerequisite for many long-term scientific and educational activities. It is Reserve policy to ensure that all Reserve-managed or endorsed activities are compatible with the mission of the NERR System and with the NBNERR Stewardship Plan.

### **2. Mutual Reinforcement Regarding Goal-Specific Plans and Staff**

All staff members are expected to be familiar with goals and objectives expressed in this Management Plan, so that they can structure projects to serve multiple Reserve purposes. Possible examples include:



- Stewardship activities implemented by public involvement in trail maintenance and monitoring
- Restoration-oriented research used to improve stewardship of degraded habitats
- Educational and interpretive presentations disseminating information about recent research or stimulating public involvement in stewardship

This policy does not preclude implementation of a project that advances only a single goal. However, if such a project is proposed, it is carefully assessed for opportunities to simultaneously advance additional NBNERR goals and objectives.

### **3. Inter-Plan Consistency**

The multi-purpose mission of the Reserve requires constancy between all activities. Activities in support of any one goal should be compatible with the objectives of another. Reserve and RIDEM staff are responsible for ensuring the absolute consistency of programs and projects at the NBNERR.

### **E. Management Issues**

There are major management issues pertinent to the NBNERR that must be addressed. The management strategy of the Reserve is designed to cope with these concerns to minimize adverse impact and derive positive benefit where possible. The revised management plan provides the mechanism and flexibility to address the issues of concern. The following are the current priority issues:

- Non-point source runoff
- Shipping channel dredging
- Fish and wildlife management
- Stewardship of natural areas
- Eutrophication of Narragansett Bay
- Tidal marsh restoration
- NBNERR boundary revision
- Tick-borne disease prevention and management
- Controlling human usage (e.g., public access, restricted sites, zoning, education)
- Development of Quonset Point intermodal port
- Achieving a balance of off-site and on-site education
- Developing the scientific basis for management decisions
- Developing the infrastructure and staffing for the Reserve

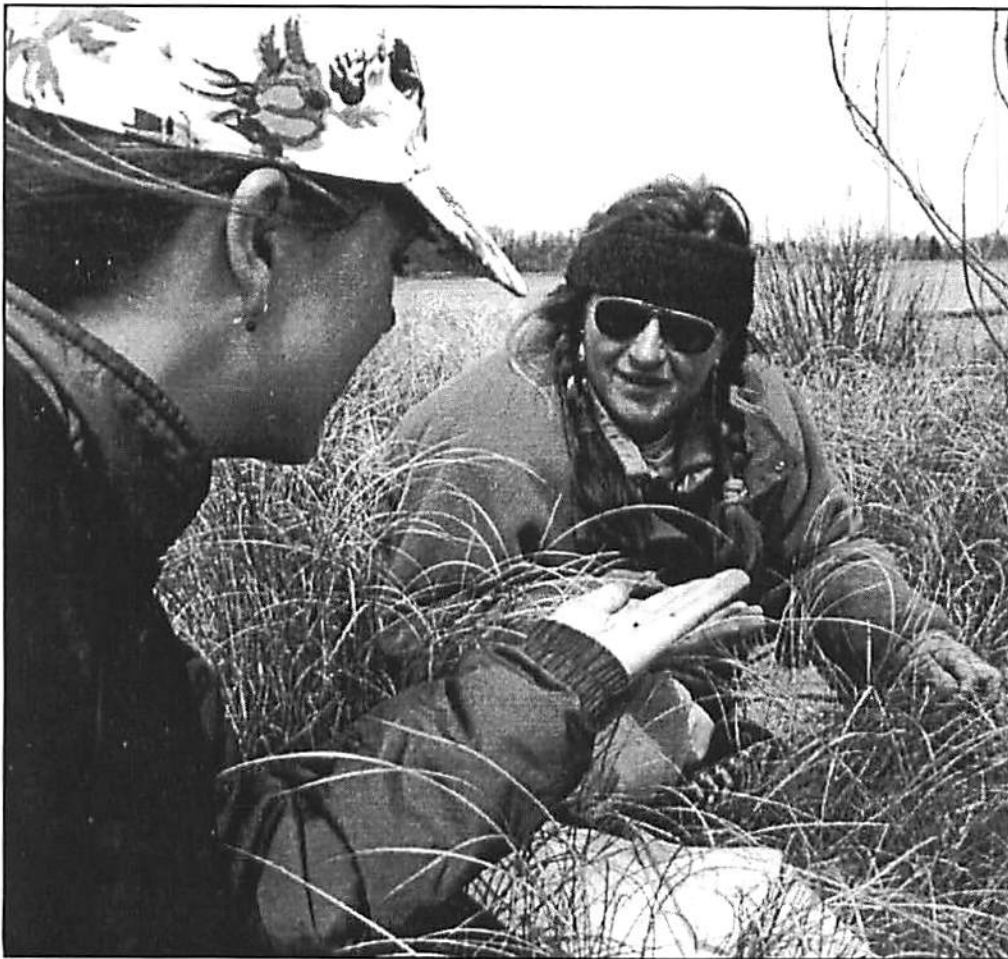






# Administrative Framework and Plan

## CHAPTER IV



Natural history studies  
support the stewardship of  
Reserve properties.





## IV. ADMINISTRATIVE FRAMEWORK AND PLAN

### A. Mission

Provide administrative relationships, facilities, and resources necessary to fulfill the Reserve's mission as established in Federal law, administrative rules, and interagency agreements.

Narragansett Bay NERR is a partnership between the United States and the state of Rhode Island. It has administrative links to both Federal and state government, and receives support from both sources.

### B. Relationship to Federal Government

#### 1. Federal Law

A number of Federal statutes and regulations govern Reserve operation:

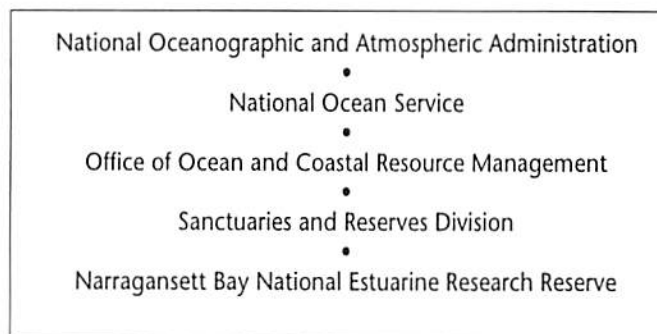
##### a. Coastal Zone Management Act (16 U.S.C. section 1541 et seq.)

Section 315 of the Coastal Zone Management Act established the National Estuarine Reserve System and created the basic framework of the System (see IB."Creation of the National Estuarine Research Reserve System").

##### b. Federal Regulations

Having created the NERR System, Congress delegated to the Secretary of Commerce responsibility for developing regulations that govern administration of NERR programs, grants, and funding. These regulations, which are periodically updated, are published in the Federal Register, and appear as Appendix B to this document.

#### 2. Federal Agency Relationship



The NBNERR, like all other NERRs, receives Federal support through the Sanctuaries and Reserves Division (SRD) of the Office of Ocean and Coastal Resource Management. OCRM is within the National Ocean Service of NOAA.

SRD plays three roles in NBNERR operations. First, it disburses and oversees expenditures of Federal funds for research, education, land acquisition, operations, and development of NBNERR. Second, SRD coordinates and provides guidance in development of policy for the Reserve System. Finally, as required by Federal law (16 U.S.C. section 1461(f)), SRD periodically evaluates NBNERR operations for compliance with Federal requirements and with the approved NBNERR Management Plan.



*With the exception of uplands located within the Reserve, the entire core area is considered a critical area.*

## **C. Narragansett Bay NERR and the State**

### **1. The Coastal Zone Management Program**

The R.I. Coastal Resources Management Council (CRMC) was created in 1971 with the enactment of section 46-23 of the Rhode Island General Laws. The council, which is comprised of 16 members and a support staff, was mandated to “preserve, protect, and, where possible, to restore the coastal resources of the state for this and succeeding generations.” Using funding provided under the CZMA, the R.I. Coastal Resources Management Program (RICRMP) was developed and subsequently approved by the U.S. Secretary of Commerce in 1978.

#### **a. Management of Coastal Resources**

In order to administer the RICRMP, the CRMC is authorized to approve, modify, set conditions, or reject the design, location, construction, alteration, and operation of specified activities under the council’s jurisdiction. CRMC jurisdiction includes all of the tidal waters and submerged lands of Rhode Island out to the limits of the state territorial sea. The inland jurisdiction of the council is determined based upon the coastal feature (type of shoreline), the type of activity proposed, and whether or not the activity is located in a critical watershed for which the council has developed a special area management (SAM) plan.

Basically, the CRMC requires permits for all development activities within 200 feet of any coastal feature. In the SAM plan jurisdiction, the CRMC requires permits for large development projects, including subdivisions of six or more units, structures serviced by an on-site sewage disposal system servicing 2,000 gallons or more per day, activities that result in the creation of 40,000 square feet of impervious surface, construction or extension of sewage treatment facilities or lines, and construction or extension of water distribution systems or supply lines. The CRMC also reviews certain inland activities regardless of their location in the state because of the potential for these activities to impact coastal resources. These activities include solid waste disposal facilities; minerals extraction; chemical transfer, processing, and storage facilities; power generation facilities; petroleum transfer, processing, and storage facilities; and sewage treatment and disposal facilities.

As the authorized coastal zone management agency for the state, the CRMC is responsible for review of direct and indirect Federal activities for consistency with the enforceable policies if the RICRMP pursuant to Section 307 of the 1972 CZMA. Accordingly, all Federal activities, including Federal licensing and permit activities and financial assistance, must conform with RICRMP regulations when there is potential impact to Rhode Island’s coastal resources.

The RICRMP can be characterized as a strategic plan for coastal uses in which the waters of the state have been classified in accordance with appropriate uses relative to shoreline characteristics and existing development. The six water type designations are:

- Type 1 Conservation Areas
- Type 2 Low Intensity Boating
- Type 3 High Intensity Boating
- Type 4 Multipurpose Waters
- Type 5 Commercial and Recreational Harbors
- Type 6 Industrial Waterfronts and Commercial Navigation Channels

Policies, standards, and prohibitions for specific activities are determined based on the coastal feature and adjacent water type.

The waters surrounding the NBNERR are designated as either Type 1 or Type 2. The primary coastal feature found at the site is coastal bluff. Applicable policies are protective of the resources and restrict development.

#### **b. Enforcement**

The CRMC maintains an enforcement team that responds to reported violations. In addition, each town is served by a team, composed of an engineer and a biologist, which is responsible for



reviewing and making recommendations on proposed projects. Since permit teams are dedicated to specific areas of the state, they are aware of permitted activities as well as potentially unauthorized activities. Waterside patrolling and two-way radios assist in the detection of violations. In addition, the CRMC works cooperatively with DEM conservation officers to ensure reported violations are addressed in a timely manner.

### **c. Cooperation**

Since the NBNERR site is located on an island, it is, by nature, somewhat isolated. Nonetheless, CRMC and NBNERR personnel endeavor to keep each other apprised of activities and matters of mutual concern. To that end, the CRMC has a designated point of contact for NBNERR-related issues.

Several cooperative projects between the NBNERR and CRMC are being considered. These include:

- Developing a SAM plan for Coggeshall Cove
- Incorporating NBNERR GIS data into the CRMC database
- Designating a CRMC representative to serve on the NBNERR Research Advisory Committee
- Jointly sponsoring workshops for coastal zone decision-makers on management issues of concern

## **2. Department of Environmental Management, Office of the Associate Director for Natural Resources Management**

R.I. DEM is designated as the agency responsible for overall administration of the Reserve and the Office of the Associate Director for Natural Resources Management is the specific office responsible for on-site management. The office is responsible for the proper utilization, management, and human enjoyment of the Reserve.

The NBNERR is part of the office and administers the operations of the Reserve. Involvement regarding Reserve management includes providing expertise on natural resource protection for the Reserve; 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.

## **3. Other Divisions Within the Department of Environmental Management**

Management and operation of the Reserve requires cooperative actions by other DEM divisions. A DEM organizational chart is presented in Appendix B. Division responsibilities are coordinated with the Reserve manager and briefly described below.

### **a. Division 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.

The division involvement regarding Reserve management includes acquiring land, designing and supervising all site developments, and surveying sites for unique natural features as well as for rare and endangered flora and fauna.

The Natural Heritage Program is part of the Division of Planning and Development. The staff of the program has been very active in characterizing the flora and fauna of the Reserve to determine if there are rare or endangered species. The various properties of the Reserve include open waters, shoreline, marshes, and upland habitats. These habitats may support certain threatened and endangered species. The Rhode Island Natural Heritage Program carries out its responsibilities under Federal and state endangered species protection acts. Their activities in part involve research and monitoring to establish baseline data concerning all native or introduced plants and animals found in Rhode Island. These surveys are conducted jointly with the DEM nongame/endangered



*The Narragansett Bay Project  
(NBP) is part of EPA's  
National Estuary Program  
to protect the health of key  
U.S. estuaries.*

species program. Surveys for rare plants and animals, including breeding birds, have been conducted at the Reserve under this program.

**b. Division of Enforcement**

This division is charged with the responsibility of enforcing Rhode Island's conservation laws and maintaining security in recreational areas under DEM jurisdiction.

The division's involvement relative to Reserve management includes enforcing shellfishing and hunting regulations within the Reserve boundaries and enforcing other Reserve regulations.

**c. Division of Forest Environment**

This division is charged with the responsibility of administering Rhode Island's forests and some natural areas. It assists other agencies and local governments in urban programs relating to trees, forest green belts, and environmental enhancement and fire protection on lands acquired by the state water resources board until time of specific development.

The division's involvement regarding Reserve management includes forestry management, assisting in the development of a fire suppression plan, providing fire-fighting training to Reserve staff, and providing equipment when feasible.

**d. Division of Water Resources**

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

The division's involvement regarding Reserve management includes carrying out the various regulatory functions for maintaining marine water quality in Narragansett Bay.

**e. Division of Groundwater and ISDS**

The primary responsibility of the division is to protect the groundwater resources of the state and to ensure that individual sewage disposal systems are designed and constructed in accordance with state law and regulations.

The division's involvement regarding Reserve management is to review the agreements between the DEM and the Prudence Island Utility Corp., to ensure that withdrawal of drinking water from the Reserve is done in a manner that does not adversely affect the groundwater resources of the Reserve.

**f. Division of Water Supply Management**

The primary responsibility of the division is to protect the surface drinking water supplies of the state by ensuring that the watersheds are adequately protected.

The division's responsibility regarding Reserve management is to review the agreements entered into by the DEM and Prudence Island Utility Corp., to ensure that the agreements contain provisions that will protect the watershed which is almost entirely within the boundaries of the Reserve.

**g. The Division of Freshwater Wetlands**

The primary responsibility of this division is to protect the freshwater wetlands of the state from being altered in a manner that would diminish the natural values of those wetlands.

The division's responsibility regarding the Reserve is to review agreements entered into by the DEM and Prudence Island Utility Corp., to ensure that the agreements include adequate safeguards to protect the vast freshwater wetlands within the watershed of the Reserve and to review proposed alterations of freshwater wetlands outside of the Reserve boundaries to determine if such alterations would impact the resources of the Reserve.

**h. Office of Business Affairs**

This office manages DEM fiscal affairs which encompass budget maintenance, general





accounting, Federal grants accounting, fiscal reporting, and revenue accounting. Its involvement regarding Reserve management includes managing the fiscal affairs of the Reserve and preparing financial reports.

#### **i. Office of Employee Relations**

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

#### **j. Narragansett Bay Project**

The NBP is part of the U.S. EPA National Estuary Program. The NBP developed a Comprehensive Conservation and Management Plan for Narragansett Bay (CCMP) during a period of seven years (1985-1992). More than 100 people representing 45 Federal, state, and local agencies, universities, trade organizations, and public interest groups participated in the \$11 million effort.

The NBP's specific mandate under Section 320 of the Federal Clean Water Act was to "recommend priority corrective actions and compliance schedules addressing point and nonpoint sources of pollution to restore and maintain the chemical, physical, and biological integrity of the estuary, including restoration and maintenance of water quality, a balanced indigenous population of shellfish, fish and wildlife, and recreational activities in the estuary, and assure that the designated uses of the estuary are protected."

In order to satisfy this broad charge, the NBP governing committee directed the completion of more than 100 peer-reviewed scientific and policy studies that focused on the following identified issues of concern:

- Impacts of toxic pollutants
- Impacts of nutrients and eutrophication
- Land-based impacts on water and habitat quality
- Health and abundance of living resources
- Fisheries management
- Health risk to consumers of seafood
- Environmental impacts on commercial and recreational uses of Narragansett Bay

These studies provided the NBP governing committees with an objective basis to determine the relative significance of problems confronting the Bay basin in terms of environmental impacts and impairment of water quality-dependent uses of the Bay. These studies, in combination with NBP briefing papers, also provided a starting point for recommending specific actions to protect and restore Narragansett Bay.

The CCMP was completed in 1992 (U.S. EPA, 1992). The NBP continues to provide valuable assistance to the Reserve and also provides financial assistance for joint projects.

The Reserve will be affected by many of the recommendations of the CCMP as implemented by the appropriate agencies.

#### **k. Other Divisions of DEM**

Other divisions may be involved with the management and operation of the Reserve in the activities of environmental regulation involving air pollution and hazardous waste disposal.

### **4. Other Federal and State Agencies**

There are other Federal and state agencies that have jurisdiction over land and waters of the Reserve although they are not directly involved with the Reserve's administration. The Reserve will only undertake activities that conform with the regulations of these agencies.



*Prudence Conservancy  
provides citizen volunteers  
to support Reserve  
programs including trail  
stewardship and water  
quality monitoring.*

**a. Army Corps of Engineers (COE)**

The COE administers the issuing of permits for planned construction or fill activities in U.S. waters, including wetlands. Activities requiring COE permits include the following:

- Construction of bulkheads, piers, catwalks, boathouses, breakwaters, jetties, etc.
- Alterations, including backfill and bank excavation, dredging, filling and depositing dredged material in wetlands (marshes, swamps, bogs, etc.) and in waterways, overhead and underwater transmission lines, cables, and pipes.

COE permitting jurisdiction is separate from state and local agencies. Therefore, when applicable, a COE permit is required even after one has been issued at the state or local level.

**b. Environmental Protection Agency (EPA)**

Founded in 1970 as a consolidation of existing departments and agencies, the EPA draws most of its power from several new and modified laws. While some of its authority under Federal environmental law relating to Rhode Island issues is delegated to DEM, the EPA itself serves a vital role in local environmental issues.

The agency will often assume responsibility for groundwater testing and, through Superfund, hazardous waste investigations and cleanup.

Like the COE, the EPA is divided into regional sections. Rhode Island resides in the EPA New England Region.

The NBP was part of EPA's National Estuary Program to protect the health of key U.S. estuaries.

**c. R.I. Department of Administration's Division of Planning**

This governmental agency produces and revises the "Rhode Island State Guide Plan." This plan serves as the compendium of state policies and strategic plans including those related to natural resources. Municipal comprehensive plans are required to be consistent with the relevant elements of the guide plan. The NBP CCMP is element 715 of the plan.

The Reserve must be in compliance with the state guide plan.

**d. Department of Health**

The DOH has primary responsibility for matters involving public health. The agency has an active program in preventing, detecting, and treating Lyme Disease and other illnesses affecting the outdoor-using public. It regulates the health aspects of the public water supply, including wellhead protection and bacteriological and chemical testing of drinking water. The DOH analyzes for microbial and chemical contamination of seafood, including shellfish and finfish. It shares responsibility with DEM for regulating the repair of failed septic systems.

The DOH laboratory analyzes shellfish samples regularly to determine whether the shellfish within the waters of the Reserve are safe to eat. DOH has also helped to determine the extent of the health risk associated with the population of deer ticks in the Reserve and has advised DEM on strategies to protect visitors from contracting Lyme Disease.

**e. R.I. Statewide Planning Program**

The SPP is the state government's central planning agency. Federal, state and local officials make up the state planning council, which guides the program. The Division of Planning within the R.I. Department of Administration serves as the staff component of the SPP.

According to the SPP, "the objectives of the program are to plan for the physical, economic, and social development of the state; to coordinate the activities of governmental agencies and private individuals and groups within this framework of plans and programs; and to provide planning assistance to the governor, the general assembly, and the agencies of state government."

The SPP is closely but indirectly linked to all levels of state and local government. This unique position helps make the Program an objective part of the decision-making process and the only state agency solely involved with planning. The SPP comments on applications for the CRMC and



other state agencies but is non-regulatory. The agency is very helpful as a source of land and water resources inventory and planning information for local officials and private citizens concerned with planning and land use decisions affecting water quality in Rhode Island.

#### **f. Town of Portsmouth**

The Reserve properties lie within the political jurisdiction of the town of Portsmouth, R.I. The town exercises its responsibilities in building and zoning regulations, enforcement of municipal ordinances, and developing and implementing community planning. Certain state regulations are reinforced in part by town authorities. These include wetlands protection, septic system installation and maintenance, and transportation. Portsmouth provides police, fire, and rescue services for the community, including the NBNERR.

The Portsmouth planning board approved a new Comprehensive Community Plan in December 1991. The plan, required by state law, is intended to serve as a guide for development and environmental protection over the next 20 years. It is a policy document to be used in the community planning and decision-making process by town officials. It contains recommendations for new regulations, further study, and implementation. The plan contains an element for Prudence Island and many of the recommendations for open space, natural resources, waterfront, and land use will affect the Reserve.

### **5. Non-Regulatory Agencies**

Other non-regulatory agencies, organizations, and advisory committees have specific areas of expertise in resource management and are called upon by the Reserve to provide technical assistance. These groups include:

#### **a. Historical Preservation Commission**

This is Rhode Island's only statewide historic preservation program that identifies and protects historic properties and archeological sites. The agency is responsible for conducting a statewide survey of historic sites and buildings and, from the survey, nominating significant properties to the National Register of Historic Places and the State Register. It is also responsible for reviewing state and local projects to assess their effects on cultural resources.

The Historic Preservation Commission has worked closely with the Reserve to assess the importance of the historic North End Farm and the prehistoric Indian shell midden on the North Prudence Tract. In response to recommendations from the commission, the shell midden is being protected and the farm is becoming the focus for interpretation at the North Prudence Tract.

#### **b. Prudence Conservancy**

The conservancy is a nonprofit, publicly supported 501(c)(3) citizens group. It is incorporated in the state of Rhode Island and functions in two principle areas: 1) as an environmental "watch-dog" and public advocate on environmental affairs, and 2) as a land trust in acquiring and protecting open space and natural areas. The conservancy has a membership of more than 300 individuals and is operated by a board of directors with the chairman serving as the executive officer.

The conservancy provides citizen volunteers to support Reserve programs. These include trail construction and maintenance, meteorological and water quality monitoring, and assistance in research studies and educational programs. The conservancy owns a 166-acre natural preserve and has a management agreement with DEM on another 288 adjoining acres. Both properties are part of the overall NBNERR.

#### **c. The Nature Conservancy**

TNC has the mission of "preserving plants, animals, and natural communities that represent the diversity of life on Earth by protecting the lands and waters they need to survive." It is a national nonprofit organization that has been responsible for the protection of 5.5 million acres in all 50 states. TNC was incorporated in 1951 and now has 600,000 members. It maintains a regional headquarters in Boston, Mass., and has a Rhode Island field office in Providence.

TNC has assisted the Reserve in all land acquisitions. TNC sometimes serves as an agent of DEM in selection, negotiation, and purchase of properties to become part of the Reserve. Additionally, it provides guidance and assistance in planning of programs, managing, and monitoring the acquired tracts. TNC generally holds the property for a limited period of time until DEM is able to secure funding for permanent purchase. They also provide technical support to the DEM and PC in providing long-term protection of critical habitats.

**d. U.S. Department of Agriculture, Natural Resources Conservation Service**

This Federal agency "helps citizens, groups, organizations, cities and towns, and county and state governments reduce the costly waste of land and water resources and puts to good use these national assets.

The guiding principle is use and conservation treatment of the land in harmony with its capability and needs."

As directed by the conservation goals and priorities of the U.S. Department of Agriculture (USDA), the program provides technical and, in some cases, financial assistance through a nationwide network of conservation specialists. In Rhode Island, the staff includes soil conservationists, an engineer, a soil scientist, and a water resource specialist. Other specialists available to assist Rhode Islanders include agronomists, biologists, economists, geologists, foresters, plant materials specialists, and landscape architects. DEM received assistance from the agency in determining the suitability of soils at the South Prudence Tract for restoration as a working or demonstration farm.

The focus of the agency is on non-Federal land. Rhode Islanders can get technical assistance primarily through the state's three conservation districts. Assistance is also available through the Resource Conservation and Development (RC&D) Program.

**e. Rhode Island Resource Conservation and Development Program**

In 1973, the RC&D Program was established in order to help cities and towns make wise use of their natural resources. "The underlying philosophy of all RC&D areas is that local people, provided with proper facts, some technical assistance, and occasional financial assistance, can best develop and carry out an action-oriented resource conservation and development plan for the social, economic, and environmental betterment of their area. This means that people within an RC&D area can get professional advice and help towards coping with any local resource management problem. The Rhode Island RC&D area is at the service of regional organizations, local communities, planning boards, conservation commissions, and other groups such as fire districts and watershed associations."

The RC&D Council is made up of members of sponsoring organizations including the DEM, the SPP, the Southern, Northern, and Eastern Rhode Island Conservation Districts, and the Rhode Island Association of Conservation Commissioners. The council establishes policies and priorities and acts on requests for help. Actual technical assistance is provided through Federal and state agencies, private industry, universities, and volunteers.

**D. Narragansett Bay NERR Internal Administration**

**1. Narragansett Bay NERR Advisory Council**

The NBNERR Advisory Council was created in 1994 by order of the DEM director. The council establishes operating policies and administrative procedures for the Reserve. The council consists of the chiefs or their designated representatives from the various DEM divisions, the director, and the Reserve manager.

The council provides oversight and direction to the office of the associate director for natural resource management in its operation of the Reserve. It also sets priorities for Reserve acquisition, construction, and programs. The council also facilitates cooperative efforts between various divisions and the Reserve.



## 2. Staff

The existing staffing level likely will undergo a modest increase in the future, depending on the availability of state funds. This would allow the NBNERR to accomplish the objectives outlined in this management plan and operate as a fully functioning Reserve in the national system. Until such time as permanent, full-time positions are provided for the core staff of the Reserve (manager, research coordinator, and education coordinator), these functions will be met through a variety of mechanisms. For example, a cooperative agreement with the Audubon Society of Rhode Island (ASRI) provides the services of an education coordinator.

The long-term goal is to provide a core staff consisting of a manager, research coordinator, and education coordinator at a minimum.

The Reserve staff includes:

### a. Manager

The manager undertakes all responsibilities associated with the on-site management of the Reserve. The on-site manager is a half-time employee. The manager's duties include:

- Supervise and coordinate research, monitoring, and public education activities of the Reserve.
- Coordinate wildlife management, fisheries management, and habitat management within the Reserve.
- Prepare and implement the management plan for the Reserve.
- Review and prepare comments for DEM on permit applications and environmental impact statements dealing with proposed projects that could have impacts on the Reserve.
- Review and prepare comments on technical reports and other scientific papers that deal with the ecology of Narragansett Bay or the portion of Narragansett Bay that lies within the boundaries of the Reserve.
- Review and evaluate the probable effects of proposed legislation that might have environmental impacts on Narragansett Bay or on the Reserve.
- Represent the Reserve at professional meetings and attend other meetings as necessary to accomplish the objectives of the Reserve as outlined in the management plan.
- Prepare project proposals for Federal funds and assist in administering research grants, monitoring grants, education grants, operations grants, development grants, and acquisition grants received by the DEM for use at the Reserve.
- Review proposals for research to be performed in the Reserve.
- Develop and maintain a monitoring program at the Reserve to evaluate long-term trends in water quality, species diversity, habitat and land use; and coordinate with existing water quality, air quality, and biological monitoring programs.
- Prepare technical reports and scientific papers based on the cumulative results of monitoring conducted at the Reserve.
- Maintain essential records and files, including a library of technical reports and publications relating to the Reserve.
- Assist in the design of a permanent research laboratory and administration building and other appropriate facilities at the Reserve.



*Volunteers from public, academic and private groups supplement the Reserve staff in many areas, including stewardship, research, education and monitoring programs.*

- Prepare written informational materials to promote the Reserve and its programs.
- Assist in the development of Reserve education programs and present education programs both on and off site.
- Undertake other related work as needed to carry out the objectives of the management plan developed for the Reserve.

#### **b. Coordinator for Reserve Management**

This person coordinates the administration of the Reserve with the manager and with other divisions within the DEM. The coordinator is a full-time employee of the DEM who works as an assistant to the director in the Office of the Director. This person devotes 20 percent of his time to Reserve business.

#### **c. Caretaker/Supervisor**

The caretaker/supervisor is supervised by the manager and is responsible for all maintenance tasks associated with the Reserve property and equipment. This person is a full-time employee and devotes half of his time to Reserve tasks.

#### **d. Laborer**

The laborer is supervised by the caretaker/supervisor and is responsible for any maintenance tasks to which he is assigned. The laborer is a seasonal employee of the DEM who works 20 weeks a year on Reserve tasks.

#### **e. Naturalist**

The seasonal naturalist is responsible for conducting estuarine education programs on-site. The naturalist is also responsible for maintaining estuarine education exhibits.

#### **f. Research and Monitoring Coordinator**

This position is a core position at the reserve. NOAA/SRD is considering at least partial Federal funding to elevate the importance of these activities consistent with the NERR System mission. At present, the on-site manager performs this role as a major duty. The incumbent of this position will:

- Design and conduct long-term research and monitoring programs.
- Review and coordinate estuarine research and monitoring projects by others.
- Manage an estuarine field laboratory supporting in-house or extramural research.
- Coordinate Reserve research and monitoring programs with the NOAA/SRD research coordinator.
- Obtain outside financial and personnel resources by preparing grant applications, soliciting other funding sources, and developing cooperative ventures.
- Implement the research and monitoring program in accordance with this plan.
- Provide support services to visiting scientists and staff in accomplishing research and monitoring studies.
- Serve as a liaison with the science community.





### **g. Education Coordinator**

This position is being filled on a short-term basis through a cooperative agreement with the ASRI. At some point in the future, this should be one of the core positions and a DEM employee. The incumbent of this position will:

- Develop education programs to achieve the goals of the NERR System and the NBNERR.
  - Provide on-site and off-site educational experiences
  - Conduct comprehensive education about estuaries
  - Promote stewardship of natural resources
  - Address local, regional, and national coastal zone management issues
  - Increase the understanding and appreciation of the NERR System and NBNERR
- Target a culturally diverse audience of educators, students, coastal zone managers, and the general public.
- Function as a colleague with other Reserve education coordinators within a system of sites to operate and coordinate national estuarine education efforts.
  - Share expertise and programs throughout the national system of 22 sites and with NOAA, EPA, ASRI, and other partners
  - Participate in national educational programs developed by the NERR System
- Directly link education, research, stewardship, and resource management activities.
  - Use education as a proactive tool for resource protection and stewardship
  - Provide information and expertise to coastal resources decision-makers
- Participate in ASRI and with other education groups in ongoing public statewide and regional education activities and special events.

### **h. Conservationist**

NOAA is embarking on a new program area for stewardship of the protected lands and waters under jurisdiction of the NERR System. This major program emphasis, coupled with significant future increases in responsibilities and Federal financial support recommended in the “Knecht Report,”\* could require a specific position for a conservationist (land steward). The NBNERR will respond to any new requirement for the stewardship program and develop a staff capability to meet this new challenge.

## **3. Volunteers**

Volunteers from public, academic, and private groups supplement the Reserve staff in many areas, especially the education and monitoring programs.

Prudence Conservancy owns and operates a 166-acre preserve that is part of the Reserve. The organization has many members who are seasonal or permanent residents of Prudence Island, the major site of the Reserve. Volunteers provide the core support for trail stewardship and the long-term monitoring program. PC conducts a variety of educational activities for the island population and assists the Reserve summer naturalist program. The conservancy will be a valuable asset in the conduct of future stewardship activities.

## **4. Advisory Groups**

### **a. Reserve Advisory Committee**

A Reserve Advisory Committee (RAC) has been established to advise DEM on management and development of the Reserve and its programs. When necessary, the director of DEM will convene meetings of the RAC to obtain advice on specific issues. In some cases, when the focus of a particular issue is very narrow, the director may convene a sub-group of the RAC, consisting of members

\*The “Knecht Report” titled *The National Estuarine Research Reserve System: Building a Valuable National Asset* was prepared for NOAA by a national review panel chaired by Robert W. Knecht, University of Delaware marine studies professor.

having specific expertise or interest in the issue. If it is not convenient to arrange a meeting of such a sub-group, the director may consult with sub-group members individually.

Input from the RAC is advisory to the DEM. The RAC does not have management authority. The director of DEM has the final authority to adopt and implement management policies. The RAC members are appointed for a one-year period by the director of DEM such that it will be composed of representatives of the following groups:

- Six representatives of DEM, including the director's designee, who shall chair the committee, the associate directors for Natural Resources Management, Planning, and Administrative Services, Water Quality Management, Regulations, and a representative from the Narragansett Bay Project (or their designees)

- One representative from the DEM Division of Fish, Wildlife and Estuarine Resources
- One representative of the Coastal Resources Management Council
- One representative from the Prudence Conservancy
- Two representatives of conservation and recreation groups (e.g. Save The Bay)
- One representative from The Nature Conservancy
- One representative from the Rhode Island Historical Preservation Commission
- One representative of shellfishing interests
- One representative from the Prudence Planning Commission
- One representative of the scientific community
- One representative of the education community
- One representative from NOAA
- One representative from the U.S. Environmental Protection Agency

**b. Research Advisory Subcommittee**

A research advisory group will be established and convened from time to time for specific issues and could include outside experts, scientists conducting studies at the site, and selected members of the RAC with scientific expertise.

**c. Education and Interpretation Advisory Groups**

An education subcommittee may also be convened on an as needed basis and could include representatives from private organizations, academia, and the public education sector.



## E. Plan of Action

### 1. Goal and Objectives

Provide administrative resources and management framework to fully function as a Reserve and achieve the mission as established by Federal and state laws, regulations, and guidance.

#### Objective I

Maintain and strengthen the Federal-state partnership between NOAA/SRD and DEM.

#### Tasks:

- Implement actions required or suggested in the NOAA evaluation reports.
- Assist and cooperate in the development of NERR System strategic planning, budget and resources, priorities, and program operations.

#### Objective II

Develop and maintain cooperative relationships with other entities to achieve a harmonious, cost-effective functioning of the Reserve.

#### Tasks:

- Increase cooperation and interaction with the Coastal Resources Management Council (CRMC is the R.I. CZM agency). Provide technical assistance to CRMC.
- Utilize the management council and advisory committees to gain the expertise and resources of other groups in conducting Reserve operations and programs.
- Improve the collaboration and contribution of the Reserve in coastal zone management by local, state, and Federal authorities.

#### Objective III

Provide adequate staffing for accomplishing the full range of duties of a fully functional Reserve.

#### Tasks:

- Establish and fund new positions as the Federal emphasis and budget permits.
- Obtain outside resources and expertise through advisory committees, cooperative agreements, and volunteer efforts.
- Continue the use of seasonal laborers, naturalists, and job-sharing to achieve the optimal cost-effective staffing mix.





# Stewardship Plan: Managing the Ecosystem

## CHAPTER V



Stewardship activities  
promote protection and  
knowledge of the ecosystem.







## V. STEWARDSHIP PLAN: MANAGING THE ECOSYSTEM

### A. Mission

The National Estuarine Research Reserve System is a Federal, state, and community partnership of protected areas established to promote informed management and stewardship of the nation's estuarine and coastal habitats through scientific understanding linked with public education. The NBNERR stewardship plan is designed to ensure that the integrity of the natural system is protected to preserve the representative ecosystem and support long-term research, monitoring, and education programs. Implementation of the stewardship plan will maintain the NBNERR as an outdoor laboratory and classroom to develop relevant information for natural resource and coastal zone management actions.

The specific mission is to restore and maintain the integrity of the natural system representative of the Virginian-southern New England biogeographic region and to preserve the core areas of the Reserve for research, monitoring, and educational purposes.

NBNERR stewardship plans will be periodically reviewed and revised as new property is acquired, changing site conditions or new habitat management opportunities arise. All stewardship actions will be based on the best scientific information available.

The plan is guided by the federal regulations set forth in CFR Section 921.13(a)(8) Resource Protection; Section 921.13(a)(9) Restoration; and Section 921.13(a)(10) Habitat Manipulation.

### B. Goals

The NBNERR stewardship plan addresses the need to appropriately manage the Reserve as a protected, representative estuarine ecosystem. The Reserve is to be suitable for long-term research, monitoring, and education. There are three basic goals in stewardship:

GOAL I. Protect and preserve the diverse estuarine habitats representative of the Virginian-southern New England region consistent with the NERR System goals and the mission of the NBNERR stewardship.

GOAL II. Restore or manipulate the structure and functional diversity and dynamics of native biotic communities in lands and waters managed by the NBNERR to emulate the ecological conditions of specific periods in time (to be determined with the assistance of research advisory subcommittees).

GOAL III. Participate and cooperate with resource protection activities for the Narragansett Bay ecosystem and watershed.

The existing stewardship and planned actions are designed to achieve the stated goals and are detailed later in this chapter.

### C. General Policy

#### 1. Rules and Regulations

Stewardship of the natural systems within the Reserve is also governed by state statutes. Rules and regulations are derived from these laws by the DEM advisory committee, DFW and by the Reserve. The policies, rules, and regulations are elaborated in the section on stewardship activities and following sections on acquisition, public access, education, research, and other specific programs. Generally, the intent of all NBNERR natural systems stewardship is to maintain and restore the integrity of the estuarine ecosystem and protect it from influences that could alter or affect the natural structure and function of its components. The goal is to preserve the lands and waters for long-term scientific and educational uses.

Policies governing daily operations are administered by DEM. They cover on-site activities



*Trails and recreational areas are provided for visitors to reduce traffic and use of more sensitive areas.*

undertaken by Reserve staff, visitors, scientists, and others utilizing all or part of the Reserve.

The policies, rules and regulations are enumerated in following sections of this revised management plan detailing specific activities conducted on the Reserve and off-site operations by Reserve staff.

## **2. Implementation and Enforcement**

Visitors and users of the Reserve usually voluntarily observe the NBNERR stated and posted policies, rules, and regulations. Reserve staff are the front-line in interacting with visitors and have the ancillary duty of informing the public and enforcing the on-site rules and regulations. Conservation officers patrol the Reserve to ensure compliance with hunting, fishing, and shellfishing regulations.

In situations where an individual is non-cooperative, poses a danger to resources, staff, or others, or violates state or Federal law on Reserve property, staff will contact appropriate enforcement officials.

### **ENFORCEMENT AGENCIES ASSISTING IN RESERVE STEWARDSHIP**

<b>ACTIVITY</b>	<b>AGENCY</b>
Public safety	Portsmouth Police
Fish and game regulations	DEM Conservation Officers
Pollution	DEM Water Resources Div.
Vandalism, theft	Portsmouth Police DEM Div. of Enforcement
Boating	Portsmouth Harbormaster DEM Conservation Officer
Coastal violations	CRMC and/or DEM
Narcotics	RI State Police
Wetlands violation	CRMC DEM Div. of Freshwater Wetlands

The NBNERR itself does not establish penalties for violations of rules and regulations. They are provided for under state and Federal statutes and regulations of the individual enforcement agencies involved.

## **D. Stewardship Action Plan**

### **1. Land and Estuary Use**

#### **a. Background**

The Reserve supports a variety of uses including research, education, and recreation. If these activities were not regulated, they could pose a threat to the environmental quality and integrity of the living resources. The U.S. Department of Agriculture, Forest Service utilizes a "carrying capacity" concept termed "Limits of Acceptable Change" (LAC) System to establish acceptable and appropriate resource and social conditions in impacted areas (USDA, 1985). This planning procedure consists of a series of interrelated steps leading to a definition of resource conditions to be maintained and management actions necessary to maintain those conditions. Considering this



carrying capacity approach, the Reserve is divided into different management zones to allow multiple use yet protect sensitive resources. Zones are based on the following factors:

#### Site Factors

- Ecological sensitivity of the site
- Ecological importance of the site
- Unique or significant geological, historical, archaeological, or ecological factors
- Visual qualities, climate, and hazards

#### Use Factors

- Existing uses: need for support facilities, such as docks, roads, and structures, to support Reserve activities
- 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.

**1) Protected Zone (P):** These zones will be limited to certain uses, and access will be limited to personnel and scientists who have been granted permits to conduct research within the area. A small percentage of the Reserve'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.

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

**3) Activity Zone (A):** 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 Reserve, such as docks, education programs, or recreational activities.

The three management zones just described can be applied to each of the four major ecological areas within the Reserve (terrestrial, freshwater, tidal wetlands, and tidal deepwater). As a result, there may be 12 distinct management zones within the Reserve. Different policies have been established for each of the 12 zones to facilitate multiple use and at the same time to protect the resources of the Reserve.

Under certain circumstances it may be necessary to change the use restrictions for a particular zone, or to grant special exceptions to the regulation. Proposed exceptions or regulation changes will be reviewed by the CRMC, which will make recommendations to the associate director for natural resources management for final determination.



*Historic human uses will generally be continued, provided such uses are consistent with the stewardship, research, monitoring, and education objectives of the Reserve.*

## MANAGEMENT PRIORITIES FOR EACH ZONE

### Protected Zone

- Research
- Rare or endangered species
- Archeological or historic site

### Conservation Zone

- Education
- Research and monitoring
- Passive recreation
- Support facilities for the above mentioned activities

### Activity Zone

- Support facilities and uses necessary to manage Reserve
- Educational programs
- Recreation (including hunting)
- Research and monitoring

A zoning map for the NBNERR that meets the requirements of this section and is consistent with state planning regulations and DEM policy will be prepared. Specific regulations for each zone will be developed to achieve the balance between use and protection based upon the LAC concept.

Management of aquatic resources is an important priority in Reserve management. The NBP has developed "Recommended Strategies to Improve Management of Living Marine Resources." The Bay fisheries are primarily regulated by the Rhode Island Fisheries Management Council (RIFMC) and DEM. The DFW develops species management plans, conducts research and monitoring, advises RIFMC, and enforces the appropriate regulations.

A number of commercially and recreationally important species have experienced significant declines in population over the past 10 years. These include the winter flounder, summer flounder, conch, soft clam, and quahaug. A variety of causes have been postulated, with overfishing recognized as a determinant factor. The NBP recommendations recognize the importance of the NBNERR in preserving critical habitats and controlling fishing pressure. Options could include expanding the Reserve to encompass selected critical habitats to afford selected species a greater level of protection.

### **b. Policy**

- The NBNERR will preserve natural resources using the LAC concept.
- Resource protection will be consistent with NERR System regulations.
- Resource use will be managed by the NBNERR through zoning to limit inappropriate activities on a geographical basis.
- Historic human uses will generally be continued, provided such uses are consistent with the stewardship, research, monitoring, and education objectives of the Reserve.
- Resource protection measures will be consistent with the regional NBP plan for management of living marine resources.

### **c. Action**

- Define limits of acceptable change for Reserve habitats and resources.
- Develop NBNERR zoning map and listing of permitted and prohibited activities in each zone.



- Utilize existing DEM and CRMC policies or regulations to enforce use limitations.
- Participate in the Narragansett Bay regional planning and management for protecting living marine resources.

## **2. Biota**

### **a. Background**

Commercial species of finfish and shellfish are harvested from the waters of the Reserve. State regulations promulgated by the RIFMC limiting fishing season, amount of catch, gear allowed, and other conditions concerning the Bay-wide fishery will be observed and enforced by DEM conservation officers in the Reserve waters.

Bow hunting for controlling the herd of white-tailed deer has been an historic use of the Reserve for many years. The program was originally designed to reduce the over-abundance of deer on Prudence Island and improve the health of the herd. A new plan will be developed to continue the use of hunting to control the size (health) of the herd and provide recreational hunting. The plan will consider other factors including the threat of Lyme Disease and other tick-borne diseases, damage to residential gardens and landscaping, and destruction of native flora.

Threatened, endangered, or species of concern in the state as identified by DEM's Rhode Island Natural Heritage program will be preserved and protected to the full extent of the law. Periodic surveys will be made to discover such species, and plans will be developed for protecting these species.

Exotic (non-native) species exist in many areas of the Reserve. Typically, they disrupt or degrade habitat for desirable native species. Exotic species are those which developed in one ecological setting and have since been introduced in another. In the non-native setting, many introduced species become dominant, destructive misfits with attributes not desirable in their new setting. Many exotic species (e.g., bittersweet, phragmites, and purple loosestrife) can out-compete the native species because the exotics reach maturity quicker, reproduce more profusely, overrun available habitat, and/or lack natural controls such as disease, predators, or parasites. The net impact of introduced species is the loss of desirable native plants and habitat for other historically occurring animals and plants. Introduction of non-indigenous species is prohibited unless approved by the NBNERR Management Council. A survey will be conducted and a plan developed to identify the exotic species posing the greatest threat and to determine which species can and should be controlled. The plan will outline appropriate control strategies.

### **b. Policy**

- The DEM will enforce all RIFMC rules and regulations regarding commercial and recreational fisheries in Reserve waters.
- Bow hunting is the primary means of controlling the size of the white-tailed deer population. Other means of control may also be employed in the future if available and necessary.
- Threatened, endangered, or species of special concern in the state will be aggressively protected as part of DEM's Rhode Island Natural Heritage Program.
- Exotic, invasive species that pose a risk to desirable and/or native plants and animals will be eradicated or controlled to the extent practical.

### **c. Action**

- Ensure that DEM conservation officers enforce all applicable fish and game laws governing the wildlife of the Reserve.
- Determine the maximum size of the white-tailed deer herd that is consistent with protecting human health, maintains the health of the herd individuals, prevents deer grazing damage to desirable flora, and considers the cultural carrying capacity of the Prudence Island community.





*Research and educational use of all sites may be allowed only with the approval, assistance, and guidance of the Reserve manager, provided such uses are consistent with the stewardship plan.*

- Continue and/or revise the existing population control program for regulating the deer herd size which currently utilizes bow hunting as the appropriate management tool.
- Investigate the feasibility of other deer population control measures and utilize in the overall program where practical and cost effective.
- Utilize the R.I. Natural Heritage Program to identify and protect rare or endangered species.
- Identify undesirable exotic species. Develop and implement an eradication or control plan.

### **3. Freshwater Resources**

#### **a. Background**

The water supply for Prudence Island residents is principally produced from groundwater sources within the Reserve boundaries. The upper watershed feeding the groundwater reservoirs subject to withdrawal from public wells is located on NBNERR property. The Prudence Island Utility Corporation (PIUC) is a privately owned water company providing water service to 350 of 420 residences on the island. The PIUC is regulated by the Rhode Island Public Utilities Commission. The PIUC commissioned an extensive study, "Ground Water Availability on Prudence Island," authored by Daniel C. Urish, chair of the civil engineering department at the University of Rhode Island. The following discussion is primarily derived from the Urish report.

The principal watershed and groundwater reservoir on Prudence Island, mentioned above, is the Mill Creek Basin, a central northerly trending valley of 386 acres. Geologically, the region is a buried glacial valley with a relatively thin cover of glacial sediments overlying bedrock. It has a useful, but limited, aquifer potential for water supply development.

Of the five wells belonging to the PIUC, Indian Spring is the most productive with a capacity of about 25 gallons per minute. Three of the remaining wells are unsuitable as public supply wells due to recent contamination. The second most productive well, the former Army well, has a limited capacity of about 11 gallons per minute and is susceptible to saltwater intrusion if heavily pumped. There is no contingency water supply in the event one of the two main wells becomes unusable.

Both the Indian Spring and Army wells are on Reserve property. The PIUC has deeded rights and easement to pump and distribute water from these wells.

The Urish study, for the purpose of evaluating groundwater availability, was accomplished during 1990. The results of this study indicate that, under current water withdrawals, Mill Creek goes dry for several days even in a normal year. Additional pumping will increase the length of this no flow period. For this reason, groundwater withdrawals from the Mill Creek basin should not be increased.

The Indian Spring well has experienced several recent incidents of bacterial contamination, putting the source at risk. Therefore, it is planned to develop one or more good production wells in a more protected wellhead location than that of the current wells. A deep rock well is being drilled on PIUC land adjacent to the existing pump house at Indian Spring.

#### **b. Policy**

- The NBNERR will protect the Mill Creek watershed within its boundaries through enforcement of the Rhode Island Wetlands Protection Act and DEM regulations to ensure the quality of groundwater for the Prudence Island community drinking water supply.
- No additional withdrawal from the Mill Creek Basin will be allowed in excess of the existing 13 million gallons per year. Water pumping above this quantity would cause reduced stream flow and constitute a wetlands violation.
- The existing course and flow conditions will be maintained for Mill Creek.





#### **c. Action**

- The PIUC water withdrawal from the Mill Creek Basin will be monitored to ensure no increase above the allowable maximum.
- Monitor the Mill Creek stream flow and prevent any reductions in flow or alteration to the course of the stream.

### **4. Uplands Management**

#### **a. Background**

The Reserve contains large upland tracts on the North Prudence, Barre, Heritage, Prudence Conservancy, South Prudence, Hope Island, and Patience Island units. About 1,500 acres of uplands are managed as buffer areas to protect critical estuarine habitats and to preserve terrestrial biodiversity. In general, Reserve forest management is passive with little intervention except as detailed here.

The uplands will be managed in accordance with an integrated forest-wildlife concept. A management plan will be developed for each Reserve unit. An historic public wood-cutting program has occurred at the South Prudence unit. A small amount, 30 cords or less, of timber is harvested annually as part of the overall management plan for that unit. This removal of trees is closely regulated and by permit issued by the NBNERR under an integrated forestry management plan developed for each area of timber harvesting. Incidental tree harvesting may be a component of management techniques in other units but only as part of the approved forest-wildlife plan for that unit.

#### **b. Policy**

- Uplands management is generally passive with intervention kept at a minimum in occurrence, scope, and scale and only when consistent with goals and objectives for buffer area stewardship.
- Public wood-cutting is allowed as an historic activity and as part of the measures to carry out an integrated forest-wildlife management plan.

#### **c. Action**

- Inventory the flora and fauna of the Reserve uplands areas.
- Develop and implement an integrated forest-wildlife management plan for each unit of the Reserve.
- Continue the historic public wood-cutting program as one of the overall forest-wildlife management practices.

### **5. Archeological Resources**

#### **a. Background**

The Reserve contains a number of archeological sites that reflect American Indian and Colonial activities dating back many centuries. Both the prehistoric (Indian) and Colonial sites have been inventoried. One major find indicating considerable use by Indians inhabiting Narragansett Bay was found on the North Prudence unit. This site is under protection and not accessible to the public for any purpose. Numerous Colonial farm sites have been identified throughout Prudence and on Hope and Patience islands. The two best examples are extensive foundations at North Prudence and the Conservancy units. The farm at North Prudence is on the National Historic Register. There is an outdoor education display to acquaint the public with the former use of the property as one of the 15 working farms on Prudence in the mid-1700s. The Prudence Conservancy site is well preserved but undeveloped.



*Narragansett Bay, like any estuary, provides a variety of different habitats for living things.*

#### **b. Policy**

- Unauthorized excavation of archeological sites is strictly forbidden by Rhode Island historical preservation laws.
- Archeological sites will be protected and care will be taken not to draw public attention to these artifacts.
- Non-disruptive educational use of archeological sites is permissible at sites that can support this use.
- Research and educational use of all sites may be allowed only with the approval, assistance, and guidance of the Reserve manager, provided such uses are consistent with the stewardship plan.

#### **c. Action**

- Develop a stewardship plan for archeological resources.
- Provide protection for all archeological sites by preventing or minimizing public awareness of undeveloped sites and prohibiting trespassing or any disturbance except for approved scientific investigation.
- Continue the use of the north Prudence farm site for educational purposes.

### **6. Controlling Visitor Usage**

#### **a. Background**

The zoning of Reserve areas to accommodate public use and protect natural resources is discussed in Section D.1.

Public visits to the Reserve advance the NERR System goals by expanding citizen awareness of the NERR System, and by increasing opportunities for the public to physically experience an estuarine setting. Visitors are invited to explore the Narragansett Bay NERR's trails at all times of the year, and to treat themselves to the sights and sounds of wildlife, forest, and marsh.

Under Federal and state law, public access to the Reserve must be consistent with NERR and state policy—that is, Reserve management may facilitate public access, but its primary obligation must be to maintain the integrity of the Reserve, protect it from uses and activities which may alter or affect the ecosystem and its processes, and preserve the area for long-term scientific and educational uses.

Visitors can contribute significantly to ecosystem protection by adopting the stewardship practices embodied in the Narragansett Bay NERR administrative rules and briefly summarized below (see the "Public Involvement Plan" for other public participation opportunities). The stewardship rationale for various rules will be included in NBNERR education and interpretation presentations (see "Education, Information, and Interpretation Plan: Including Research and Stewardship in Educational and Interpretive Programs").

Unfortunately, certain visitor activities and behavior can be detrimental to protection of natural resources. Camping is not allowed by DEM on state property except in designated areas of the South Prudence unit. Presently, all camping is prohibited due to the high risk of Lyme Disease. Picnicking and fires are restricted to designated picnic areas only. Motorized vehicles can be operated on roadways designated for the purpose. Off-road vehicles are prohibited in all areas. Regular trails are provided for group use and numerous individuals. The trails guide the visitors along selected paths to discourage random wanderings and degradation of more pristine resources.

#### **b. Policy**

- Camping will be limited by DEM to specific areas of the Reserve.



- Trails are provided for visitors to reduce traffic and use of more sensitive areas.
- Motorized vehicles are permitted on designated roads.
- Off-road, all-terrain vehicles are not allowed by DEM and the town of Portsmouth on the Reserve.
- Picnicking is restricted to designated sites.
- Fires are prohibited by DEM and the Prudence Island Volunteer Fire Department regulations except in fireplaces provided by the Reserve.

**c. Action**

- Continue to enforce existing controls and prohibitions.

## **E. Habitat Manipulation Plan**

### **1. Background**

Narragansett Bay NERR is committed to stewardship of the natural resources entrusted to its care. This program includes the concept of habitat manipulation. Habitat manipulation includes restoration and is the deliberate intervention in the current status of the Reserve's natural resources to alter the existing condition to a state more consistent with stewardship objectives. The rules and regulations governing habitat manipulation are delineated in 15 CFR Part 921.

### **2. Policy**

Habitat manipulation will be allowed for research, human health, ecological, or stewardship purposes only, consistent with the following limitations:

- The manipulative activities must be specified in the current management plan or revision.
- It must be consistent with the goals of the stewardship program as listed in 15 CFR Part 921.
- The activity is to be limited in scope and scale to the minimum action necessary to accomplish the stated objectives.
- Manipulative activities that could compromise the representative integrity and character of the Reserve are prohibited.
- Habitat manipulation for resource management purposes is allowable only if approved by NOAA as:
  - a) A manipulation consistent with all provisions of 15 CFR, Part 921, Section 921.1
  - b) An activity necessary for the protection of public health
  - c) Required for the preservation of other sensitive resources which have been identified or are eligible for protection under relevant state or Federal laws (e.g., threatened/ endangered species or significant cultural resources)
  - d) Restore or improve Reserve habitats that have been degraded through past human use or introduction of exotic species.
- Pre-existing cases (manipulations) are allowable if they were occurring prior to the designation or boundary expansion of the Reserve. They must be necessary for the protection of human health, the preservation of sensitive resources, or a long-term pre-existing use in a buffer area in accordance with 15 CFR Part 921 Section 921.1(d).



*Marsh restoration would involve controlling invasive species, the elimination of artificial ditches and the re-establishment of a pre-ditched salt marsh.*

- Manipulative activities with a significant or long-term impact of Reserve resources requires the approval of NOAA.

### **3. Action**

#### **a. Hope Island Colonial Nesting Restoration**

##### **1) Background**

The population of double-crested cormorants has more than doubled in the past 10 years. Cormorants compete for habitat with other species of colonial shorebirds and often displace these other species from their normal habitats. Furthermore, their destructive behavior and sheer numbers can permanently despoil traditional nesting sites for other species.

##### **2) Objectives**

- Preserve the critical habitats on Hope Island to encourage nesting of colonial shore birds.
- Eliminate a human health threat from cormorant feces and dander.

##### **3) Tasks**

- Design project to reduce the double-crested cormorant population on Hope Island in order to preserve colonial bird nesting sites. Colonial bird species include, but are not limited to, glossy ibis, great egret, snowy egret, cattle egret, black-crowned night heron, and little blue heron.
- Acquire all relevant state and Federal permits.
- Stop cormorant destruction of nesting areas by removing a sufficient number of cormorants and by discouraging their breeding and nesting on Hope Island.
- Eliminate human health threat by reducing the presence of cormorants.
- Determine the efficacy of the management action by research and monitoring the results of manipulation.
- Revise and continue program to restore the breeding of colonial shore birds to historic 1980–1990 levels.

##### **4) Implementation**

- The DFW will direct and/or conduct the manipulation in cooperation with the Reserve staff.

#### **b. Fire Management**

##### **1) Background**

Periodic wildland fires were a natural and common occurrence during the past history of Prudence Island. In early Colonial days fire was used to clear and maintain agricultural land. Fires also had natural causes such as lightning strikes. Beginning in 1875, tourism with an increase in dwellings and visitors resulted in more emphasis on fire suppression. The ability to put out or control fires was limited until the establishment of the Prudence Island Volunteer Fire Department (PIVFD) in the mid-1940s. Fire suppression policy of the PIVFD is immediate and aggressive in all situations.

The use of prescribed burns as a tool in wildland management was initiated in the 1980s to increase browse for the Prudence Island deer herd and thus improve the health of the undernourished animals.



More recently, fire ecology has become accepted as one means of promoting native biodiversity. North Prudence is a potential site for habitat manipulation using prescribed burns. Much of the unit is covered by scrub-shrub growth and poor quality cherry and swamp maple growth. The understory is choked with greenbrier and climbing vines, including the invasive species of bittersweet and Virginia creeper. The area would support a more diverse and desirable biota if some areas were devoted to open fields or mature stands of hardwoods with herbaceous openings and a lush understory.

Other natural area managers in the state are now utilizing controlled wildland fire techniques. This has led to the formation of an advisory committee with representatives from TNC, ASRI, DEM Division of Forest Environment, and other experts in open space stewardship.

## **2) Objectives**

- Controlled wildland fire will be considered as a means for promoting biodiversity or achieving other objectives in natural resource management.
- Restore, to the extent practical, to north Prudence the flora and fauna of a time period to be determined by the management council.

## **3) Tasks**

- Determine the natural resource management objectives for the North Prudence unit.
- Determine management actions to achieve the objectives. Fire ecology will be a prime consideration.
- Design and conduct a pilot study on the use and results of prescribed burns.
- Construct and maintain a system of firebreaks to contain prescribed burns or wildland fires to selected areas. Firebreaks will also protect private property from fires spreading from the Reserve.
- Monitor results.
- Determine additional management actions and expand the use of fire ecology on other units of the Reserve based on the results of the test case.

## **4) Implementation**

The Reserve staff and the NBNERR Advisory Council must approve the plan for the use of fire in managing the natural areas. The *ad hoc* statewide fire ecology committee will help design the prescribed burn program. The burns will be conducted by the DEM Division of Forest Environment, the DFW and Reserve staff.

## **c. Eelgrass Restoration**

### **1) Background**

Eelgrass (*Zostera marina* L.) beds are an especially critical habitat for a wide variety of finfish and macroinvertebrates. For example, the eelgrass community provides a breeding area and nursery for flounder, scallops, and crabs. Aquatic wildfowl, geese, and ducks utilize the leaves and seeds as a principal food source.

In the early 1930s extensive lush eelgrass meadows were found in the shallow waters of the Reserve. Today, only two healthy beds exist within the boundary of the NBNERR. The largest bed extends from the T-wharf at south Prudence for approximately 400 yards north along the east shore. A much smaller bed exists just south of Sheep Pen Cove. The demise of the once prolific beds was due to several factors, including a wasting disease in the 1930s, poor water quality in the '40s and '50s, and two major hurricanes in 1938 and 1956.

Recent advances in the scientific understanding for managing eelgrass beds provides the basis for successful reintroduction of eelgrass into areas with historic eelgrass occurrence where suitable

water and sediment quality now exist. Methods for propagating and transplanting *Zostera* have been worked out and tested.

The policy of the NBNERR is to re-establish eelgrass in selected areas with a high potential for successful restoration.

## **2) Objectives**

- Restore eelgrass to NBNERR shallow water areas.
- Continue research and monitoring to ensure the success of restoration, and support management action to perpetuate the eelgrass meadows.
- Educate the public on the benefits of this critical aquatic habitat.

## **3) Tasks**

- Develop an eelgrass restoration plan.
- Conduct a pilot study to transplant *Zostera* in at least three locations.
- Monitor results, revise methodology if needed.
- Expand restoration efforts to all areas with a high potential for successful re-establishment of eelgrass.
- Determine and institute management practices to protect eelgrass.
- Educate the public on the benefits of *Zostera* and the need for preservation.

## **4) Implementation**

The NOAA National Marine Fisheries Service (NMFS) Damage Assessment and Restoration Program and the NMFS Restoration Center will provide Federal expertise and guidance for the design and conduct of the eelgrass restoration efforts. The NBP and the URI Graduate School of Oceanography will provide the on-site expertise for project design and accomplish the actual restorations. The Reserve staff will collaborate with the other participants, facilitate the overall efforts, and assist in monitoring the results. The NBP and Reserve staff will collaborate in developing management measures and public education.

# **d. Mosquito Control**

## **1) Background**

Saltwater mosquitoes are abundant in the marshes of the NBNERR in the north Prudence and Patience Island areas. These insects are a considerable nuisance for both residents and visitors during July and August, the peak visiting period for the Reserve. The residents of Prudence Island have petitioned the town of Portsmouth, R.I., for action to reduce the abundance of the pests.

Despite the existing management efforts, mosquito populations remain relatively high. These biting insects are a significant harassment to the outdoor-loving public.

From the 1930s to 1960s, mosquitoes were controlled primarily through the construction and maintenance of ditches to drain areas of standing water. Currently, periodic aerial spraying of *Bacillus thuringiensis var. israelensis* (Bti) is the control measure of choice. This method is used in recognition of environmental concerns with ditching or the use of pesticides and Bti's demonstrated effectiveness in causing larvae mortality.

In addition to Bti applications, marsh restoration and open marsh water management (OMWM) may be acceptable control strategies to reduce the size of the mosquito population. OMWM is designed to reduce breeding habitat by altering marsh morphology (Christie, 1990). The technique utilizes the natural drainage features of the marsh. Narrow, deep ditches are designed to connect deep pools to the broad shallow pans where the mosquitoes breed. These reservoirs support insect feeding fish that characteristically utilize the marshes. The existing shallow ditches, no longer maintained, would be filled or deepened consistent with the natural drainage





pattern. The goals are to: 1) restore and retain the high, naturally occurring, saltwater profile necessary for maintaining a "healthy" ecosystem; and 2) reduce the breeding areas producing the majority of saltwater mosquitoes.

Marsh restoration would involve the elimination of artificial ditches and the re-establishment of a pre-ditched salt marsh. This management strategy, like OMWM, would reduce the mosquito population by removing mosquito breeding sites and providing mosquito-eating fish with channels to reach the upper marsh.

## **2) Objectives**

- Control mosquito populations to reduce the nuisance to the public and eliminate threats to human health.
- Reduce mosquito populations through a combination of OMWM or marsh restoration and annual spraying of Bti as part of Portsmouth's control program.
- Monitor the marsh systems to establish a baseline status to determine the effectiveness of control measures and document changes in the marsh ecosystem related to control measures.

## **3) Tasks**

- Conduct an annual assessment to determine the need for mosquito control.
- Conduct aerial spraying of marshes with Bti under Portsmouth's mosquito control program when appropriate and consistent with the overall stewardship plan.
- Establish baseline status of marsh systems.
- Design OMWM project or marsh restoration project.
- Obtain peer review of project design by NOAA.
- Obtain required permits.
- Conduct OMWM project or marsh restoration project.
- Develop management decision criteria for initiating future mosquito control action.
- Institute a long-term monitoring program.

## **4) Implementation**

The town of Portsmouth, R.I., will conduct the annual assessment of the mosquito population. If the numbers indicate a nuisance or threat to human health, Portsmouth will use aerial spraying of Bti as a control measure. The Reserve staff will explore a collaborative venture with the CRMC and the COE to design and accomplish a restoration program utilizing OMWM principles or marsh restoration to eliminate or reduce the need for spraying.

## **e. Recreational Boating**

### **1) Background**

Potter Cove at north Prudence is a favorite anchorage for recreational boaters. As many as 150 boats occupy the cove on a typical summer weekend. The discharge of boater-generated wastes degrades the water quality of the cove during periods of high usage. Elevated bacteria levels is one result of boaters' waste and causes a closure of the cove to the taking of shellfish every May through mid-October. Other adverse consequences of boating activity include occasional eutrophication with reduction of dissolved oxygen in the water column and high levels of hydrocarbons, copper, and other contaminants from power boat operations. Coggeshall Cove and Sheep Pen Cove are also beginning to exhibit elevated levels of bacterial contamination but not yet to the extent to warrant closure.

## **2) Objectives**

- Restore the water quality of Potter Cove.
- Reduce sediment contamination.
- Open the cove to shellfishing during the summer season.
- Prevent degradation of other areas used by boaters.

## **3) Tasks**

- Prepare a SAM plan to protect the Reserve waters from nonpoint source pollution.
- Reduce the allowable density of boats in Potter Cove.
- Establish a "zero discharge" zone for Reserve waters.
- Restrict small boats from shallow waters and creeks in the marsh systems.

## **4) Implementation**

- The CRMC will be requested to develop a SAM plan for Reserve waters in cooperation with Reserve staff.
- The town of Portsmouth will reduce the number of permitted moorings in the cove.
- The DEM Water Resources Division and the Reserve staff and citizen volunteers will monitor water quality to assess restoration of natural water quality in the coves.

# **F. Joint Stewardship of the Narragansett Bay Region**

## **1. Need for Joint Stewardship**

The Narragansett Bay NERR is one of many government entities entrusted with protection of the environment of Narragansett Bay. Federal, state, local, and private groups have some role in overall Bay governance. The specific role of some of the more actively involved entities is discussed in Chapter IV.B. and C. The Reserve will participate and contribute to the greatest possible extent in any planning action that affects Narragansett Bay and its watershed. Staff will support local to national initiatives and leadership in Narragansett Bay and watershed research, education, and stewardship efforts.

Narragansett Bay environmental quality is degraded by urban activities and runoff in the upper Bay region, Greenwich Bay, and Newport harbor. Small embayments around the Bay are experiencing the symptoms of eutrophication. Shellfish beds are closed in over 30 percent of the Bay because of bacterial contamination. The status and trends in Bay health is also discussed in Chapter II.A.8-12.

The NBP has recently produced a CCMP to integrate the efforts of all members of the Bay and watershed communities. The CCMP is the master plan "for restoring and preserving the quality and essential character of Narragansett Bay."

## **2. Joint Planning**

Joint planning will be carried out primarily with the NBP and CRMC. The Reserve is part of the NBP Advisory Committee supporting the implementation of the CCMP.



The Reserve will provide technical assistance to the CRMC and will serve on several committees established to carry out the CZMA Section 6217 requirements for control of nonpoint source pollution.

The Reserve will provide technical assistance and enter into cooperative projects with other Bay-related organizations or government programs as opportunities arise.

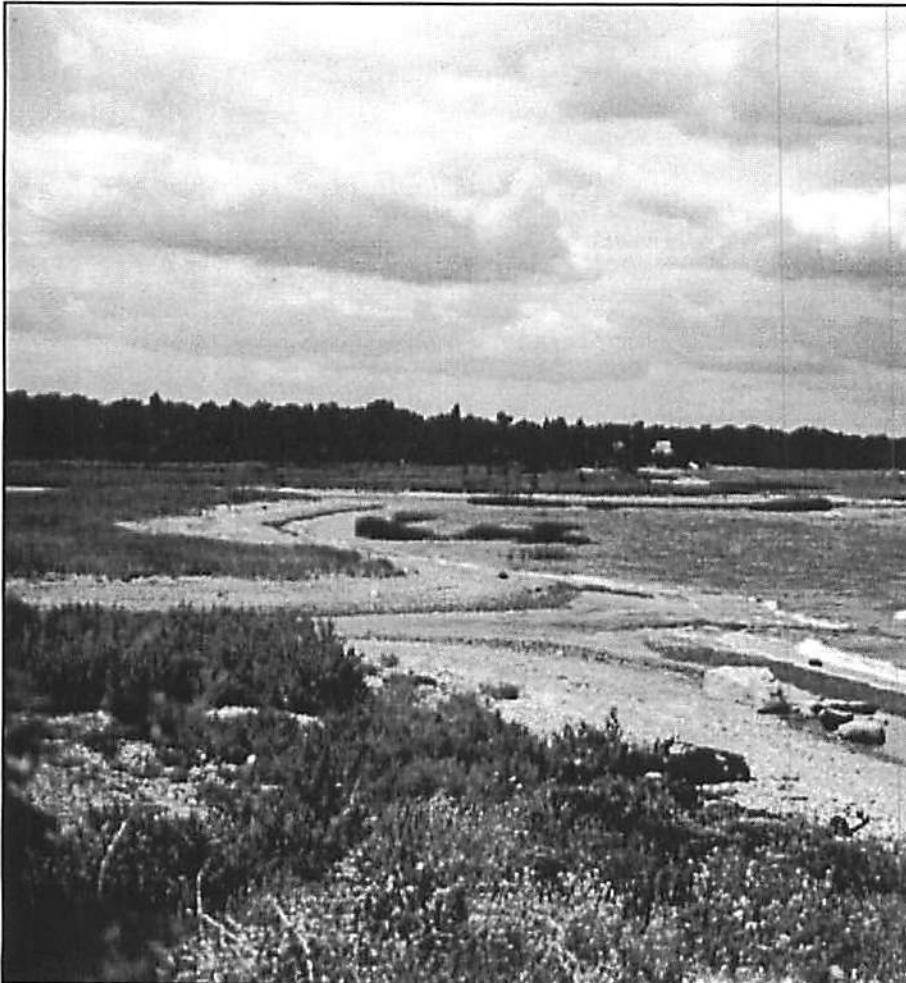
In the event of natural or human-induced disaster, the NBNERR will offer technical assistance to local, state, and Federal agencies having jurisdiction and responsibility for such occurrences. The Reserve is part of a consortium of regional agencies for oil or other contaminant spill response, assessment, and damage control activities.





# Boundary and Acquisition Plan

*CHAPTER VI*



The Reserve core areas include critical habitats such as salt marshes.







## VI. BOUNDARY AND ACQUISITION PLAN

### A. Goals and Objectives

The overall mission of the NERR System is to establish and manage research Reserves representative of the various regions and estuary types in the United States and its possessions. Individual sites are to be relatively undisturbed from the natural state and suitable for supporting long-term research, education, and interpretation.

The NERR System Federal regulations (15 CFR Part 921.11(c)(3)) state that:

"...Research Reserve boundaries must encompass the area within which adequate control has or will be established by the managing entity over human activities occurring within the Reserve. Generally, Reserve boundaries will encompass two areas: key land and water areas (or 'core area') and a buffer zone. Key land and water areas and buffer zone will likely require significantly different levels of control (see Sec. 921.13(a)(7)). The term 'key land and water areas' refers to that core area within the Reserve that is so vital to the functioning of the estuarine ecosystem that it must be under a level of control sufficient to ensure the long-term viability of the Reserve for research on natural processes. Key land areas and water areas, which comprise the core area, are those preserving, for research purposes, a full range of significant physical, chemical, and biological factors contributing to the diversity of fauna, flora, and natural processes occurring within the estuary. The determination of which land and water areas are 'key' to a particular Reserve must be based on specific scientific knowledge of the area. A basic principle to follow when deciding upon key land and water areas is that they should encompass resources representative of the total ecosystem, and which if compromised could endanger the research objectives of the Reserve. The term 'buffer zone' refers to an area adjacent to or surrounding key land and water areas and essential to their integrity. Buffer zones protect the core area and provide additional protection for estuarine-dependent species, including those that are rare or endangered. When determined appropriate by the state and approved by NOAA, the buffer zone may also include an area necessary for facilities required for research and interpretation. Additionally, buffer zones should be established sufficient to accommodate a shift of the core area as a result of biological, ecological, or geomorphological change which reasonably could be expected to occur. National Estuarine Research Reserves may include existing Federal, state, or land already in protected status where mutual benefit can be enhanced."

Specific objectives of NBNERR acquisition and boundary expansion include:

- Incorporating examples of the southern New England-Virginian bioregion not presently in the Reserve
- Achieving coordinated and compatible stewardship of critical habitats outside the current boundaries
- Protecting the habitat quality of core areas by exercising stewardship of surrounding buffer zone
- Establishing a continuous "green corridor" extending from the South Prudence unit to Providence Point at north Prudence
- Incorporating areas that would facilitate achieving the stewardship, research, monitoring, education, and interpretation objectives of the NERR System and the NBNERR



*Individual sites are to be relatively undisturbed from the natural state and suitable for supporting long-term research, education, and interpretation.*

## B. Key Land and Water Areas of the Reserve

The current boundaries of the NBNERR are depicted in Figure 3. The land areas include the privately owned Prudence Conservancy, all state owned properties on Prudence Island, all of Hope and most of Patience islands. The aquatic areas of the Reserve are delineated by all waters out to a depth of 18 feet.

To ensure that the Reserves represent the greatest possible range and variety of estuarine ecosystem types, NOAA has developed a typology of 14 major estuarine ecosystem groups. An ecosystem type may occur in more than one bioregion and may have several subgroups within a bioregion. The Virginia province contains 11 major ecosystem types. Six of the 11 types are inadequately represented or are minimally represented in segments too small to provide research, monitoring, and education sites.

**TABLE 4  
REPRESENTATION OF BIOREGIONAL ESTUARINE ECOSYSTEM TYPES WITHIN  
THE NBNERR**

<u>Shorelands:</u>	<u>Transition Areas:</u>	<u>Submerged Bottoms:</u>
Maritime forest	Coastal marshes*	Subtidal hard bottoms*
Coastal cliffs	Intertidal beaches	Subtidal soft bottoms*
Coastal shrubland	Intertidal mud and sand flats	Subtidal plants*
Coastal grassland*	Intertidal algal beds*	

\*Ecosystem types not yet adequately represented in NBNERR

The Reserve's existing core and buffer areas are:

- North Prudence Unit - 1340 acres

The entire tract is a core area and includes extensive coastal marshes—notably Coggeshall Marsh and Sheep Pen Marsh—coastal grassland and coastal shrubland. The land areas are fringed with intertidal beaches and sand and mud flats. The water boundary out to the 18-foot isobath includes almost 600 acres of subtidal soft bottoms and subtidal plants represented by an eelgrass bed southwest of Sheep Pen Cove. The historic North Farm educational site is located here.

- Barre Unit - 205 acres

The core area encompasses approximately 50 acres of the Nag Creek, south coastal marsh, and also 40 acres of soft bottom. There are a few acres of fringing coastal shrublands. The balance of 115 acres is a buffer area and is primarily maritime forest with a freshwater stream, Mill Creek, and several acres of freshwater wetlands.

- Little Unit - 90 acres

This is a core area of the Reserve with 51 acres of soft bottom, 33 acres of Nag Creek, North Marsh, and about 6 acres of intertidal beaches. The balance of the land is surrounding coastal grassland and coastal shrubland.

- Heritage Unit - 288 acres

This is essentially a buffer area and composed of maritime forests. There are about 80 acres of wetlands. Schoolhouse Swamp is contained within this unit and is the upper watershed for Mill Creek which supplies the privately owned Prudence Island drinking water source located on the east border of the Barre unit of Indian Spring. There are no long-term pre-existing uses in this buffer area. It has been maintained by previous owners as natural open space.



- Prudence Conservancy Unit - 166 acres

This land is also a buffer area and is chiefly maritime forest and also contains a portion of the Mill Creek watershed. The property also has the historic Baker Farm site which was continually operated from the early 1700s to 1930. The contiguous forest areas on both the Heritage and Prudence Conservancy tracts comprise the largest, unoccupied forest area in the immediate Narragansett Bay region. This buffer area has a pre-existing use by the PIUC. A water supply well is located just to the north of the historic farm site and a distribution line runs south from the well to a water storage tank on Broadway Avenue.

- South Prudence Unit - 1140 acres

The 600-acre core area of this unit includes coastal cliffs, intertidal beaches, subtidal soft bottoms, and subtidal plants (the largest eelgrass bed in the mid-Bay region). The remaining 540-acre buffer area is equally divided between maritime forests and coastal shrubland. About half of the buffer area has been disturbed by the presence of a U.S. Naval Station from 1942 to 1972.

- Patience Island Unit - 205 acres

The entire parcel is a core area with 70 acres of coastal shrubland, 10 acres of coastal marsh, a fringing intertidal beach, and 220 acres of aquatic habitat with a soft bottom benthic environment.

- Hope Island Unit - 91 acres

The island and surrounding waters are part of the overall core areas of the Reserve. The 91-acre island is mostly coastal shrubland with coastal cliffs with several small patches of intertidal beach. It is an important rookery for shore birds. The water boundary encompasses about 100 acres of subtidal soft bottoms.

## C. Acquisition Strategy

A number of Federal, state, and private nonprofit organizations have or may acquire land ownership or stewardship rights over key habitat or buffer appropriate to the Narragansett Bay NERR mission. In these instances, the NBNERR may seek cooperative agreements or Memoranda of Understanding that allow the Reserve to assume stewardship of property owned or acquired by another organization.

All Narragansett Bay NERR initiatives pertaining to land acquisition or extended scope of stewardship will be undertaken in cooperation with the local community, and will follow all notice-related procedural requirements of Federal and state law.

Criteria to be used in assessing any proposed acquisition will include: (1) all Federal regulations and NERR guidelines then in effect; and (2) Narragansett Bay NERR land acquisition criteria, including community support (see Table 5).

Agreement for NBNERR stewardship of any given parcel of land may vary according to the particular ecological values of the land (i.e., "key" or "buffer") and the interests of the particular landowner. For example, the Reserve could negotiate conservation easements with private landowners whose property lay within the present administrative boundaries. Another landowner might choose to gain income or inheritance tax benefits by donating property, a portion of property, or a conservation easement to the Reserve. The NBNERR will work with interested landowners to explore techniques that will transfer some of all stewardship responsibilities in a mutually satisfactory way.

Techniques which the Reserve might employ include:

- outright purchase
- outright purchase or donation, with life estate to seller
- outright purchase, partial donation for income or inheritance tax benefits
- donation or bequest of full title
- grant of limited rights (e.g., development, timber)
- grant of first right of refusal
- grant of conservation easement, retained right of residence

- lease with option to purchase
- land trade with or purchase from third party, followed by any of above
- memorandum of understanding, authorizing use by researchers without transfer of title

In addition to developing transfer agreements with private landowners, the NBNERR will work with private nonprofit conservation groups or other municipalities or agencies that seek stewardship assistance for estuarine habitat.

---

**TABLE 5**

**CRITERIA TO BE CONSIDERED IN NARRAGANSETT BAY NERR LAND ACQUISITION  
(In addition to Federal regulations and NERR guidelines)**

It is not possible to identify the relative significance of these factors because the circumstances of each parcel of land are unique; in a given case, a single very strong factor could outweigh several others.

**Habitat Quality**

- Contains key land and water areas
- Excellent example of estuarine habitat typical of Virginian bioregion
- Degree of reversion or restoration needed/possible
- Shape: edge effect
- Potential linkages
- Community composition, structure, dynamics, interactions

**Consistency With Reserve Objectives**

- Estuarine habitat of a type inadequately represented within Reserve
- Provides buffer against existing or probable future impacts for portions of ecosystem which are already under Reserve stewardship, or which are reasonably anticipated acquisitions
- Fulfills research and monitoring, education and interpretation, stewardship, or facilities purposes, or other management needs identified in NBNERR Management Plan

**Cost**

- Cost of acquisition (including long-term savings on overall Reserve costs, e.g., increased efficiency, improved security)

**Degree of Threat**

- Imminence of development
- Presence of state or Federally listed threatened and endangered species
- Protected or protectable by other programs

**Defensibility**

- Area adequate for continued functioning of ecological unit (as is, or will be with reasonably anticipated adjacent acquisitions)
  - Adequately buffered from adjacent existing and/or anticipated future land uses (as is, or will be with reasonably anticipated additional acquisitions)
  - Reasonably accessible for monitoring
  - Reasonable opportunity for management of public access
  - Low probability of succumbing to ecological pressures: encompasses full range of significant physical, chemical, and biological factors necessary for long-term viability (e.g., acceptable population levels, exotic species minimal or absent)
  - Expense of long-term monitoring and stewardship
-



## D. Proposed Acquisitions

Future acquisitions are not prioritized but all rank highly based on the criteria in Table 5. The opportunity to acquire these parcels is driven by owner willingness and circumstances and the availability and mechanism of funding. For example, the Heritage unit became available when the former owner needed funds for other purposes. The Champlin Foundation advanced private money and The Nature Conservancy purchased title. Several years later, Federal funds were provided and the parcel was acquired by the state in a "bargain sale," then added to the Reserve.

- Dyer Island - 20 acres

Approximately 0.5 mile east of the Reserve T-wharf at the south end of Prudence Island, this privately owned island has been a major rookery for numerous species of shorebirds, which have been monitored by state wildlife biologists since 1985. Nesting declined dramatically in 1992 as a result of a hurricane in the fall of 1991 which inundated the island and killed some of the vegetation previously used for nesting. Since then, the island has shown signs of vegetation regrowth. A 1992 NBP-funded study identified Dyer Island as a critical habitat for nesting birds and recommended the island for some form of protection. The report also ranked Dyer Island as second only to Rose Island for diversity of macroalgae, and for this reason suggested that the island be protected. Forty-seven species of macroalgae were identified in the waters off Dyer Island.

- Ballard Property - 100 acres

This privately owned 100-acre tract abuts the northern boundary of the Reserve's Heritage unit and includes both upland forests and freshwater wetlands. The wetlands are part of the wetland system originating on the Heritage unit of the Reserve and flow into the Barre unit to the north. Acquisition of the Ballard Property would enhance protection of the entire freshwater wetland stretching through two other units of the Reserve and is important to the protection of the Indian Spring well on the Barre unit, which is the major source of drinking water for Prudence Island residents. In addition, the acquisition provides an important link creating a Reserve greenway from Providence Point at the north end of Prudence Island to the T-wharf at the south end. This greenway would stretch the entire 7-mile length of the island.

- Nag Creek Marsh—West and Jenny Creek - 40 acres

The entire eastern portion of this tidal system is within the boundaries of the Reserve. The purchase of the western half of Nag Creek adjoining Jenny Creek and associated uplands owned by Luther Blount of Warren, R.I., would protect these extensive coastal marsh systems. Numerous birds nesting at the Hope Island rookery (within the Reserve) wade in the shallow waters of the creeks and catch fish to feed themselves or their young back at the rookery. A variety of terrestrial mammals, fish, and invertebrates also utilize this marsh habitat.

- Little Unit—Phase II - 50 acres

The acquisition involves 50 acres of the eastern portion of property owned by Barbara Little adjoining the western 39 acres of the property which was purchased and incorporated into the Reserve in 1991. This proposed acquisition would help to protect the fragile salt marsh system on the west side of Prudence Island. It also abuts the watershed for the Prudence Island water supply, which is drawn primarily from the Indian Spring well on the Barre unit of the Reserve.

- Bacon Shorefront - 30 acres

This land, comprising 30 acres and desert area, owned by the Bacon Family Trust links the Ballard property to the Little unit and is a key acquisition in the Reserve greenway running the length of Prudence Island. This property has an undisturbed metamorphic rocky shoreline distinct from the sedimentary rock outcrops along the western shore of south Prudence. Several endangered species of insects inhabit the sand barrens area, locally called the "desert."

- Dutch Island - 300 acres

This island at the mouth of Narragansett Bay is already in state ownership so no acquisition cost would result from inclusion of this island in the Reserve. It has historic significance since it was

used by Dutch traders during the Colonial Period, has a Civil War Battery, and numerous World War II military remains. The island's southern shore is cliff with deep water adjacent to it.

- **Fort Wetherill**

This site is already in state ownership so there would be no acquisition cost. The site has high cliffs facing Rhode Island Sound and is used extensively by scuba divers because of the relatively clear water and diversity of subtidal life. This property is on Conanicut Island, which is accessible to the mainland via bridges. Therefore, public access to this site is better than exists at any other Reserve property. This would provide an outstanding opportunity for education, interpretation, and compatible recreational uses. The fact that this site is on the open ocean would provide significant research and monitoring opportunities, expanding Reserve sites from the Upper Bay to the mouth of the Bay.

- **Colt Park**

A small section of Colt State Park, already in state ownership, could be added to facilitate visitation to the Prudence Island units. NOAA has already provided funds to construct a dock at Colt Park (for ferry service to Prudence Island units) and DEM has placed wayside exhibits near the dock to inform the public about the Bay and the Reserve. Colt State Park is in the town of Bristol on the mainland so it is readily accessible. This would be a very convenient site for education and interpretation.

- **Prudence Park (Chibachuweset) Preserve**

The ASRI acquired 240 acres of waterfront and uplands along the southwest shore of Prudence Island in 1997. They have expressed an interest in including this property under the jurisdiction of the Reserve. Their holdings about the NBNERR South Prudence unit and the Heritage unit.

## **E. Boundary Expansion**

Establishing boundaries of Reserves connotes a degree of control by the managing entity over human activities and the resident natural resources with the Reserve. Generally, Reserve boundaries will encompass both core and buffer areas. Control is exercised by direct ownership or jurisdiction by the Reserve or by indirect means such as easements and administrative measures.

Reserve boundaries are proposed by the state and approved by NOAA. Criteria for setting boundaries are contained in the NERR System regulations, 15 CFR Part 921. The procedure for proposed boundary delineation includes the following elements:

- **Conduct a natural resource inventory of the proposed site(s):** Identify the boundaries on the landward and/or water side. The inventory would consider land form, flora and fauna, land or water use, natural delineation between discrete land forms or water bodies, and physiochemical characteristics.
- **Identify core area:** Determine and rank the most important ecological units essential to maintaining the representativeness of the area and its resources.
- **Identify buffer areas:** Human activities or natural processes occurring outside the core areas could pose a risk to the integrity of core areas. The buffer area must help ensure the long-term viability of the core for research, monitoring, and educational purposes.

Once the proposed acquisitions identified above are acquired, changes in the boundary of the Reserve may be made following written approval by NOAA (CFR Part 921.33). Future boundary expansions may include other state properties presently under jurisdiction by other state or Federal agencies such as Dutch Island, Gould Island, Fort Wetherill, Colt State Park, and the ASRI property. The seaward boundary will also be adjusted to achieve jurisdiction over inadequately represented open water areas and soft bottom habitat.





## F. Action

- Complete the site profile document required by NOAA for each Reserve to include proposed new additions.
- Expand administrative boundaries in aquatic habitats as shown in Figure 3.
- Prepare acquisition plan conforming to NERR System requirements (15 CFR Part 921.13(a)(7)).
- Obtain financial assistance from NOAA, the state of Rhode Island, or other sources to acquire identified key parcels.
- Acquire core and buffer areas listed in Section D.
- Extend jurisdiction and stewardship over the newly acquired units of the expanded Reserve.

The cost and schedule for accomplishing the action items will depend to a great degree on opportunity and funding availability. Partners to help implement acquisition plans will include the DEM Division of Planning and Development, which will prepare the grant package for accessing Federal funds and will accomplish the various administrative details of the transaction to meet NOAA requirements; The Nature Conservancy, which will assist as appropriate with acquiring private funds and facilitating the process much as they have functioned in previous acquisitions.

Prudence Conservancy, a local land trust and support group, may facilitate, acquire, manage/monitor, or otherwise support the acquisition process consistent with NOAA needs and requirements.





# Public Involvement and Access Plan

*CHAPTER VII*



Public involvement is key  
to the accomplishments  
of most Reserve programs.





## VII. PUBLIC INVOLVEMENT AND ACCESS PLAN

### A. Mission

The mission of the NBNERR regarding public involvement and access is to create opportunities for the public to contribute to and benefit from the NBNERR through participation in Reserve operations, research, monitoring, and education.

### B. Policy

Community contributions of time and talent can be among the most significant components of Reserve operations and are recognized as such. It is the policy of the NBNERR to provide volunteers with a working environment of at least the same quality as that enjoyed by paid staff. Individuals and groups who offer their services to the Reserve are entitled, at a minimum, to efficient administrative support, adequate workspace, and planning, orientation, scheduling, training, and supervision as needed.

The Reserve also recognizes an obligation to provide interested volunteers with unique activities and learning opportunities. These opportunities may consist of learning new skills on the job or participating in events such as "volunteers-only" guided walks to the more remote portions of the Reserve. Ideally, Reserve volunteers grow in abilities and understanding in exchange for their contributions to operation of the Reserve.

### C. Goals

The NBNERR public involvement plan has three goals:

GOAL I. Create public understanding, appreciation, and support for the Reserve.

GOAL II. Expand and/or improve research, monitoring, or educational activities.

GOAL III. Provide unique experiences and benefits to participants.

### D. Background

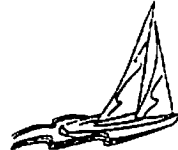
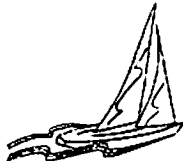
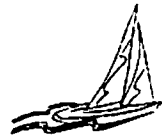
Public access to Reserve lands is encouraged consistent with the NBNERR zoning plan. Most of the Reserve's natural areas are accessible to hikers by an island-wide network of trails (Figure 7). The South Prudence Field Station, learning center, and recreation areas are open to the public at prescribed times. Certain areas used for research or possessing important natural or historical resources may be restricted.

The Reserve's activities to encourage public involvement will be expanded when volunteers can be provided with a work area (see Chapter VIII, Facilities Plan).

Groups and service organizations have provided significant volunteer benefits to the Reserve. Several have supplied labor and skills for large trail-related projects which could not otherwise have been accomplished. These groups include The Nature Conservancy, Prudence Conservancy, Save The Bay, and many others.

Volunteer work assignments can range from a few hours to many years; volunteers may choose to support routine operations or offer their services for one-time-only projects.

Participants in the Reserve's Public Involvement Program have ranged from school groups to experienced retirees. Some contribute skills acquired during professional careers, while others bring enthusiasm and willingness to learn from staff and other volunteers. Some volunteers are local residents who want to learn more about their environment, while others are already well informed and want to share their expertise with the public.



**— TRAIL MAP —**  
**Narragansett Bay National Estuarine Research Reserve**

- Walking Trails
- Picnic Area
- Research Laboratory
- Naturalist's Building
- Parking

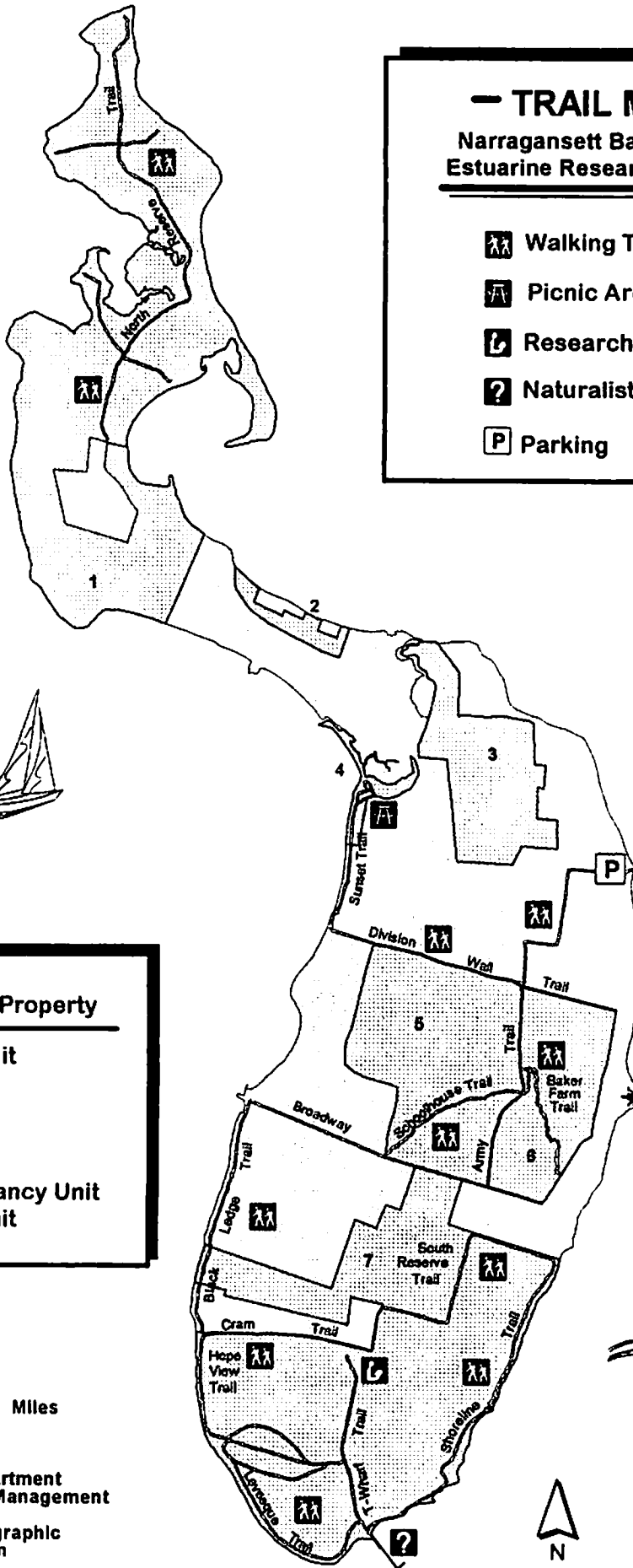
**Research Reserve Property**

- 1 North Prudence Unit
- 2 Blount Unit
- 3 Barre Unit
- 4 Little Unit
- 5 Heritage Unit
- 6 Prudence Conservancy Unit
- 7 South Prudence Unit

0.3 0 0.3 0.6 Miles



Rhode Island Department of Environmental Management  
 Rhode Island Geographic Information System



*Ferry Landing*

*Sandy Point Lighthouse*  
 Built in 1923 on Goat Island, the lighthouse was moved to Prudence Island in 1951. It is the oldest existing lighthouse in Rhode Island.

Originally named Chibachweset, the island was purchased from two Indian sachems by Roger Williams and Governor John Winthrop of Massachusetts. The name was changed to Prudence, not a woman's name, but a virtue that all should seek.



**Figure 7. NBNERR Trail Map**





At present, the following volunteer opportunities are available on a limited basis:

- Operations  
Trail construction and maintenance  
Tree harvesting
- Research  
Field assistance
- Monitoring  
Water quality analyses  
Weather station operation
- Education  
School programs  
Guided walks  
Informational displays

The existing activities are discussed in more detail. See sections of the plan covering research, monitoring, education, and public access.

The scope and scale of public involvement and access of the Reserve will be enhanced by the construction of permanent facilities at south Prudence and future boundary expansions.

## **E. Action**

Provide public access to Reserve property and facilities.

- Provide visiting hours for the public at the south Prudence learning center.
- Expand and improve the hiking trail network.
- Provide recreational facilities at south Prudence, including swimming beach, ballfield, and picnic areas.

Create public understanding, appreciation, and support for the Reserve.

- Continue and expand the existing programs involving the public and focus these activities at the learning center.
- Publicize the Reserve and the ongoing activities to increase support of the local community.
- Collaborate with Save The Bay and the NBP to reach a statewide audience and generate public understanding and support for protecting the quality of Narragansett Bay.
- Preserve public access and utilization of facilities by public groups.

Expand or improve research, monitoring, and educational activities.

- Publicize opportunities for volunteer activities.
- Train, equip, and supervise volunteers to assist visiting scientists on specific research projects.



*Reserve management  
may facilitate public access,  
but its primary obligation  
must be to maintain the  
integrity of the Reserve....*

- Conduct long-term air, land, and water-quality monitoring augmented with citizen volunteers.
- Involve the local community in on-site educational activities.
- Acknowledge volunteer contributions and provide for public recognition of outstanding volunteers.



# Facilities/ Construction Plan

## CHAPTER VIII



*Visitors quarters  
and research and  
education facilities  
reside on Reserve  
property.*





## VIII. FACILITIES/CONSTRUCTION PLAN

### A. Goal

NBNERR physical facilities consist of all buildings, utilities, vehicles, equipment, roads, trails, docks, and all associated appurtenances. The goal is to provide all facilities that are necessary for public access and support the programs of a fully functioning Reserve and to achieve the mission of the Reserve.

### B. Objectives

- Provide accessible facilities to fulfill the Reserve's mission and meet local, state, and Federal accessibility requirements.
- Provide facilities to support the NBNERR mission in research and monitoring.
- Provide facilities to support the NBNERR mission in education.

### C. Guidelines and Policies

- Facilities are provided and operated to accomplish the Narragansett Bay NERR programs and achievement of the Reserve's goals.
- Facilities also serve a more subtle and powerful role as physical expressions of the NBNERR values and priorities. Through choices in facility siting, design, and construction materials, NBNERR communicates—or inadvertently contradicts—its core message. Buildings, trails, and roads function as exhibits that may illustrate or ignore responsible ecosystem management.
- Accordingly, the NBNERR will be guided by a set of core principles in all facility development.

#### Principles Applicable to All Facilities

- All facilities will, at a minimum, comply with the requirements of the Americans with Disabilities Act.
- To the greatest extent possible, facilities will be designed and located to support multiple Reserve goals.
- Planning for any significant new facility will consider input from groups expected to use the facility.
- Facility siting factors will include consideration of impacts from increased site use, including parking and storm water, wastewater, and sewage disposal.
- Construction techniques shall be adapted for minimal environmental impacts, with particular attention to possible accelerated runoff, erosion, pollution (including vehicular), and soil compaction issues.
- To the greatest possible extent, facilities and equipment planning and purchases will strive for energy efficiency and anticipate technological advances.

- Runoff from roads and parking lots will be directed whenever possible through an adequate vegetative filter prior to entering any water body.
- Siting of all buildings and vehicular and pedestrian access routes will be consistent with NBNERR stewardship and land-use planning.
- Buildings will be as unobtrusive as possible in both site and form. Design will be as compatible as practical with the character of the local community.
- Facilities and access routes will create minimum visual impact or obstruction to scenic views both within and beyond the Reserve's administrative boundaries, recognizing that walkways or other structures may alter the view but not negatively impact it if carefully designed.
- Only native plant species already found within the Reserve or historically growing in the area will be used in new plantings.

#### **D. Existing Facilities**

Most buildings and appurtenances owned by the NBNERR consists of houses, garages, shops, sheds, and docks that pre-date the 1993 expansion of the Reserve to include south Prudence. The exceptions to this include the docking facility at Potter Cove and nearby weather station located on the North Prudence unit and the field station completed in 1996.

In 1993, the DEM Division of Planning and Development completed a facilities master plan to assess the existing conditions and future renovation and construction necessary for the Reserve to accomplish its mission and programs. This study found that the former U.S. Navy World War II structures were in need of repair and alterations. Several structures were beyond economical repair and slated for demolition. Subsequently, a NOAA grant was secured to initiate the repairs, alterations, and construction. The actions below detail a four-phase initiative to upgrade the facilities. The most significant project is the development of a multipurpose headquarters complex at south Prudence. Space will be provided for a field research laboratory, education classroom, and headquarters office. This structure is an essential first step in the process of bringing the NBNERR to the status of a fully functioning Reserve.

Existing major facilities of the Reserve include a small boat dock at Potter Cove, the research weather station nearby, and facilities at south Prudence, which include the following:

field station with learning center, research lab and office  
garage and maintenance building  
caretaker/supervisor's house  
overnight visitors' cottage  
deepwater, large, T-wharf and floating, small-craft dock  
small interpretive building at T-wharf  
temporary manager's office  
carpenter shop  
former U.S. Navy mess hall (unused)  
various storage sheds and outbuildings (mostly unused)  
utilities, including electrical, telephone, drinking water, and waste disposal systems  
concrete roadway system  
sports field  
picnic area  
beach



## E. Facility Needs

The NBNERR now has an on-site facility to serve as a focus for operations and programs. The previous lack of office, meeting, and storage space has hindered the cost-effective management of the Reserve since its inception in 1980. The new building provides educational exhibit space, a research lab, meeting rooms and the NBNERR office. This facility now provides adequate support for year-round activities at the site, enhances communications with SRD and other Reserves, and meets other requirements for a fully functional NERR.

Until recently, the physical isolation of the NBNERR in the center of the Bay, several kilometers at the closest point to the mainland, has constrained the accessibility of the Reserve for scientific investigations. In the past several years a new car/passenger ferry was placed in service with a minimum of four round trips a day in winter and five trips weekdays to seven trips on Sundays. The presence of an on-site manager has provided a point of contact for coordinating and supporting field investigation. Visiting scientists have been heavily utilizing the overnight facilities, especially in the active summer months. The research lab supports scientists to fully utilize the attributes of this unique site. The facilities and equipment are available for multiple users, and the scientific community has significantly expanded research in this less studied and important area of Narragansett Bay. Experience to date has indicated a high potential for original, multidisciplinary studies that would add immeasurably to our understanding of this complex marine system.

At present there are no suitable research or educational support facilities at the NBNERR. The research opportunities being hampered or lost involve those requiring on-site facilities to store heavy or bulky equipment that is not feasible to transport on a daily basis. This equipment could include anchor dredges, box corers, otter trawl, fyke nets, cages, and scuba gear.

The availability of laboratory space and equipment would enable prompt and effective sample preparation where timeliness is essential to preserving the sample qualities being measured. The ability to generate, analyze, synthesize and report data on-site will allow investigators to quickly discern if data gathered in the field is appropriate to the tasks performed, is sufficient in quantity and quality, and not lost due to equipment malfunction or error. Missing data can be easily regathered in the field before researchers leave for their home institutions.

Lack of adequate visiting scientists' year-round overnight facilities restricts habitation at the Reserve to warmer months and precludes winter seasonal studies which require researchers to stay on-site for several days or more.

At present, the focus of on-site education and interpretive programs is outdoors, using foot trails and pre-determined routes to guide people to unique features of the Reserve. An educational hikers' guide helps Reserve visitors learn more about the Reserve in an informal manner. Wayside exhibits provide another educational component and are an integral part of the Reserve's educational strategy.

However, the recently completed indoor educational exhibits and library space allow year-round protected space for the full range of endeavors to educate a diversity of public individuals and groups.

## F. Action Plan

### 1. Phases

The facilities plan is divided into four phases and is dependent on availability of Federal funds.

#### a. Phase I (completed in 1995)

NOAA has provided a 1994 grant of \$375,000 and a second grant in 1995 of \$241,000 to accomplish Phase I and II construction and alterations which included:

- Replace flat roofs on the caretaker's cottage, visiting scientists' quarters, and the existing carpenter shop.



- Renovate 2,500 square feet at the north end of the existing carpenter shop to provide 900 square feet for a field research laboratory, 500 square feet for an education center, and 650 square feet for administrative and common space.
- Provide water and sewage disposal facilities for the renovated multi-purpose space.
- Remove asbestos from piping and heating systems in the cottages and shops.
- Revise main electrical service to eliminate safety problems and conserve energy.
- Provide exterior siding and trim for the carpenter shop, which includes the headquarters.
- Accomplish site work and landscaping.

**b. Phase II (completed in 1996)**

Phase II involved further upgrades to the cottages and completion of tasks to provide a fully functioning multi-purpose headquarters building:

- Replace roof over the headquarters building.
- Equip research laboratory and educational facilities.

**c. Phase III**

Phase III will complete upgrading the cottages and improving weather tightness, energy efficiency, and safety of the cottages and headquarters facility:

- Replace existing electrical system with new panel and interior wiring.
- Replace existing steam heating system with energy efficient oil-fired hot water heating system including baseboard units.
- Renovate baths and kitchens of both cottages.
- Replace windows and storm doors for the cottages.
- Insulate and weatherproof the maintenance garage.

**d. Phase IV**

Phase IV is the expansion of the educational facility at the T-wharf and construction of a wet lab for the field research station:

- Demolish abandoned former U.S. Navy structures including the mess hall, boiler room, and wood-frame garage.
- Expand educational facility, located at the T-wharf, to 400 square feet.
- Construct wet lab as a 500-square-foot addition to the field research facility.



- Provide a meeting room and two natural history laboratories at the field research station.

## **E. Estimated Schedule and Costs**

The primary determinants for scheduling the various phases of the overall plan is availability of Federal funds and machinations of the state procurement system.

The following schedule and costs is provided and are subject to change due to uncontrollable factors:

- Phase I                      Completion - 8/30/95  
   Cost            - \$375,000
- Phase II                     Completion - 8/30/96  
   Cost            - \$241,000
- Phase III                    Completion - 4/30/99  
   Cost            - \$320,000
- Phase IV                    Completion - 8/30/01 (depending on availability of NOAA funding)  
   Cost            - \$380,000





# Education, Interpretation, and Outreach Plan

## CHAPTER IX



Education increases public awareness and support for estuarine protection and enhances coastal zone decision-making.





## **IX. EDUCATION, INTERPRETATION, AND OUTREACH PLAN**

### **A. Introduction**

The NERR System was created in 1972, pursuant to the CZMA, to increase our ability to responsibly manage estuarine ecosystems. A critical aspect of this mandate for the NERR System is the education, interpretation, and outreach component. In part, a Reserve must “serve to enhance public awareness and understanding of estuarine areas, and provide suitable opportunities for public education and interpretation” (CZMA 315(b)(2)(C)). Within the NERR System, each Reserve is responsible for developing and implementing a program that links education to scientific research. Each Reserve’s education program functions independently, but all have commonalities with other education programs in the NERR System.

The Narragansett Bay NERR Education, Interpretation, and Outreach Plan is built on two basic premises: (1) that healthy estuaries and estuarine ecosystems are intrinsically and economically valuable to every member of society; and (2) that those who become aware of estuarine processes and products will be better equipped to protect estuarine ecosystems, and to assist and support coastal decision makers in development of wise estuarine management policy.

Everyone lives within an estuarine watershed. Anyone can influence an estuary’s future. People are capable of sustaining, significantly altering, or inadvertently destroying estuarine ecosystems through individual actions, business endeavors, and governmental policy decisions. But without information about estuarine ecosystems, it can be difficult to understand why such estuarine ecosystems matter, or to recognize when past or proposed activities will affect estuarine productivity.

The Narragansett Bay NERR Education, Interpretation, and Outreach Plan serves a geographically and demographically broad spectrum of people, providing access to accurate information about the biological and physical systems of estuaries. In addition to providing scientific information, the NBNERR Education, Interpretation, and Outreach Plan expands opportunities for people to simply experience for themselves the aesthetic and ecological riches of an estuarine ecosystem.

### **B. Mission**

The Narragansett Bay NERR education, interpretation, and outreach mission is to:

Increase awareness, understanding, and appreciation of estuarine systems and estuarine stewardship by facilitating access to information about estuarine systems, and by providing opportunities for personal experiences with estuaries.

This mission is accomplished through application of the policy and specific goals discussed below.

### **C. Goals**

In 1993, representatives from the NERR System began to develop the first integrated, system-wide education plan. Completed in 1994, the education component of the plan envisions the NERR System as a national system of resource centers specializing in estuarine and watershed education. The goal is to design and implement a comprehensive program of education and interpretation based on solid scientific principles to strengthen the understanding, appreciation, and stewardship of estuaries and associated coastal habitats. The goal capitalizes on the NERR System’s unique ability to directly link education, research, stewardship, resource management, and restoration.

Goals for Narragansett Bay NERR education, interpretation, and outreach activities were originally established in the 1982 management plan. In accordance with this plan, an education advisory committee, with representatives from a range of environmental and educational institutions and agencies, are convened as needed to assist in redevelopment of NBNERR education programs.



*A daily ferry runs from  
Bristol, R.I., to the east  
side of Prudence.*

The NBNERR Education, Interpretation, and Outreach Plan is governed by the following goals:

GOAL I. Provide high quality estuarine information and estuarine contact opportunities related to Narragansett Bay and to regional estuarine issues.

GOAL II. Promote understanding by coastal zone decision makers within the Narragansett Bay watershed and the Northeast.

GOAL III. Collaborate in the study and development of statewide estuarine education and interpretation programs.

## **D. Guidelines and Policies**

Education policy at the Narragansett Bay NERR is designed to fulfill the guiding principles for designing and implementing an education program as defined in the NERR System Strategic Plan. These principles are to:

- Educate about estuaries holistically to include ecological, cultural, historical, sociological, aesthetic, and economic purposes
- Approach estuarine education through a perspective that includes watersheds and biogeographic regions
- Address local, regional, state, and national coastal issues
- Promote a sense of stewardship and individual responsibility
- Increase understanding of and appreciation for the NERR System
- Provide on-site and outreach educational experiences

In addition to these guiding principles, "NERR Education: A Field Perspective" lists a series of more specific education objectives for reserves. These are to:

- Develop and operate as a system of sites
- Link education programs with research, management, and stewardship
- Develop programs that encourage citizen stewardship of estuaries
- Develop reserves as resource centers that address coastal issues of global, national, regional, state, and local significance
- Maintain a cadre of professional environmental educators in the NERR System
- Evaluate program quality and program cost effectiveness

This NBNERR Education, Interpretation, and Outreach Plan charts a new course for the Reserve. In the past, NBNERR has primarily emphasized the small segment of the Narragansett Bay estuary that is under Reserve management. Offerings for public audiences have centered on the Reserve's trail system and the summer naturalist program with exhibits on general estuarine themes. The school program has focused heavily on occasional structured activities for students visiting the site.

Through this plan, the Reserve will enlarge the geographic scope and audience focus of educational and interpretive activities and forge stronger links within the biogeographic region. New initiatives will concentrate on development of techniques for reaching additional audiences, such as coastal ecosystem managers and policy makers, and for contacting traditional audiences, such as students, regional visitors, and the local community, through innovative means. In particular, the Reserve will more actively seek opportunities for working partnerships with other agencies and environmental education and interpretive entities in the region.





## **E. Existing Program**

### **1. Introduction**

The NBNERR education and interpretive program includes activities both on-site and off-site. Activities within the Reserve boundaries utilize the unique ecological attributes of the site along with research and monitoring information. At present, the focus of on-site education and interpretive programs is outdoors, using foot trails and pre-determined routes to guide people to unique features of the Reserve. An educational hikers' guide helps Reserve visitors learn more about the Reserve in an informal manner. Wayside exhibits provide another educational component and are an integral part of the Reserve's educational strategy.

Education and interpretive programs are designed to place minimum stress on the ecosystem. Generally, on-site education activities will be conducted outside the critical research areas to prevent disturbance to research projects and to avoid disruption of sensitive areas of the ecosystem. In some cases, research projects will be involved in education activities. With careful management and coordination, education and research/monitoring programs will complement and enhance each other.

### **2. Education Opportunities**

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

#### **a. Hope Island Rookery**

Several areas are of special value to education. The extensive heron and egret rookery of Hope Island is a major theme to be developed in Reserve 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 nuisance species
- A commitment to protect the rookery and the salt marshes where these birds feed

On-site interpretive programs to Hope Island 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. Education about the rookery is an important management activity for increasing awareness in protecting this site.

#### **b. North Prudence Salt Marshes**

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

- The salt marsh as a good 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 ways that people have historically used salt marshes. The extensive ditching serves as a good example of past detrimental use

#### **c. North Prudence Farm**

A farm of historical value is located at north Prudence within the Reserve. The North End Farm is used for on-site interpretation utilizing wayside exhibits and self-guided pamphlets. Historical research conducted on this site has provided the background material necessary to provide in-



*Children learning the anatomy of the quahog using a large-scale puzzle.*

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 at the farm is 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. Vehicular traffic is prohibited and access is by foot trails.

#### **d. North Prudence Schoolhouse**

Another archeological site, the North End Schoolhouse, is located at north Prudence. This one-room school was established in 1854 and ceased operation in 1904. It remained standing until the late 1930s. The foundation of the schoolhouse is near Potter Cove where many recreational boats moor on weekends. 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.

#### **e. North Prudence Shell Midden**

There is an undisturbed Indian campsite of the Late Woodland period located at north Prudence. The site has middens containing the shells of oyster, quahog, soft-shelled clam, scallop, and slipper limpet. 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 the Indians. On-site interpretive programs at this site are not planned because additional archeological study should precede any further disturbance, and the stand of golden asters grows directly over the Indian encampment. However, the information gathered by archeologists studying the site provides valuable material that can be incorporated into educational pamphlets or brochures.

#### **f. Reserve Shore (South Prudence Unit)**

The shoreline of the Reserve provides an excellent on-site teaching area for communicating many important concepts. Interpretive programs, led by the Reserve naturalist, will be offered to the public on a regular basis and originate from the T-wharf on the south end of the island. Special interpretive programs will be arranged for groups.

From the shore, visitors see activities that illustrate the ways in which people utilized many of Narragansett Bay's resources. These activities include: commercial and recreational quahaugging, purse-seining 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 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 is also 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 are interpreted by a naturalist or through a self-guided pamphlet, so that people better understand some of the Bay's dynamic physical processes.

### **3. Site Accessibility**

The Reserve is located on three islands, with only the largest, Prudence Island, served by public transportation. A daily ferry runs from Bristol, R.I., to the east side of Prudence. The ferry landing is near the Barre, Little, Prudence Conservancy, and Heritage units of the Reserve and within walking distance for visitors arriving by ferry. In addition to residents of Prudence and day-trippers, a significant portion of visitors are recreational boaters.

#### **a. Facilities**

A 1,200-square-foot nature center was recently completed as part of the South Prudence Field Station. Educational exhibits and programs using these facilities are being developed in 1998.



## **4. Off-Site Programs**

### **a. Seasonal Statewide Estuarine Education (Naturalist Program)**

The implementation of an off-site estuarine education program has extended the impact of Reserve education beyond the borders of the Reserve itself and now includes Bay-wide state parks where large numbers of visitors go during the summer. It is the experience of DEM environmental educators that many of the people visiting these Bay-side parks during the summer are interested in Reserve-related education programs even though they may never visit the Reserve.

For many years naturalists conducted estuarine education programs for the 10-week period throughout the summer. Participants in these programs include people of all ages: children, parents, and senior citizens. These programs were offered to the public and to organizations who specifically made arrangements to come to the parks and participate in estuarine education programs.

During the course of each summer, approximately 12,000 people participated in these estuarine education programs. In addition, the naturalists set up and maintain estuary exhibits in six parks. These exhibits included artwork, live displays, and handouts for people visiting the exhibits. At least 15,000 people visited these exhibits during the summer. When the naturalists were not conducting education programs, they provided informal interpretation to people in the exhibit areas.

The people hired to serve as seasonal naturalists had background in estuarine ecology and had teaching experience.

Before the season began, the naturalists participated in a training program prepared by DEM. This training included additional estuarine ecology and the techniques of interpretation.

At present, state budget constraints have eliminated these off-site education programs. Every effort will be made to reinstitute this successful training program should funding become available.

## **5. Additional Elements of the Education Program**

### **a. Brochures**

The Narragansett Bay National Estuarine Research Reserve brochure gives visitors a more detailed look at the Reserve. It describes the purpose of the NBNERR Program and the place of the Reserve within the national system. It stresses the research and education aspects of the Reserve. It also discusses how these resources have been managed to protect them for future generations. Graphics and text present the natural features of each Reserve site, placing particular emphasis on the research to protect them. A section titled "Visitor Information" explains the services provided at each of the Reserve sites and describes the public access to these islands (completed 1983).

Narragansett Bay NERR's membership in a national program is indicated by the national NERR brochure, produced in 1992 through NBNERR and available at the Reserve.

Printed information about NBNERR is locally distributed both on-site and off-site through the seasonal naturalist program and also at local gatherings such as the Prudence Conservancy annual meeting.

### **b. Curriculum Materials**

Curriculum materials dealing with Narragansett Bay subjects have been developed. These educational materials have been distributed to teachers through workshops. Although these materials are now out of print, copies have been distributed to every elementary school and middle school in Rhode Island. Additional copies are available for loan from the Audubon Society of Rhode Island.

### **c. Wayside Exhibits**

Wayside exhibits have been designed and produced for several sites at the North Prudence Tract, South Prudence Tract, and Colt State Park, which is the gateway to the Reserve. Some of the wayside exhibits have been installed at important archeological sites where they 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 explain estuarine processes and how the resources of the Reserve are used and managed.



*Lobstering is the Bay's  
second most important  
fishery.*

#### **d. Hikers' Guide**

A hikers' guide has been developed to serve people using the Reserve on their own. The guide explains the different habitats that the visitor will encounter and describes the use of the Bay's resources and management strategies for protecting these resources.

#### **e. Citizen Volunteer Program**

The citizen volunteer program, supporting specific research projects and staffing the long-term monitoring activities, also provides educational opportunities. The volunteers receive training and orientation concerning the mission, objectives, and programs of the Reserve. These individuals are residents of the neighboring community to the Reserve. Their involvement builds support for the NBNERR and awareness of estuarine processes and is passed on, at least in part, to other members of the immediate community.

### **F. New Course**

The new direction of the education, interpretation, and outreach program is designed to reach a broad audience over a wider geographical area. There will be a new emphasis on outreach beyond the borders of the Reserve and an expansion of the media utilized to reach the potential audience. The topic of stewardship of estuarine resources will be a major new focus.

The NBNERR welcomes opportunities to contribute to and learn from the education and interpretation activities of other NERRs. In the course of new program development, particularly with respect to coastal ecosystem managers and policy makers, Narragansett Bay NERR will invite other interested NERRs to assist in identification of appropriate topics and techniques. NBNERR will also share curriculum development and educational research results with other Reserves. For planned collaborative ventures, see Section G, objectives 1a and 2b, tasks.

Other state and Federal agencies throughout the region are increasingly involved in environmental education and interpretation, and "ecotourism" is becoming a significant segment of the Rhode Island economy. Narragansett Bay NERR will actively seek partnerships and collaborative opportunities with other agencies and institutions as a means of extending its audience, and to facilitate the inclusion of estuarine information into displays, exhibits, training, or other programs involving environmental education and interpretation.

The availability of an education facility at the South Prudence unit will support year-round educational opportunities and enable indoor programs during adverse weather conditions. The facility will provide an on-site focal point and attract visitors to view permanent displays and interact with Reserve staff. A cooperative agreement with the Audubon Society of Rhode Island (ASRI) will provide a cost-effective partnership in conducting a comprehensive on-site education program.

The long-range plan is to provide ferry access from Colt State Park on the mainland to Potter Cove in the North Prudence unit. Docks suitable for ferry use have been constructed at Potter Cove and Colt State Park. Wayside exhibits interpreting the Reserve have been developed and installed at both sites. Once ferry service to the Reserve is established, a Reserve interpretive area will be developed at Colt State Park, making it the gateway to the Reserve.

Coastal ecosystem managers and policy makers of Federal, state, or local agencies become aware of Narragansett Bay NERR primarily through staff members' off-site participation in various advisory committees, workshops, and seminars. The NBNERR is gaining a higher profile among state agencies through the provision of technical assistance to a number of state natural resource committees, and opportunities for such participation have grown exponentially in recent years. Narragansett Bay NERR is also alerting a number of Federal and state agencies to the NERR System through participation in recently formed multi-institutional environmental education activities.

Narragansett Bay NERR staff recognize the "ripple" effect from their participation in multi-agency advisory groups, task forces, and planning committees. Staff will continue to respond to such invitations from agencies or other branches of Federal, state, or local government, and will begin research and design of initiatives that directly respond to this group's informational needs. A direct link has been made to CRMC, and a CRMC staff person has been designated to interact with the Reserve and improve understanding and communication between organizations.



## G. Action Plan

### 1. Goals and Objectives

GOAL I. Increase the awareness, understanding, and appreciation of estuarine systems by the general public.

Objective Ia. Provide on-site opportunities.

#### Tasks

- Institute a cooperative agreement with the ASRI to develop and conduct an on-site education program.
- Continue summer naturalist program.
- Continue to provide special tours, presentations, and programs by request.
- Develop newsletter to acquaint the public with Reserve activities.
- Build educational facilities at south Prudence and construct exhibits.
- Integrate research, monitoring, and education programs to enhance education products.
- Develop new promotional and educational brochures.
- Provide exhibits and develop programs using the South Prudence Nature Center.

Objective Ib. Expand off-site outreach.

#### Tasks

- Collaborate with the ASRI and STB to utilize their facilities, teacher training and public education programs.
- Participate in statewide events such as the Governor's Bay Day.
- Continue to participate in meetings, seminars, and advisory groups to increase awareness of the Reserve in the environmental community.

GOAL II. Promote understanding, disseminate research results, and provide technical assistance to coastal zone managers.

Objective IIa. Develop and disseminate education products to coastal zone managers.

#### Tasks

- Serve on advisory and technical committees of the CRMC and NBP and other Narragansett Bay watershed managers.
- Provide technical assistance to the CRMC, NBP, the R.I. General Assembly, and DEM on request.
- Disseminate educational products to coastal zone managers at the local, state, and Federal levels.
- Translate results of research and monitoring projects into products usable to coastal zone decision-makers.

Objective IIb. Collaborate with other institutions involved in estuarine education activities.

#### Tasks

- Provide on-site facilities and staff support where possible to the URI Environmental Training Center.
- Develop joint educational program with the DFW.
- Collaborate with the Rhode Island Sea Grant Program and the NBP to produce a "Narragansett Bay Calendar" for the interested public.
- Develop, with Rhode Island Sea Grant and the NBP, an analysis of economic dependence of Narragansett Bay activities to acquaint the public to the economic benefit of Bay use.
- Develop partnerships with the NBP and CRMC to reach coastal zone managers.





# Research and Monitoring Plan

*CHAPTER X*



Research and monitoring programs provide a scientific basis for coastal zone management decisions.







## **X. RESEARCH AND MONITORING PLAN**

### **A. Introduction**

The NERR System was created under the CZMA to increase our ability to responsibly manage estuarine ecosystems. The NERR System provides a mechanism for addressing scientific and technical aspects of coastal management problems through a comprehensive, interdisciplinary, and coordinated approach. Research and monitoring programs, including the development of baseline information, form the basis of this approach. NERR research and monitoring activities are guided by national plans that identify goals, priorities, and implementation strategies for these programs. This approach, when used in combination with the education and outreach programs, will help ensure the availability of scientific information that has long-term, system-wide consistency and utility for managers and members of the public to use in protecting or improving natural processes in their estuaries.

### **B. Research Plan**

#### **1. Mission**

The NERR System was established to recognize the fact that estuarine habitats were experiencing serious declines in quality, and rapid, widespread destruction. The system is designed to gather and provide information necessary to improve understanding and management of estuarine ecosystems by encouraging and supporting the activities of researchers in the field and by disseminating that information to the academic, scientific, and coastal management communities.

The research mission of Narragansett Bay NERR is to expand the scientific knowledge of estuarine processes to help address coastal resource management issues.

#### **2. Goals**

The Narragansett Bay NERR Research Plan is based on five goals:

- Promote opportunities for original basic and applied research toward the advancement of understanding of estuarine processes
- Support the use of NBNERR as a natural laboratory and reference site to assess status and trends of environmental quality in the Narragansett Bay estuary as representative of the Virginian bioregion
- Encourage and assist in a science-based multi-agency approach to ecosystem and watershed management to protect the quality and use of Narragansett Bay
- Develop and integrate appropriate scientific and technical information into the coastal resource management decision-making process
- Transfer scientific and technical information to the general public through integration with the Reserve education program

#### **3. Guidelines and Policies for Research**

##### **a. Research Goals of the NERR System**

Research policy at Narragansett Bay NERR is designed to fulfill the NERR System goals as defined in the NERR System regulations. These include:

- Addressing coastal management issues identified as significant through coordinated estuarine research within the system
- Promoting Federal, state, public, and private use of one or more Reserves within the system when such entities conduct estuarine research
- Conducting and coordinating estuarine research within the system, gathering and making available information necessary for improved understanding and management of estuarine areas

#### **b. Non-Staff Researchers**

Any researcher with adequate scientific qualifications and financial support may request permission to conduct estuarine research within NBNERR, and such requests are typically granted. Those who use the NBNERR as a research site may investigate fundamental questions of broad application, or may address particular management issues on topics consistent with the purposes of the Reserve. Qualified scientists, students, nonprofit research organizations, and local, state, or Federal agencies are among the entities that have conducted research at the NBNERR.

Projects that involve manipulation of habitat may require advance approval by NOAA and must be approved by the NBNERR Management Council. By Federal regulation, projects known to be destructive to habitat or otherwise counter to NBNERR goals are not permitted. Projects which have been approved must be discontinued if they prove to be destructive.

All visiting researchers are asked to complete a form briefly summarizing their proposed work and research site(s) within the Reserve to avoid duplicative projects or incompatible projects at the same site. To ensure access, researchers are requested to contact the NBNERR whenever they intend to visit the Reserve.

#### **c. Research Topics (Priorities for Research Funding)**

Research by independent or Reserve staff scientists may be conducted in the Reserve on any topic consistent with the NERR System goals, and may be funded from any source. In practice, the topics investigated by both staff and independent researchers at the Reserve are typically those that have been prioritized by NOAA. NOAA is one of the most common research funding sources, and its research funds are preferentially awarded to proposals reflecting NOAA's national research priorities (see "NOAA Funding Priorities" below).

Reserve-initiated research proposals, regardless of funding source, should be compatible with NOAA guidelines. NOAA SRD-supported research. They may be oriented to a specific Reserve, but projects that benefit more than one Reserve are given a higher funding priority.

#### **d. NOAA Funding Priorities**

NOAA's Sanctuaries and Reserves Division (SRD) is a significant source of research funding for both independent and NERR staff researchers. NOAA regulations (15 CFR Part 921.50(a)) specify the purposes for which research funds are to be used:

- Support management-related research that will enhance scientific understanding of the Reserve ecosystem
- Provide information needed by Reserve managers and coastal ecosystem policymakers
- Improve public awareness and understanding of estuarine ecosystems and estuarine management issues.

NOAA encourages coordinated research among Reserves and other scientists by preferentially funding research proposals on specific estuarine topics that it has identified as national priorities (Table 6). This unified approach promotes the exchange of research findings among Reserves, state



and Federal agencies, and members of the academic research community.

Research funding priorities for the NERR System were first established in 1984, when a group of leading scientists convened to evaluate the status of estuarine knowledge. The group identified a diverse set of estuarine issues which were to receive top priority for research funding. These included:

- Sediment quality
- Nutrient enrichment
- Chemical inputs
- Coupling primary and secondary productivity
- Fishery habitat requirements

The NERR System research program was re-evaluated in 1991 and again in 1994. Under the previous system, NOAA identified an overall research objective, with a set of sequential research priorities through 1996. In 1997, the cooperative research program changed to a graduate fellowship program with a minimum of two fellowships supported at each site (Table 6). Every two years, the NERR System will review future research needs and establish the next two-year research priority. Consideration may also be given to project proposals of special merit that address other significant coastal management issues on a regional or national scale; however, funding availability will be determined after the primary research priority has been addressed.

---

**TABLE 6**

**SRD-FUNDED RESEARCH PRIORITIES, 1993-1998  
THE NATIONAL ESTUARINE RESEARCH RESERVE SYSTEM**

The current goal for SRD-funded estuarine research is to study natural and anthropogenically induced change in the ecology of estuarine and estuarine-like ecosystems that comprise the NERR System.

This research priority recognizes that we do not yet understand the range of natural and human causes and effects of change within estuarine ecosystems, nor do we adequately understand how change within adjacent habitats affects estuarine ecosystems. The increasing pressure of residential and industrial development in estuarine areas underscores the need for integrated, interdisciplinary research. Scientific studies of the processes of estuarine change will strengthen the information base for development of management policy throughout the bioregion.

NOAA has identified three aspects of estuarine ecological change for particular emphasis:

1993-1994	Nonpoint Source Pollution (pollution inputs from non-focused or non-identifiable sources)
1995-1996	Habitat Restoration (restoration of habitats that have been altered by cultural activities and/or inputs)
1997-1998	Graduate Research Fellowships

Every two years, NOAA will review future research needs and establish the next two-year research priority.

---



*The Reserve is serving as a regional benchmark for status and trends of the ecosystem health of Narragansett Bay.*

#### **e. Research by the NBNERR**

In addition to the national funding priorities, NOAA recognizes that individual Reserves may adopt site-specific approaches to issues such as natural resource status and trends, contaminant fate and effects, system processes, and assessment of anthropogenic influences.

The NBNERR has developed a set of priority topics for research at the Reserve (Table 7). These NBNERR priorities represent aspects of the national priorities of particular significance to the Reserve. In all cases NBNERR research priorities involve aspects of the physical, chemical, or biological processes that characterize or affect estuarine systems. The Reserve's management council is typically advised of the focus, application, and potential policy implications of research proposals being submitted to funding agencies.

Proposals initiated by Narragansett Bay NERR visiting research scientists may be funded from any source. Regardless of funding source, however, all research and research-related projects undertaken by the Reserve are reported to the national research coordinator to facilitate system-wide use and coordination.

---

**TABLE 7**

#### **NBNERR RESEARCH PRIORITIES, 1995–2005 Status and Trends of Ecosystem Health**

NBNERR research priorities for 1995–2005 apply NOAA's current research priorities to the Reserve context under the theme of "status and trends of ecosystem health." The Reserve has identified three areas of emphasis within this theme and specific issues of Reserve management concern.

##### **1) Investigation of links between land-margin ecosystems**

- Atmospheric deposition of contaminants
- Material transfer links among near shore, estuarine, and coastal upland habitats
- Relationships between levels of fecal coliform bacteria and estuarine shellfish contamination
- Contaminant transport and exposure
- Mechanics of tidal flux and advective circulation
- Larval transport within and among estuaries

##### **2) Assessments of functional biodiversity and ecology (e.g., species richness, relation to habitats, population dynamics, species interactions)**

- Extent and distribution of indigenous eelgrass
- Biology and ecology of introduced eelgrass
- Effects of invasive (nonindigenous) species
- Distribution and abundance of larval and juvenile fish
- Biological effects of contaminants
- Biology and ecology of estuarine invertebrates
- Conservation biology and functional refugia
- Impacts of episodic disturbance and regional climate change on estuarine communities
- Biology and ecology of forests and uplands

##### **3) Evaluation of the effects of human disturbance and natural stressors**

- Effects of boater wastes on small embayments
- Nonpoint source pollution and discharge into estuarine habitats
- Influence of oyster cultivation on sediments, infauna, and epifauna
- Effects of landfill runoff on estuarine tidelands
- Experimental evaluation of restoration and enhancement techniques for eelgrass, tidal wetlands, and fringing uplands
- Overharvesting of fish and invertebrates

---



## **4. Research Implementation Strategy**

### **a. Support Services**

The Narragansett Bay NERR provides administrative, physical, and informational support for estuarine research by scientists and students from universities, research institutions, and other agencies. The Reserve supplies services and equipment to staff researchers and to visiting investigators, and provides sites on the Reserve suitable for research. The Reserve is also participating in the NERR national monitoring program by developing an inventory and continuing record of Reserve biotic and abiotic conditions which can be used by researchers as background data and by coastal ecosystem managers to track long-term trends (see "Monitoring Plan" below).

Visiting scientists' quarters are provided in the guest cottage at south Prudence. This facility is available for overnight or longer periods such as seasonal occupancy.

A 1,200-square-foot field station laboratory is available for all resident and visiting scientists. The lab is furnished and there is a modest array of scientific instruments and appurtenances for common use.

The Reserve land and water areas are extensively mapped, and data are in the Rhode Island Geographic Information System (RIGIS). These data are available to all. Support for producing maps or other technical assistance is the responsibility of the individual researcher.

A fully equipped meteorological station is located at Potter Cove. Data are accessible by modem to authorized users.

A citizens volunteer group from Prudence Conservancy is available for assisting the researchers in gathering field data and operating or maintaining equipment. They have provided support for studies such as atmospheric deposition of nutrients and determining the available drinking water supply on Prudence.

### **b. Reaching the Scientific Community**

To increase awareness within the scientific community of estuarine research opportunities at the NBNERR, the Reserve annually prepares a description of research projects consistent with current NOAA funding priorities that can be carried out at the Reserve. This list is mailed to prospective researchers and research centers in the region, including marine stations, universities, state agencies, Federal agencies, and private consulting firms. The scientific community also learns of NBNERR as an estuarine research site through publication of research results in technical publications and journals and an outreach effort involving personal contacts with groups and individuals likely to have an interest in the Reserve as a site for research.

Graduate and post-graduate students become aware of research opportunities at the Reserve through written notices, lectures, and by published studies, and are encouraged to use Reserve sites for thesis and doctorate work. Students may become involved in research through internships and through temporary staff positions.

The NBNERR funds selected outside research projects that are consistent with the mission, goals, and priorities of the Reserve. Generally, the funding is limited and used for enhancing an ongoing project to add sites in the Reserve or to provide "seed money" to encourage a scientist to address specific needs of the NBNERR.

### **c. Availability of Scientific Information**

The Narragansett Bay NERR also facilitates research by making available information about historic conditions in the ecosystem, and by maintaining visual and quantified records of selected aspects of the Reserve's natural systems (see "Monitoring Plan"). Reserve background information includes aerial photos documenting coastal configurations, vegetation, and land use patterns. Sampling stations for measurement of water quality have recently been established, with further refinement and improvements currently underway.

As discussed in the "Monitoring Plan," a community profile of the Reserve was prepared in late 1996. The Reserve provides all of its inventory and monitoring information to researchers and managers in a computerized Geographical Information System (GIS) format, which can be readily adapted to varying needs. A GIS system, coupled with an electronic network, is likely to prove





*Scientists are determining the importance of salt marsh habitat to estuarine fishes.*

most useful for staff, other agencies, and other estuarine ecosystem managers, and will allow the Reserve to more fully achieve its mission for the region.

The Reserve is serving as a regional benchmark for status and trends of the ecosystem health of Narragansett Bay. The NBNERR will also conduct research to determine the degree and kind of degradation that has occurred, and will research cost-effective restoration techniques. Particular focus will be given to restoration issues frequently encountered in the bioregion. Research will therefore include assessment of change and approaches to restoration of estuarine functions for eelgrass beds, ditched marshes, and improving habitat in uplands. Habitat restoration or alteration in connection with this management-oriented research is not expected to have adverse effects and will be conducted with NOAA approval (as required by Federal regulation, 15 CFR Part 921.1(e)). The results of this research are intended to help ecosystem managers for coastal communities identify and measure ecosystem changes in other regional estuaries and to test how new, restorative changes might best be accomplished.

The NBNERR seeks to assist in developing a coordinated system for agency-sponsored research and data acquisition. Agencies' research needs could be met more efficiently and at lower cost through establishment of agreed priorities and Memoranda of Understanding to facilitate cooperative work.

On a more local scale, the Reserve supports the concept of a joint venture arrangement among the local, state, and Federal agencies involved in management of Narragansett Bay. Such a consortium can develop a prioritized list of research issues on topics identified by the group as priorities, create an extensive, shared technical database, apply for research funds, and conduct field work. The NBP will be a major partner in such collaborative projects.

Dissemination of information about on-going or completed research is one of the most important functions of any NERR. The NBNERR will pursue a highly active approach to the dissemination of research results. Staff are encouraged to submit papers to and otherwise participate in local and national professional meetings and conferences where research results or research possibilities will be of interest. Information about NBNERR research is provided to SRD and other resource management-oriented publications, and is directly shared with other NERRs as appropriate. Research results are communicated to the general scientific community through publication in technical journals and to professional audiences through special interest publications. Research results are also incorporated in presentations to higher education faculty and students.

Research-based technical information is currently disseminated to coastal ecosystem managers by several means. NBNERR staff participate in state and local agencies' advisory groups, such as the NBP Technical Advisory Committee and the CRMC (issues involving management of estuarine, near-shore, shoreline, and submerged lands). Education, interpretation, and outreach initiatives will be developed in this planning period which are specifically aimed at that audience (see "Education, Information, and Interpretation Plan: Providing Information to Coastal Ecosystem Managers"). Staff also communicate technical information through informal contacts with a variety of local and regional agencies whose activities affect the estuarine habitat.

At present, staff are highly responsive to requests for information drawn from research in the Reserve, but for each response, information must be compiled from assorted "hard-copy" documents in a highly time-consuming process. NBNERR will seek funding for systematic organization of all research that has taken place within the Reserve. This database will include the complete inventory generated under the Reserve monitoring plan, together with results of other studies conducted within the Reserve. This compilation is expected to provide coordinated, readily accessible background data for future NBNERR management decisions and research.

#### **d. Personnel Support**

The NBNERR staff may provide occasional services on request for physical assistance in field studies, on-island transportation, and small boat use for aquatic research. Providing personal services to support visiting scientists will be more common in the future when NBNERR adds a full-time research coordinator to the staff.

The NBNERR utilizes temporary help or grant-supported individuals to accomplish its research goals and collaborates with visiting scientists. These temporary positions can include staff positions, internships, Sea Grant fellowships, and graduate students.





The NBNERR also provides structured opportunities for volunteer citizens to participate in research activities. This is dependent on need and availability for adequate training and guidance of volunteers.

The reserve scientist/research coordinator will continue to periodically convene special advisory groups of regional and national scientists on an ad hoc basis. These groups provide expert assistance in planning and implementation of major Reserve projects.

#### **e. Site Profile**

Each reserve is expected to produce a site profile document by 2001. The purpose of the profile is to review the existing state of the knowledge of the Reserve's natural resources, describe the existing research and monitoring program, and to identify future research needs. Site profiles are intended to be technical documents and targeted for coastal zone managers, local decision-makers, and educators.

The NOAA SRD has promulgated national guidance for the profiles. The completed document includes descriptions of ecosystem components, ecological processes, habitats, and the floral and faunal communities. The goal is to provide an adequate basis for the development of scientific studies and applied management investigations.

### **C. Action Plan - Research**

#### **1. Goals and Objectives**

GOAL I. Provide opportunities for scientists, agency investigators, university faculty, graduate students, undergraduate students, and the public to make significant contributions to our understanding of the dynamics of near shore and estuarine systems.

Objective Ia. Encourage and facilitate research projects that focus on identified sets of national and site-specific priorities.

##### Tasks

- Prepare and distribute an annual description of opportunities for NOAA-sponsored research with Narragansett Bay NERR (per NOAA and NBNERR priorities).
- Collaborate with the scientific research community to encourage development of research proposals.
- Maintain and distribute a list of state contributions available as matching funds for research proposals.
- Actively recruit researchers from outside institutions to continue work at the NBNERR.
- Complete the NBNERR site profile.

Objective Ib. Provide laboratory facilities, vessels, and essential equipment as required by visiting and resident researchers to conduct management-oriented research.

##### Tasks

- Develop field laboratory facilities for the NBNERR (1994-96) (see "Facilities Plan: Laboratories").
- Renovate the visiting scientists quarters.
- Purchase and maintain essential laboratory equipment, field supplies, vehicles, and small boats required by resident and visiting scientists.

- Assist visiting researchers with field implementation of on-site and off-site research projects.
- Provide researchers with access to NBNERR technical reports, site characterization, and computerized data-base for meteorological and habitat quality data (see "Monitoring Plan").

**GOAL II.** Support the use of the NBNERR as a natural laboratory and reference site for assessing status and trends of environmental quality in the Narragansett Bay estuary as representative of the northern Virginia bioregion.

**Objective IIa.** Characterize and establish baseline conditions and determine trends for key environmental quality parameters and natural resource populations and communities.

**Tasks**

- Develop a site characterization and provide an electronic data base for NBNERR natural resources.
- Continue a long-term program for assessing water quality trends.
- Establish a long-term program for assessing habitat and biological community trends.
- Continue the GIS mapping project to provide mapping capabilities for individual units of the Reserve, critical habitats, and resource overlays.
- Continue operation of the NBNERR weather station and provide computerized data to researchers.
- Encourage investigators of the Narragansett Bay estuary to use the Reserve as a reference site in determining sampling sites for outside studies.

**Objective IIb.** Provide resource managers and coastal zone managers with access to NBNERR research and baseline information in computerized format, including GIS.

**Tasks**

- Continue collaborative development of the NBNERR GIS system with the University of Rhode Island; purchase and install necessary hardware and software.
- Provide local area network (LAN) and electronic network capabilities to maximize data accessibility (hardware and software).
- Enter NBNERR inventory and research information into a GIS database.

**Objective IIc.** Generate and disseminate information about change that has occurred in estuarine biological and hydrological processes due to human action and information on effecting change from those altered conditions to restore natural functions.

**Tasks**

- Develop techniques to restore eelgrass beds to provide a rejuvenation of this productive estuarine habitat.
- Develop techniques to restore the natural drainage and circulation in ditched marshes.
- Develop information to reduce boater impact on coves and shallow waters of the Reserve.



- Provide information to reduce the threat of Lyme Disease to users of the Reserve.
- Disseminate research results throughout the Virginian bioregion regarding impacts of past practices, potential degrees of recovery, and comparison of active and passive restoration techniques.

GOAL III. Encourage and assist in development of a science-based, multi-agency approach to problems that face Narragansett Bay and other estuarine systems in the Virginian biogeographic region.

Objective IIIa. Coordinate research activities and opportunities for joint scientific efforts among local, state and Federal resource agencies.

Tasks

- Convene a series of workshops and/or meetings to establish goals and objectives and to prioritize research needs.
- Integrate research and monitoring studies by DFW staff with NBNERR projects.
- Develop Memoranda of Understanding and interagency agreements with resource agencies to facilitate cooperative research and monitoring.
- Coordinate Narragansett Bay NERR research with local and regional resource managers (in conjunction with the stewardship plan).

Objective IIIb. Participate with other Narragansett Bay managers in carrying out the Narragansett Bay Comprehensive Conservation Management Plan (CCMP).

Tasks

- Work closely with the NBP and local, state, and Federal agencies to implement recommendations to the CCMP.
- Attend meetings and workshops to develop a Narragansett Bay watershed strategic research and monitoring joint venture.
- Prepare and submit proposals to secure funds to support research and monitoring efforts.
- Participate in collaborative studies to develop the scientific basis for Bay management.

GOAL IV. Improve the availability of research results and scientific information as a basis for coastal zone management decisions throughout the northern Virginian biogeographic region.

Objective IVa. Attend conferences and workshops and deliver presentations to promote wider understanding of estuarine resources and solutions to specific coastal ecosystem management problems (on local, regional, and national scales).

Tasks

- Participate and present research findings through NOAA and the annual meeting of the National Estuarine Research Reserve Association, the Natural Areas Association, and other peer groups.

Objective IVb. Publish and distribute scientific and technical information that will inform a wide audience about the results and implications of estuarine research (regional, national, international).



*Monitoring the occurrence and abundance of seaweeds to assess nutrient enrichment of Bay waters.*

#### Tasks

- Publish results of research undertaken at NBNERR in the scientific literature.
- Present information in various media to communicate with the public, managers, and others.

Objective IVc. Participate in an advisory capacity during public, private, local, and regional meetings that focus on land-use decisions that may impact estuarine habitats.

#### Tasks

- Continue to participate as a member of the NBP Technical Advisory Committee.
- Continue to contribute in an advisory capacity to CRMC.
- Continue to participate in an advisory capacity to DEM.
- Continue to participate in an advisory capacity to other entities involved in estuarine and watershed management.

Objective IVd. Provide assistance to land use planners in the watersheds of Narragansett Bay.

#### Tasks

- Develop and maintain local and regional contacts with resource decision makers.
- Respond to requests for assistance in locating data.

## **D. Monitoring Plan**

One function of the NERR System is to provide benchmark or status information to researchers and to coastal communities and ecosystem managers. Degrees of change in regional estuarine ecosystems can be measured by comparison to known, regularly monitored conditions in the Reserve. The monitoring plan for NBNERR is modeled on the strategic plan recently developed for the NERR System.

### **1. Mission**

The mission of the NBNERR Monitoring Plan is to detect, quantify, and predict both short- and long-term changes in the health and viability of estuarine ecosystems and to provide a scientific basis for coastal resource decision making.

### **2. Policy**

The monitoring strategy at the NBNERR is based on the premise that physical, chemical, and biological aspects of habitats and communities of organisms are excellent indicators of the effects of a vast array of environmental factors. Chronic environmental disturbances are expressed through changes in habitat quality, species composition, population abundance, distribution, growth, and mortality rates. An understanding of baseline conditions and subsequent monitoring will facilitate Reserve stewardship by providing early warning of changes in estuarine and upland resources. Monitoring will also allow the Reserve to develop new research priorities, measure the success of restoration efforts, and contribute to the NERR System overview of trends in estuarine processes. Accordingly, the NBNERR will monitor critical habitat parameters and the dynamics of selected communities to gain insights into ecosystem health.



#### **a. NERR System Guidelines: Phased Monitoring Plan**

It is the policy of the Narragansett Bay NERR to follow the phased monitoring plan initiated by NOAA in 1989, and as outlined in the NERR System Regulations and Strategic Plan.

##### Phase I

Environmental Characterization— Includes studies necessary for inventory and comprehensive site descriptions.

##### Phase II

Site Profile— Includes a synthesis of data and information.

##### Phase III

Implementation— Design of a systematic long-term monitoring program to focus on selected parameters.

#### **b. Comprehensive NERR System Environmental Monitoring Program**

The NERR System has recently developed a system-wide monitoring program that would simultaneously provide critically needed, standardized information on national estuarine environmental trends while allowing the flexibility to assess coastal management issues of regional or local concern. This program is designed to enhance the value and vision of the NERR System as a system of national reference sites. The program has three components which will be implemented in phases, depending on funding:

##### **1) Abiotic Parameters**

Each Reserve will monitor a uniform set of physical and chemical processes that either impact or reflect the health of estuarine ecosystems. These will include basic water quality indicators, atmospheric conditions, and specific processes such as tidal and groundwater flow and contaminants. Where possible, existing data collected by other agencies will be incorporated.

##### **2) Biodiversity**

Across the NERR System, each site will monitor two fundamental features of their respective estuarine ecosystems: (1) basic community structure in major estuarine habitat types (e.g., uplands, emergent wetlands, benthos, etc.); and (2) population trends of important "target species" including those of commercial, recreational, or conservation significance (e.g., SAV, marsh plants, wading birds, endangered species, etc.).

##### **3) Land Use Patterns**

In recognition of the profound influence of land and water use on estuarine resources, the NERR System monitoring program will compile existing and new data on major patterns of habitat classification and use within NERR System watersheds. Data will be gathered from a variety of state and Federal sources, including NOAA. Data will be updated periodically and used to detect and track significant changes in watershed use and its impacts on Reserve resources.

##### **4) Central Data Management "Hub"**

Information generated by the NERR System monitoring system will be compiled electronically at a central data management "hub" and will be disseminated to all Reserves, CZM programs, OCRM, and other qualified parties. Each Reserve will have constant electronic access to all system-wide data and summary statistics on environmental trends at the national, regional, or site-specific levels. An on-line web site will be available for interested parties.

### **3. Goals**

The goals of the NBNERR inventory and monitoring plans are to:

**GOAL I.** Establish environmental characterizations of estuarine habitats, riparian areas, upland forests, and biota under management of the NBNERR.

GOAL II. Develop a comprehensive site profile of NBNERR ecosystems.

GOAL III. Implement a monitoring plan to record physical and biological parameters relevant on national, regional, and local scales.

#### **4. Existing Program Status**

##### **a. Past Monitoring**

The first monitoring at the NBNERR was initiated in 1988 to provide weekly records of weather data. This was expanded in 1990 to include water quality parameters in estuarine portions of the Reserve. Weather data are collected for six variables:

- rainfall
- air temperature
- wind speed
- wind direction
- barometric pressure
- humidity

Water quality parameters include the variables listed below at 1 meter below the surface at three stations.

- temperature
- dissolved oxygen
- salinity
- pH
- secchi depth

##### **b. Available Inventory Information**

A comprehensive inventory of physical and biotic resources has never been compiled for NBNERR. Existing information about Reserve biota is the net product of scientists working individually over the years on a wide range of topics, and coordinated by the Reserve manager. Their work has produced information about the geology, hydrology, stratigraphy, and several biotic communities within NBNERR and its adjacent estuarine habitats. However, this set of data was not designed or gathered as part of a comprehensive inventory and does not constitute a profile of the biotic communities within NBNERR. Moreover, because each researcher was conducting a discrete investigation, foci and formats were selected as appropriate for individual purposes rather than synthesis.

The NBP published a system-wide "Habitat Mapping and Resource Inventory" (French, et al., 1990) that has some general data relative to the Reserve's habitats and natural resources.

##### **c. Current Activities**

The first phase of the water quality monitoring plan data collection began in 1990. The project was designed to address the three main habitat types found within the Reserve: marshes, coves, and channels. Monitoring of upland forests (recovering forests, discontinued farming sites, and roads) began in mid-1994 and continued through 1996 to acquire sufficient data for the site profile.

Work is being conducted by research interns, graduate students from several institutions, conservation organizations, and DEM staff under the supervision of the Reserve manager. A systematic long-term monitoring of Reserve ecosystems will build on the environmental characterization efforts and expand to include participation in the NERR System national program.

To date, the inventory and planning stages of the Narragansett Bay NERR monitoring plan have been primarily conducted by others, with oversight by the Reserve manager. In the future, with implementation of NBNERR stewardship and public involvement plans, routine monitoring





tasks may be accomplished by volunteers with continued oversight and participation by Reserve staff.

## **E. Action Plan - Monitoring**

### **1. Goals and Objectives**

GOAL I. Establish environmental characterizations of estuarine, riparian, and upland areas within the NBNERR.

Objective I. Complete data collection with field inventory and habitat assessment for aquatic upland areas.

#### Tasks

- Design and document appropriate field sampling and assessment protocol, a prioritized list of study sites, and sample parameters.
- Secure temporary and volunteer personnel to assist with inventory field work and sampling.
- Prepare volunteer job descriptions and deliver training seminars and workshops for the volunteer monitoring work force.
- Conduct scheduled field work within the NBNERR.
- Assemble field notes, maps, data sheets, and other quantitative records into a hardcopy and computer database.

GOAL II. Develop a comprehensive site profile of the NBNERR ecosystem.

Objective IIa. Synthesize information from baseline inventories, published literature, student reports, and other sources to provide researchers and resource managers with detailed knowledge of the NBNERR.

#### Tasks

- Conduct a thorough search of the literature for published and unpublished scientific data and student reports.
- Meet with representatives of state and Federal resource management agencies to acquire access to relevant technical literature.
- Identify and fill additional data needs.
- Store data in a computerized form, including a GIS. (Database will be accessible to resource managers and coastal ecosystem policy-makers via computer networks and will be used by NBNERR for resource management and resource-oriented research.)

Objective IIb. Identify and maintain specific sites dedicated to monitoring.

#### Tasks

- Develop data management system and incorporate NBNERR database.
- Identify significant environmental indicators.



**GOAL III.** Initiate and conduct long-term monitoring program.

**Objective IIIa.** Collaborate in the NERR System-wide monitoring program.

**Tasks**

- Install multi-parameter electronic water quality monitors at several sites.
- Participate in the Clean Water Act Section 6217 nonpoint source NERR System monitoring.
- Continue in development and participation in NERR System long-term monitoring programs.

**Objective IIIb.** Establish long-term monitoring of critical habitats in the NBNERR.

**Tasks**

- Participate in the Save The Bay citizens volunteer monitoring program.
- Continue water quality and atmospheric monitoring projects.
- Establish biological monitoring program.
- Require special projects for natural resource stewardship.



# **Appendices**

**A. Memorandum of Understanding  
Between DEM and NOAA SRD  
Concerning the Management of  
the NBNERR**

**B. DEM Organizational Chart**





**A. Memorandum of Understanding  
Between RIDEM and NOAA SRD  
Concerning the Management of  
the NBNERR**





State of Rhode Island and Providence Plantations  
Department of Environmental Management  
Narragansett Bay National Estuarine Research Reserve  
P.O. Box 151 South Park  
Prudence Island, RI 02872



## MEMORANDUM OF UNDERSTANDING

between

**Rhode Island Department of Environmental Management**

and

**The Office of Ocean and Coastal Resource Management  
The National Oceanic & Atmospheric Administration**

concerning the management of the

**Narragansett Bay National Estuarine Research Reserve**

WHEREAS, the State of Rhode Island (R.I.) has determined that the waters and surrounding coastal habitats of Narragansett Bay, including Prudence, Patience and Hope Islands, provide unique opportunities for the study, and increased public awareness, of the natural and human processes occurring within the estuarine ecosystems of the State; and

WHEREAS, the National Oceanic and Atmospheric Administration (NOAA), U.S. Department of Commerce has concurred with that finding and pursuant to its authority under Section 315 of the Coastal Zone Management Act of 1972, as amended (CZMA), 16 U.S.C. 1461, and in accordance with implementing regulations at 15 CFR 921.30 has designated this area as a National Estuarine Research Reserve; and

WHEREAS, the Governor of the State of Rhode Island has designated the Department of Environmental Management (DEM) to act on behalf of the State in matters concerning the Narragansett Bay National Estuarine Research Reserve (NBNERR), the boundaries of which are delineated in the NBNERR Management Plan (Plan); and

WHEREAS, to help carry out Reserve purposes as specified in the Plan, NOAA is authorized to provide federal funds on a matching basis or as otherwise specified by law for Reserve management and operation, monitoring and education, and is authorized to provide additional funds on a matching basis or as otherwise specified by law for supplemental acquisition and development, (see specifications in the Plan Article I).



NOW, THEREFORE, in consideration of the mutual covenants contained herein it is agreed by and between RI DEM and NOAA as follows:

## **ARTICLE I - RESERVE PURPOSES**

The Reserve is to be operated and managed on a permanent basis in a manner consistent with the Mission and Goals of the Program and Goals and Objectives of the Reserve, as defined below and as further specified in the Plan, and with Section 315 of the CZMA and its implementing regulations.

### **A. Mission and Goals of Program**

1. The mission of the Program is the establishment and management, through Federal-State cooperation, of a permanent national system of estuarine research reserves representative of the various regions and estuarine types in the United States, in order to provide opportunities for long-term research, education, and interpretation.
2. The goals of the Program for carrying out this mission are to:
  - a) Ensure a stable environment for research through long-term protection of estuarine reserve resources.
  - b) Address coastal management issues identified as significant through coordinated estuarine research within the System.
  - c) Enhance public awareness and understanding of the estuarine environment and provide suitable opportunities for public education and interpretation.
  - d) Promote federal, state, public and private use of one or more reserves within the System when such entities conduct estuarine research.
  - e) Conduct and coordinate estuarine research within the system, gathering and making available information necessary for improved understanding and management of estuarine areas.

### **B. Goals and Objectives of the Reserve**

1. To manage the Reserve as a field laboratory and educational site for learning about natural and human processes within estuarine environments.
2. To disseminate information on the ecological importance of estuaries as widely as possible.
3. To work with other national estuarine research reserves to develop joint research programs for addressing regional and national estuarine issues.
4. To study man and his effect on estuarine systems, including the cultural, historical and economic factors that provide competing pressures on the use of coastal resources.
5. To protect fish, wildlife and plant communities, and to prevent activities detrimental to migratory waterfowl and other wildlife communities, particularly endangered and threatened species.



6. To promote the cooperative management of the Reserve land and waters by federal and state agencies that have supervision of such land and waters.
7. To allow for multiple uses of the Reserve, including public access to the state-owned land and the continuation of existing low intensity recreational uses and activities related to fish and wildlife uses (e.g., hunting, fishing, wildlife observation), that are compatible with the Reserve's character as a natural field laboratory and educational site and Section 315 of the CZMA and implementing regulations..

## **ARTICLE II - STATE-FEDERAL ROLES IN THE RESERVE**

- A. The DEM's role will include, but not be limited to, implementing the Plan, ensuring that the Reserve continues to be operated and managed in a manner consistent with the Plan, the Program's Mission and Goals, and the Reserve's Goals and Objectives, and Section 315 of the CZMA and its implementing regulations, and acquiring remaining land and undertaking construction in a manner consistent with the Plan. To this end, the RI DEM will diligently seek funds from the State and other sources.
- B. The Office of Ocean and Coastal Resource Management (OCRM) role will be to administer the provisions of Section 315 of the CZMA and implementing regulations, including having authority to help implement the Plan (through operation and other awards) and to periodically evaluate the RI DEM's performance in operating and managing the Reserve, including implementation of the Plan and the Program's Mission and Goals and the Reserve's Goals and Objectives, (see Article I), and to provide technical assistance to the RI DEM.

## **ARTICLE III - PROCEDURE FOR RESOLUTION OF ISSUES**

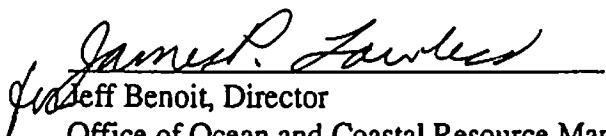
If OCRM finds, after an evaluation of the RI DEM's performance, that the site is being deficiently operated or managed as a National Estuarine Research Reserve (see Section 315 of the CZMA and its implementing regulations), the RI DEM and OCRM shall attempt to resolve the issue in a manner consistent with the purposes for which the Reserve was established. If such resolution is not possible, Reserve designation may be withdrawn in accordance with the procedures established in Section 315 of the CZMA and its implementing regulations.

## **ARTICLE IV - OTHER TERMS AND CONDITIONS**

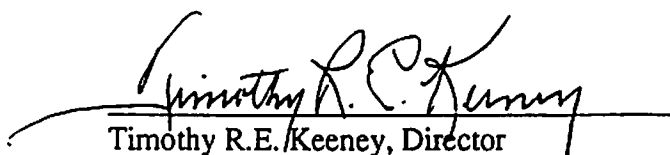
- A. This Memorandum of Understanding shall take effect upon signature by both parties and remain in effect until terminated by mutual written agreement, or upon ninety days' written notice by either party to the other.
- B. This Memorandum of Understanding may be amended at any time by mutual written agreement.
- C. Nothing herein is intended to conflict with current Department of Commerce/NOAA/OCRM or RI DEM directives. If any term or condition of this Memorandum of Understanding is inconsistent with such a directive, then that portion(s) of this Memorandum of Understanding that is determined to be inconsistent shall be invalid, but the remaining terms and conditions not affected by the inconsistency shall remain in full force and effect. At the first opportunity for review of this Memorandum of Understanding, all necessary changes shall be made by either an amendment to this Memorandum of Understanding or entering into a new Memorandum of Understanding, whichever is deemed expedient to the interest of both parties. Should disagreement arise about the

interpretation of the provisions of this Memorandum of Understanding that cannot be resolved on the operating level, the area(s) of disagreement shall be stated in writing by each party and presented to the other party for consideration.

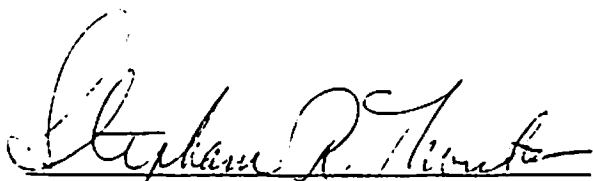
IN WITNESS WHEREOF, the parties hereto have caused this Memorandum of Understanding to be executed.

  
Jeff Benoit, Director  
Office of Ocean and Coastal Resource Management  
National Oceanic & Atmospheric Administration

August 16, 1996  
Date

  
Timothy R.E. Keeney, Director  
Rhode Island Department of Environmental  
Management

July 10, 1996  
Date

  
Stephanie R. Thornton, Chief  
Sanctuaries & Reserves Division  
Office of Ocean & Coastal Resource Management  
National Oceanic & Atmospheric Administration

8/15/96  
Date



## B. RIDEM Organizational Chart

# Rhode Island Department of Environmental Management Table of Organization

