

I. INTRODUCTION

Purpose and Scope of Plan

This management plan is a revision of the New York State Department of Environmental Conservation (NYSDEC) Hudson River National Estuarine Research Reserve's Final Management Plan dated January 1993. The initial management plan established the Reserve's basic management structure and described initial plans for administration, resource protection, public access, facilities, research, education, and acquisition.

This updated management plan has been developed in accordance with Part 921.13 of Title 15 of the Code of Federal Regulations (C.F.R.) (see Appendix 1) and is consistent with Section 315 of the Coastal Zone Management Act of 1972 and its amendments. This plan will be useful in guiding the future direction of the Reserve. Implementation will be evaluated in the required program evaluation (Part 921.40 of Title 15 C.F.R.). This management plan is also consistent with the New York State Coastal Management Program and its coastal policies to the maximum extent practicable.

This management plan sets forth the program mission, goals, and objectives of the Reserve, and identifies policies that protect the natural resources and ecological integrity of the Reserve sites. The plan provides guidance for operations, management, research, monitoring, education and public outreach, stewardship, resource protection, public access, and other Reserve purposes for the next five years, or until the plan is revised and updated. This Reserve management plan also describes the elements necessary to identify key resources of the Reserve, determine the appropriate level of human use for the sites and their resources, and foster their long-term protection. All agency actions in the Reserve must be compatible with the management plan goals, objectives, and policies, which will be implemented consistently throughout the Reserve.

Overview of Federal Context

National Estuarine Research Reserve System

The National Estuarine Research Reserve System (NERRS) was created by the Coastal Zone Management Act (CZMA) of 1972, as amended, 16 U.S.C. Section 1461, to augment the Federal Coastal Zone Management (CZM) Program. The CZM Program is dedicated to comprehensive, sustainable management of the nation's coasts.

The reserve system is a network of protected areas established to promote informed management of the Nation's estuaries and coastal habitats. The reserve system currently consists of 27 reserves in 22 states and territories, protecting over one million acres of estuarine lands and waters.

Mission

As stated in the NERRS regulations, 15 C.F.R. Part 921.1(a), the National Estuarine Research Reserve System mission 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.”

Goals

Federal regulations, 15 C.F.R. Part 921.1(b), provide five specific goals for the reserve system:

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

NERRS Strategic Goals 2005 – 2010

The reserve system began a strategic planning process in 1994 in an effort to help National Oceanic and Atmospheric Administration (NOAA) achieve its environmental stewardship mission to “sustain healthy coasts.” In conjunction with the strategic planning process, Estuarine Reserve Division (ERD) and reserve staff has conducted a multi-year action planning process on an annual basis since 1996. The resulting three-year action plan provides an overall vision and direction for the reserve system. As part of this process, the reserve system developed a vision: Healthy estuaries and watersheds where coastal communities and ecosystems thrive; and mission: To practice and promote coastal and estuarine stewardship through innovative research and education using a system of protected areas. The following goals are outlined in the 2005-2010 Strategic Plan.

Goals:

1. Strengthen the protection and management of representative estuarine ecosystems to advance estuarine conservation, research, and education.
2. Increase the use of reserve science and sites to address priority coastal management issues.
3. Enhance peoples’ ability and willingness to make informed decisions and take responsible actions that affect coastal communities and ecosystems.

Biogeographic Regions

NOAA has identified eleven distinct biogeographic regions and 29 sub-regions in the U.S., each of which contains several types of estuarine ecosystems (15 C.F.R. Part 921, Appendix 1). When complete, the reserve system will contain examples of estuarine hydrologic and biological types characteristic of each biogeographic region. As of 2006, the reserve system includes twenty-seven reserves and two reserves in the process of designation (Figure 1). The reserves are listed below by biogeographic region and subregion with their designation date denoted in parentheses.

Figure 1
National Estuarine Research Reserve System Bio-Geographic Regions and Sites



Reserve Designation and Operation

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

1. The area is representative of its biogeographic region, is suitable for long-term research and contributes to the biogeographical and typological balance of the System;
2. The law of the coastal State provides long-term protection for the proposed Reserve's resources to ensure a stable environment for research;

3. Designation of the site as a Reserve will serve to enhance public awareness and understanding of estuarine areas, and provide suitable opportunities for public education and interpretation; and
4. 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 reserve system, it is eligible for NOAA financial assistance on a cost-share basis with the state. The state exercises administrative and management control, consistent with its obligations to NOAA, as outlined in a memorandum of understanding. A reserve may apply to NOAA's ERD for funds to help support operations, research, monitoring, education/interpretation, stewardship, development projects, facility construction, and land acquisition.

NERRS Administrative Framework

The Estuarine Reserves Division (ERD) of the Office of Ocean and Coastal Resource Management (OCRM) administers the reserve system. The Division establishes standards for designing and operating reserves, provides support for reserve operations and system-wide programming, undertakes projects that benefit the reserve system, and integrates information from individual reserves to support decision-making at the national level. As required by Federal regulation, 15 C.F.R. Part 921.40, OCRM periodically evaluates reserves for compliance with Federal requirements and with the individual reserve's Federally-approved management plan.

The Estuarine Reserves Division currently provides support for three system-wide programs: the System-Wide Monitoring Program, the Graduate Research Fellowship Program, and the Coastal Training Program. They also provide support for reserve initiatives on restoration science, invasive species, K-12 education, and reserve specific research, monitoring, education, and resource stewardship initiatives and programs.

Collaboration with Other NOAA Line Offices

The Reserve has collaborated with several other NOAA line offices including the NOAA Coastal Services Center, the NOAA National Centers for Coastal Ocean Science, the National Weather Service, the National Marine Fisheries Service, the NOS Office of Response and Restoration, the NOS Office of Ocean and Coastal Resource Management, the NOS Office of Coast Survey, the Cooperative Institute for Coastal and Estuarine Environmental Technology, and the National Marine Sanctuary Program. These collaborations have been key to development of a wide variety of Reserve programs and projects. The Reserve envisions building stronger collaborations with these and other NOAA offices in future years.

Regional Context for the Reserve

The Hudson River Estuary

The Hudson River Estuary extends from the Federal Dam in Troy south to the Verrazano Narrows outside New York City. The Estuary's surrounding watershed, known as the Hudson River Valley, includes the 153 mile-long, tidal, main stem of the Hudson River, as well as upper New York Harbor, the Hudson's tributaries, and the upland areas of the Hudson Valley, encompassing 5,200 square miles of the river's overall 13,400 square miles of watershed. Hudson River tides are semi-diurnal, with two highs and two lows within a 25-hour period, and the mean tidal range varies from 3.2 feet at West Point to about 5 feet at either end of the estuary. From Troy south, the estuary can be divided into four salinity zones, ranging from freshwater tidal to the progressively more saline oligohaline, mesohaline, and polyhaline zones (Yozzo et al., 2005).

The Hudson River Estuary has long been recognized as a valuable state and local resource, as well as an integral part of the North Atlantic coastal environment. The estuary serves as a spawning and nursery ground for important fish and shellfish species, such as striped bass, American shad, Atlantic and shortnose sturgeon, and blue crab. More than 200 species of fish are found in the Hudson and its tributaries. The estuary contains the only significant acreage of tidal freshwater wetlands within the state. These wetlands, along with the river's brackish tidal wetlands and stands of submerged aquatic vegetation, constitute essential habitat that support the Hudson's rich and biologically diverse web of life. More than 16,500 acres of river habitat from Troy to the southern Rockland-Westchester County border have been designated "significant coastal fish and wildlife habitat" by the New York State Department of Environmental Conservation (NYSDEC) and the New York Department of State. The NYSDEC New York Natural Heritage Program has identified numerous sites where rare plant and animal species and exemplary natural communities occur. Recently, bald eagles have successfully nested and raised their young for the first time in over 100 years along the shores of the river. The estuary also serves as an important resting and feeding area for other migratory birds such as osprey, a variety of songbirds and waterfowl (NYSDEC, 2007).

The Hudson Valley Region

The Hudson Valley is a complex and rapidly changing region. The estuary's north end is flanked by the cities of Albany and Troy. Numerous smaller communities are located along both banks of the river to the southern Rockland-Westchester lines. From here south, the greater New York metropolitan area, with its estimated population of 8 million, dominates the landscape. Nearly one-half of the population of New York State lives within the 15 counties bordering the estuary, with the largest proportion located in the New York City area. Part of New Jersey's major metropolitan area, likewise, borders the estuary. Yet wilderness areas occur within a half-hour of parts of the estuary, too. Landscapes in the valley range from steep, mountainous terrain to gently rolling hills as the river cuts through several geologic regions. Biodiversity in the Hudson Valley is enormously rich, constituting a disproportionate share of New York State's plant and animal species. The valley is one of the fastest growing regions in the United States, with considerable development pressure on the counties north of the NY Metropolitan area, especially following the September 11, 2001 attacks on the World Trade Center in New York City.

Human use of the estuary dates back 8,000-10,000 years before European settlement. Today the estuary is used for commercial navigation, recreation (including boating, fishing, swimming, and wildlife observation), commercial fishing, municipal drinking water supplies, and as a source of inspiration. Several major power generating facilities, manufacturing plants, petroleum terminals, cement and aggregate plants, resource recovery facilities, and various mining operations are located along the banks of the estuary. Railroad tracks hug the shores of the river on the east from Manhattan to Rensselaer County and on the west from Haverstraw State Park in Rockland County to central Ulster County.

The entire region began celebration of the Hudson-Fulton-Champlain Quadricentennial in 2009, the 400th anniversary of Henry Hudson's and Samuel de Champlain's voyages along the river and lake that bear their names, and the 200th anniversary of Robert Fulton's successful steamboat voyage and establishment of steam commerce on the Hudson River.

Scientific Understanding of the Hudson River

Understanding of the Hudson River Estuary ecosystem has advanced substantially in the last 30 years, thanks to the dedicated scientific work of hundreds of people, dozens of research institutions, the resources of the Hudson River Foundation, the efforts of New York State, and a major fish sampling program undertaken as a permit condition by a consortium of utility companies. The current state of knowledge is comprehensively summarized in *The Hudson River Estuary*, edited by Levinton and Waldman, 2006. Many emerging organizations also promise to contribute to the scientific understanding of the Hudson River estuarine ecosystem through its research and monitoring programs.

Within this context, a major focus of the Reserve's research and monitoring programs is to increase knowledge of all Hudson River estuarine habitats, many of which are vital to the functioning of the Hudson River ecosystem. These habitats are vulnerable to development, invasive species impacts, and the effects of climate change, especially sea level rise. Work by the Reserve and partners has examined habitat locations, functions, patterns and timing of their changes, and the driving natural and human forces affecting these attributes. As a result of over two decades of scientific work at the Reserve by scientific partners and Reserve staff, coupled with a major habitat-focused investment by the NYSDEC's Hudson River Estuary Program in concert with the Reserve, scientific understanding of location, functions, and changes in Hudson River estuarine habitats has grown dramatically. More detailed information about research at the Reserve is summarized in the *Ecological Profile of the Hudson River National Estuarine Research Reserve*, by Yozzo et al., 2005, as well as in the Reserve's regularly updated publications list.

A comprehensive habitat mapping program has resulted in geographic digital databases of plant communities in the Hudson's freshwater and brackish tidal wetlands and subtidal shallows, including submerged aquatic vegetation beds and floating water chestnut beds. Deepwater benthic areas have been mapped with sonar, and efforts are ongoing to map the shallows, which occupy the one-third of the estuary's surface area that is less than four meters deep. Lastly, baseline maps of the estuary shoreline types were recently completed. Prior to these efforts, only the largest tidal wetlands were mapped. Habitat change is being monitored in tidal wetlands and submerged aquatic vegetation beds about every five years.

The functions of Hudson River estuarine habitats have been assessed through a series of projects resulting in a significantly more in-depth understanding of ecosystem services (especially biochemical and habitat functions) provided by tidal wetlands and submerged aquatic vegetation beds. Similar studies are underway or planned, in partnership with the Hudson River Fisheries Unit and others, to expand our understanding of the myriad roles played by different deep-water benthic environments with respect to sediment transport, biochemistry, and habitat functions for different life stages of important species. Studies of the functions of different shoreline types are underway, as well.

Information about habitat location, characteristics, functions, and patterns of change are being used to promote protection of these vital resources. Reserve staff members have informed the work of state, local and federal regulators and land managers through training, distribution of databases, and the provision of technical assistance about river habitats.

Estuarine Literacy

We have few quantitative measures of the state of estuarine literacy in the Hudson River Valley. However, over the last four decades, a rich community of public and private organizations has developed to educate the public about the Hudson River Estuary, its ecosystem, and the role of humans in sustaining a healthy ecosystem. The Hudson River Sloop Clearwater pioneered estuarine education on the Hudson River with its onboard and later on-land programs which have served as models for many others. Several environmental and nature centers carry on vital education work at locations up and down the Hudson River Estuary. The Hudson River Foundation, through different grant funds, has supported many education programs, projects, and site enhancements. The NYSDEC Hudson River Estuary Program, through its education grant program, has fueled a resurgence of estuarine education services, facilities, and curricula, for instance the Cary Institute of Ecosystem Studies' high school web-based curriculum, *The Changing Hudson*. "Teaching the Hudson Valley", a program of the Hudson River Valley National Heritage Area that is managed by the National Park Service and other partners, provides training and grants to teachers to help them incorporate Hudson River Valley places into their teaching about ecology, history and culture. All of these efforts have helped create a richer awareness of the estuary among communities, schools, leaders, teachers, and the public.

Climate Literacy

In the last few years, the region has seen a growing public recognition of climate change threats and the urgency of need for effective planning, mitigation, and adaptation. An emerging community of organizations is rising to this challenge, many working to raise climate literacy. Notable among these are the Hudson River Estuary Program's Municipal Climate Change Partnership, NYS Climate Change Office, Sustainable Hudson Valley, the Nature Conservancy's Hudson River Landscape Program, the NYS Energy Research Development Agency.

At the same time, we are facing social challenges, including growth in total population and density in coastal counties, growth in underserved groups, growth of the built environment, diminishing budgets for education, and decreased human interactions with the natural world.

Within this context, the Hudson River Research Reserve is updating its education, training, and outreach programs in response to the critical challenges and threats of global climate change to the Hudson's tidal habitats, and seeking to advance leadership and provide relevant scientific information on this issue. This work is being linked to social science inquiries to better understand the status of estuarine literacy among key Reserve audiences, and to take advantage of new knowledge of what may motivate people to change their behaviors to adapt to and mitigate climate change.

Greatest Challenges for Conservation

The greatest physical threat to Reserve and other Hudson River Estuary coastal sites is sea level rise, compounded by other climate change effects such as increased storm intensity, greater flooding and storm surges, and the human response to these. Predictions for sea level rise in the Hudson River Valley are variable, but a 2-3 foot rise in sea level by 2100 may be possible given more rapid melting of land and sea ice. In the past, tidal wetland accretion rates have averaged about 8 inches per century, which will clearly not be sufficient to keep up with sea level rise unless there is a shift in tidal wetland accretion patterns. Land conservation priorities are being reassessed in light of climate change, although substantial uncertainty exists about the pace and timing of change. In the meantime, the Reserve is seeking to identify areas along the Hudson River Estuary where tidal marsh migration may most readily be promoted due to topography, land development patterns, and shoreline treatments. The Reserve is leading a regional effort to inform decision making at many levels of government about shoreline erosion mitigation strategies through a project that links ecosystem function studies with economic forecasts and public outreach.

Overview of Hudson River Reserve

The Hudson River Reserve encompasses about 5,000 acres of freshwater and brackish tidal wetlands and uplands distributed at four sites that span the middle 100 miles of the Hudson River Estuary (Figure 2). From north to south the sites are: Stockport Flats (Columbia County), Tivoli Bays (Dutchess County), Iona Island and Piermont Marsh (Rockland County). These sites are administered by multiple agencies; the boundaries for these sites and land ownership within them are depicted in (Figures 3-6).

Organizational Setting

Operation and management of Reserve programs and sites occurs through the cooperative efforts of five state agencies and NOAA, as well as a host of other partners. The involved state agencies are the New York State Department of Environmental Conservation (NYSDEC), the lead agency; the NYS Office of Parks, Recreation, and Historic Preservation (OPRHP); the NYS Department of State (DOS); the NYS Office of General Services (OGS); and the Palisades Interstate Park Commission (PIPC). The management structure for the Reserve was established in a 1982 Memorandum of Understanding among the five involved state agencies (Appendix 2). The memorandum established multilateral intent to support and implement the Reserve program, and it established common policies for management of lands in the Reserve. A memorandum of un-

derstanding between NYSDEC and NOAA (Appendix 3), which is periodically updated, sets forth mutual expectations regarding management and operation of the Reserve. Appendix 4 further describes agency roles in the administration and operation of the Reserve.

Figure 2
Locations of Hudson River NERR Sites on the Hudson River Estuary.

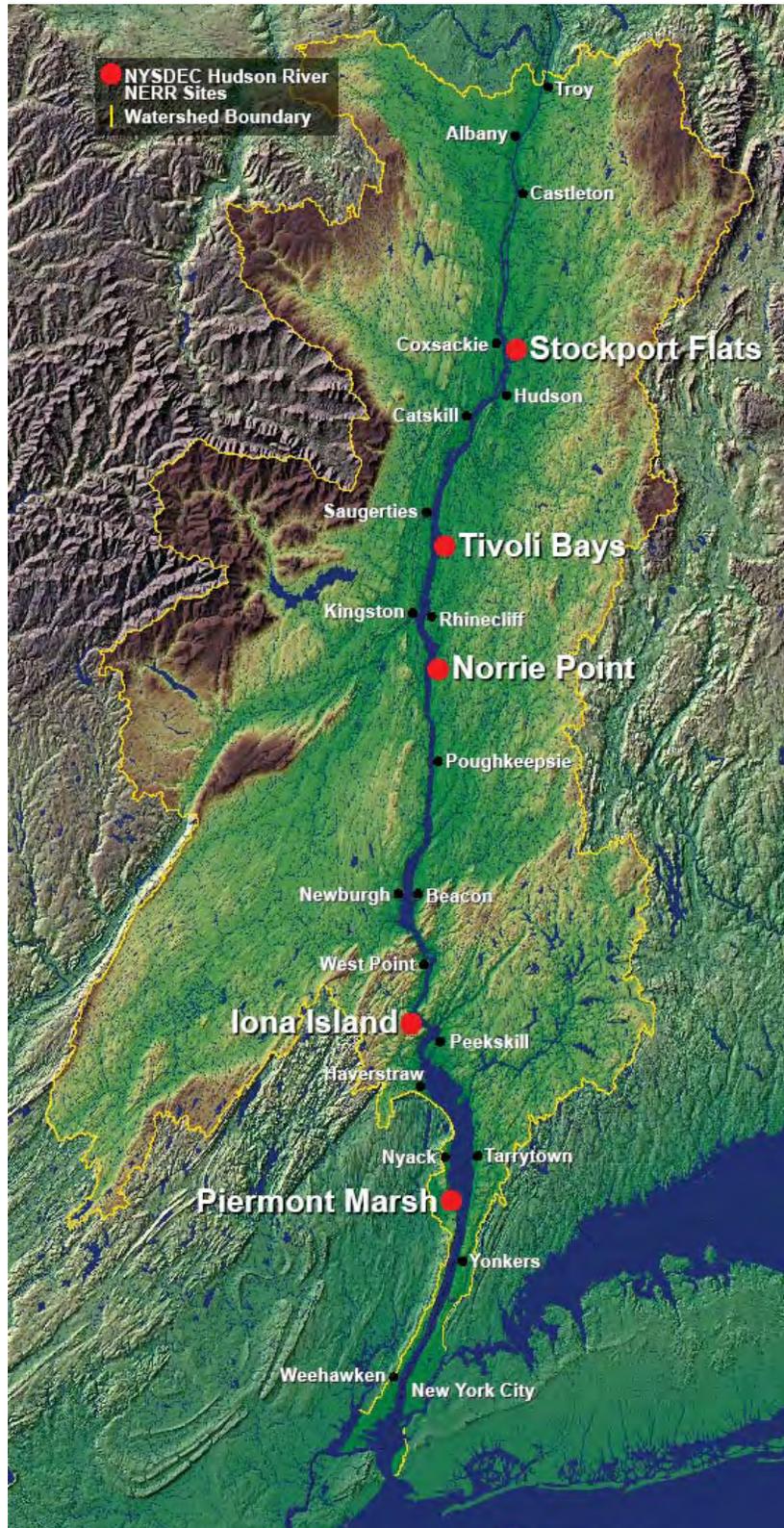


Figure 3
Land Ownership at Stockport Flats.

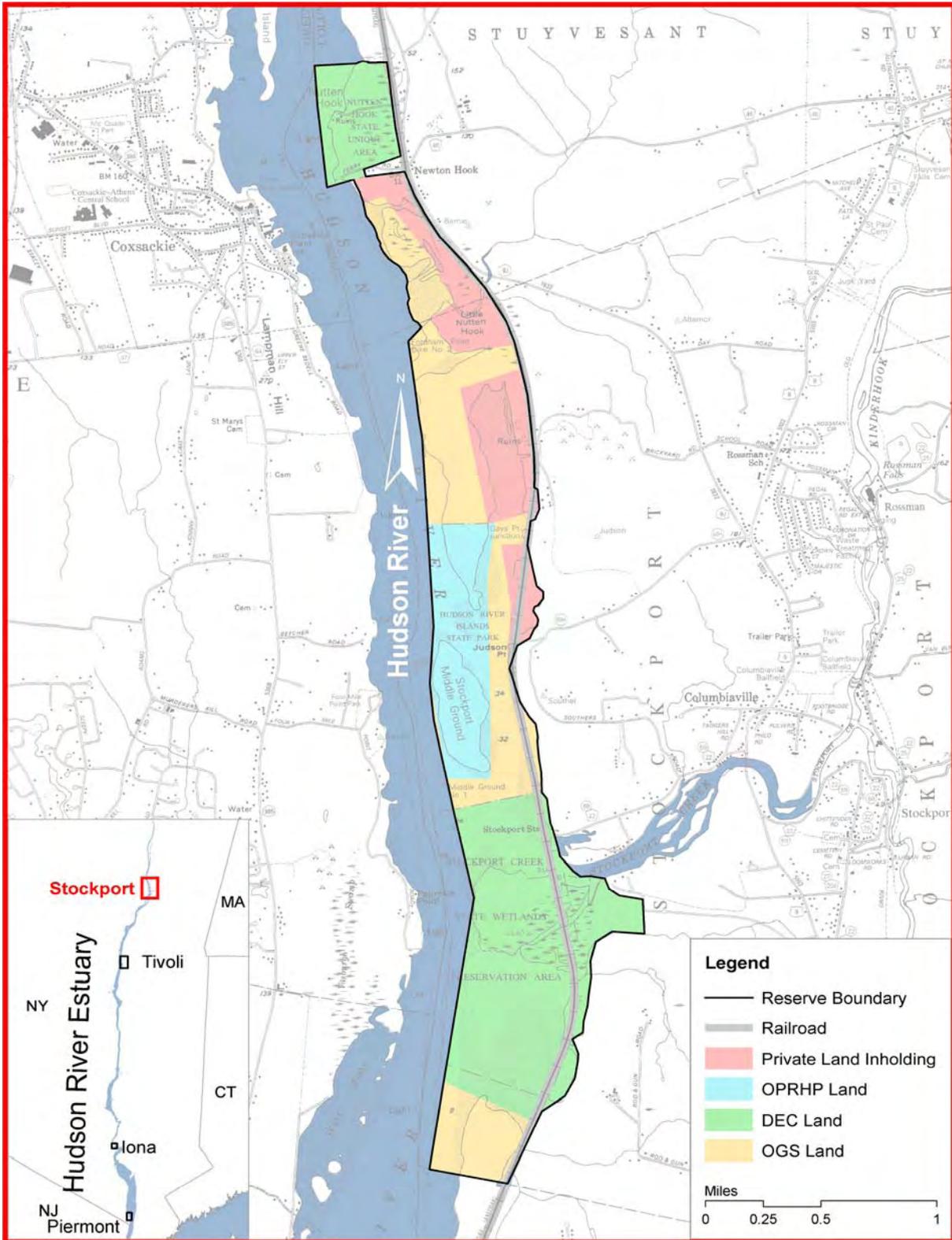


Figure 4
Land Ownership at Tivoli Bays.

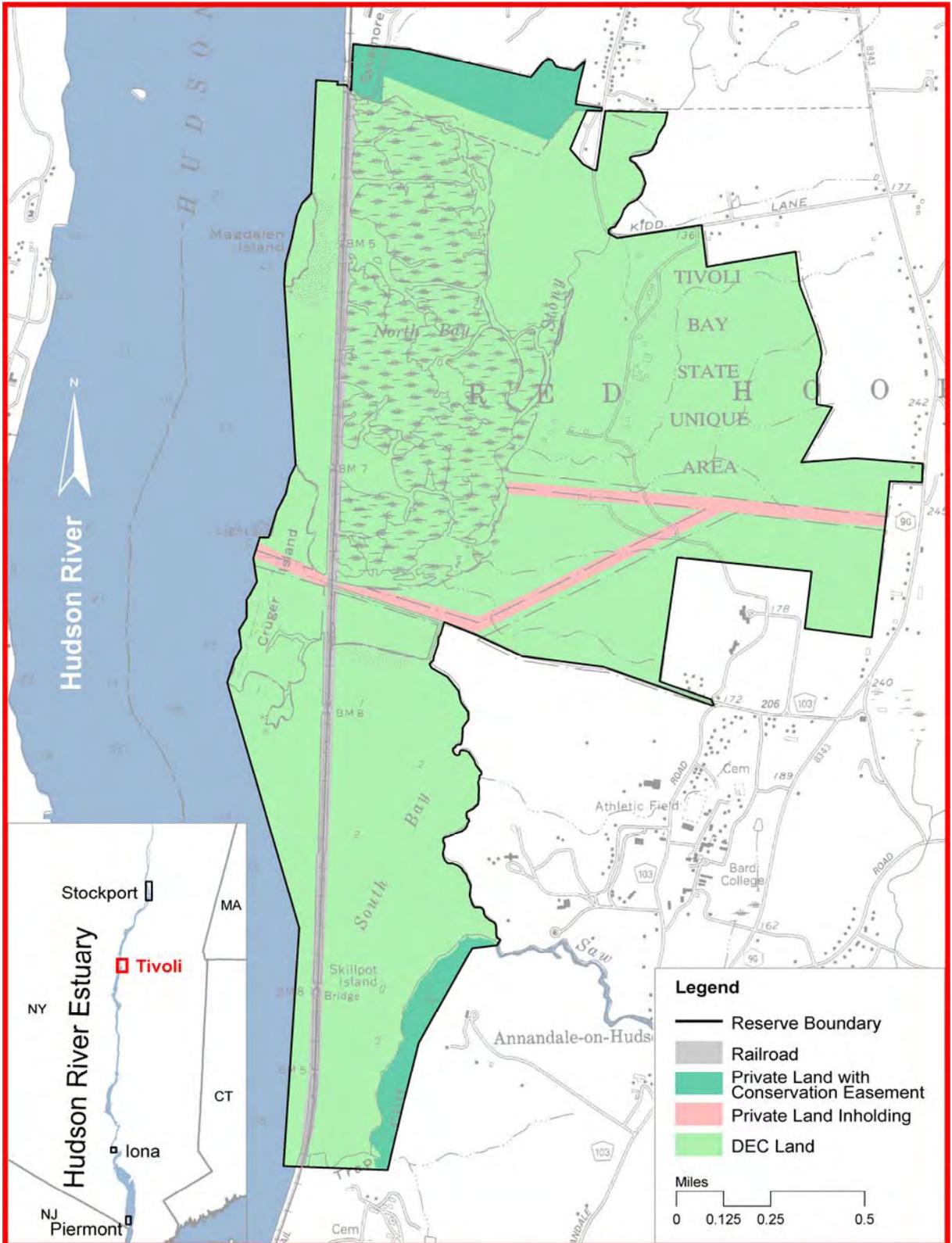


Figure 5
Land Ownership at Iona Island.

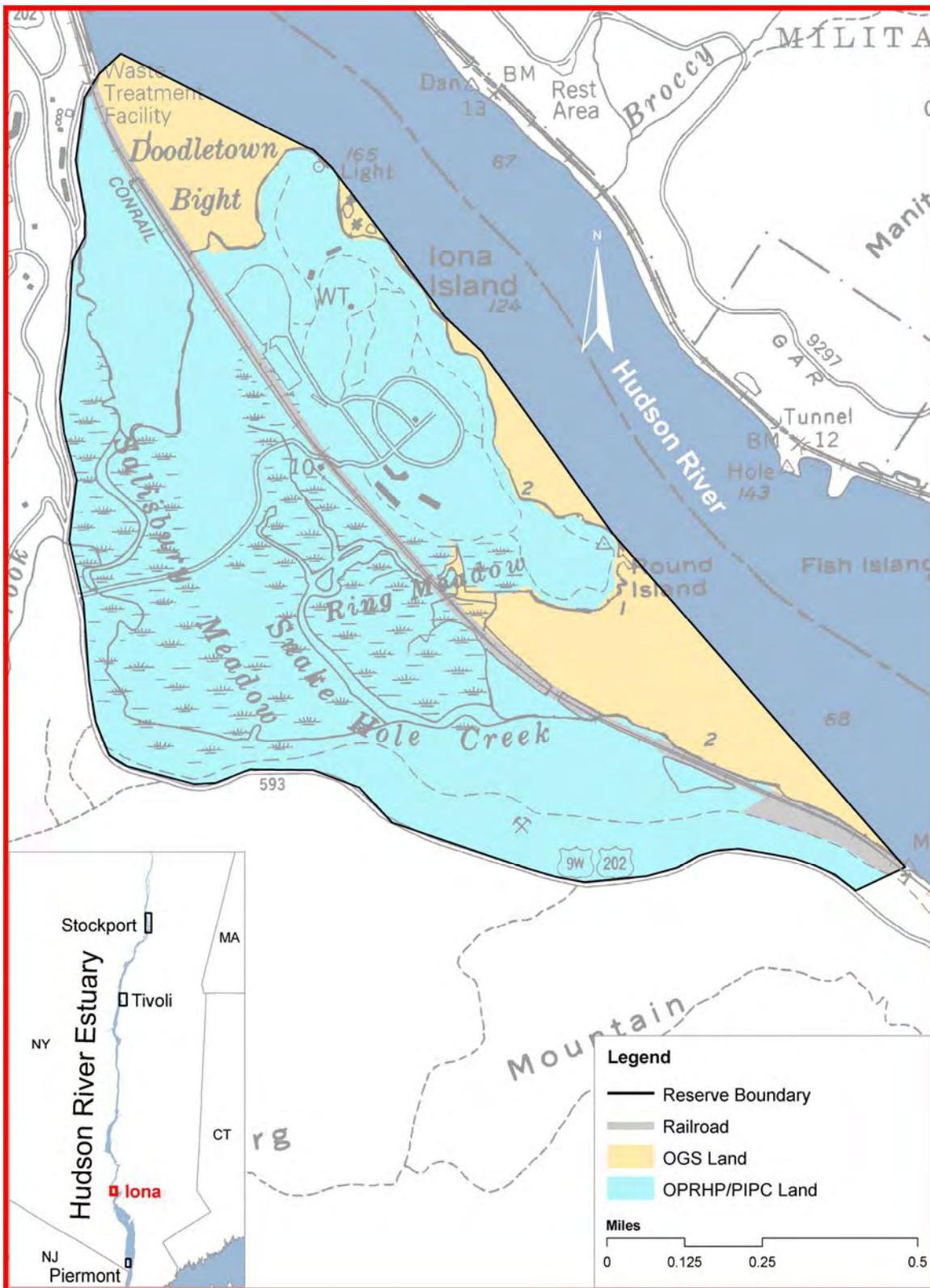
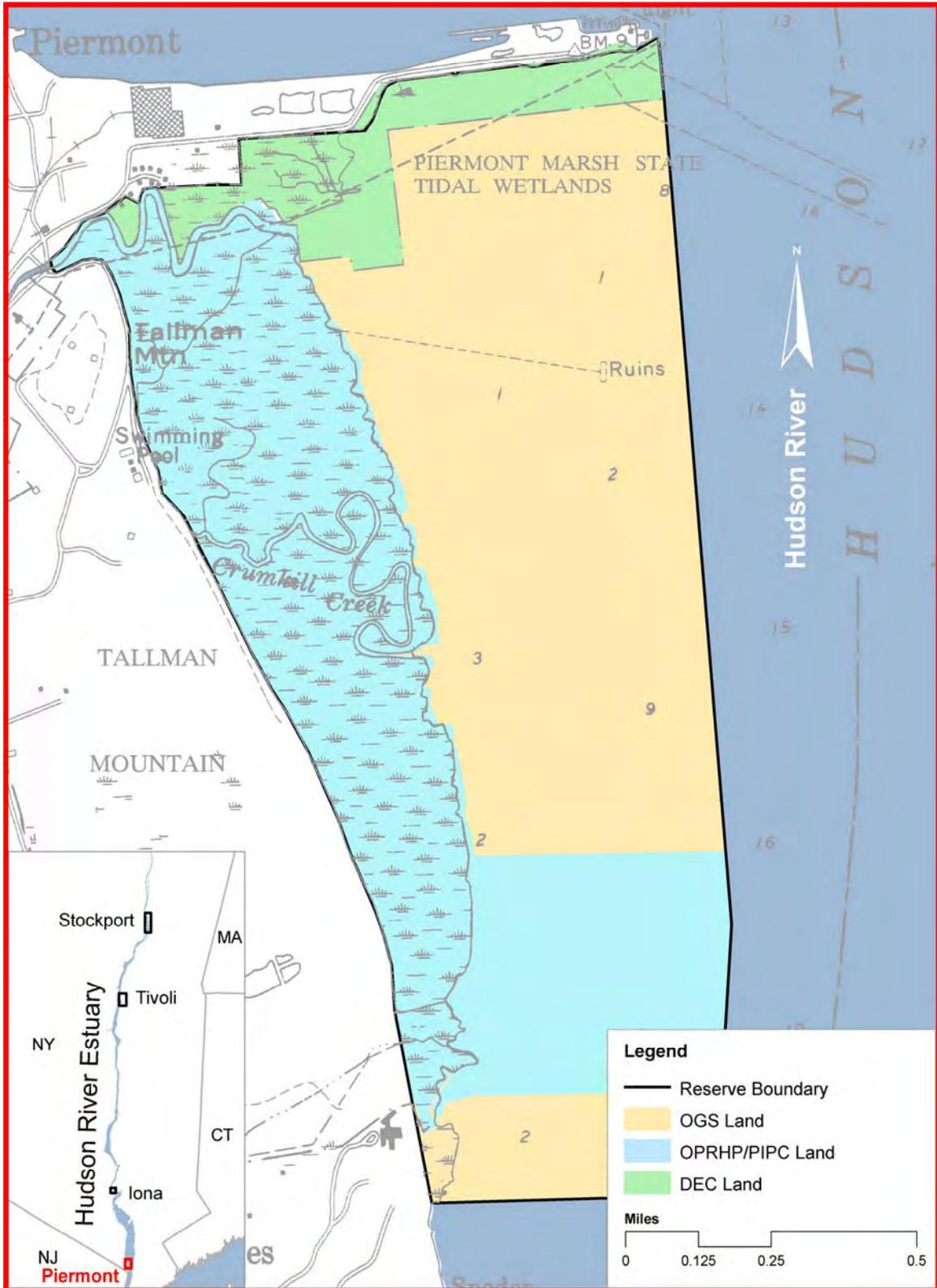


Figure 6
Land Ownership at Piermont Marsh.



As lead agency, NYSDEC is the principal state contact with NOAA for the Reserve program, as well as the recipient agency for NOAA capital, land acquisition, and operations financial assistance awards. NYSDEC hires and directs Reserve staff and carries out the Reserve programs in education, research and monitoring, resource protection and stewardship, and estuary training; operates the Norrie Point Environmental Center headquarters; prepares the Reserve management plan; coordinates implementation of the Reserve management plan; maintains records related to grants; prepares reports; and reviews management plan policies. NYSDEC participates in the development and implementation of management plans and manages land under its jurisdiction in conformance with this plan. NYSDEC is responsible for assisting other agencies in developing and reviewing management plans related to Reserve lands they maintain and effecting changes in these plans through Reserve staff input. NYSDEC actions undertaken within New York's coastal zone area must be consistent with state coastal management policies.

Within NYSDEC's matrix organization, the Reserve has both a programmatic home and an organizational home based on geography. The Reserve is programmatically housed in the Office of Natural Resources under the Division of Fish, Wildlife and Marine Resources, within the Bureau of Marine Resources' Marine Habitat Protection Section. The Bureau of Marine Resources is a central office unit that operates out of East Setauket, NY on Long Island. Organizationally, and for staff reporting purposes, the Reserve operates out of NYSDEC Region 3 in New Paltz, NY, and staff report through the Regional Supervisor of Natural Resources to the Regional Director. Organizational matrices are included in Appendix 5.

A key feature of the Reserve's organizational landscape is the NYSDEC Hudson River Estuary Program, a unique regional partnership leading the restoration of the Hudson River through implementation of the Hudson River Action Agenda. The Estuary Program, through its Action Agenda, grants to communities, and partnerships, seeks to address the priorities of sustainability, global warming, promoting smart growth and green communities, improving stewardship of and public opportunities to enjoy our natural assets, and building toxic free communities and a toxics free future. The Reserve is closely linked to the Estuary Program. Several Reserve projects and programs are consistent with and support the attainment of several goals of the Hudson River Action Agenda, including those related to conservation of river and shoreline habitats, restoration of fisheries, conservation of biodiversity, protection of streams, development of public access, promotion of public understanding of the Hudson River, and waterfront revitalization. The Reserve depends on the Estuary Program to fund one full-time contractual position, and the Reserve supervises the work of two other full-time Estuary Program staff. These and other federally funded Reserve contract staff positions are administered under NYSDEC Estuary Program contracts with either the Cornell University Water Resources Institute or the New England Interstate Water Pollution Control Commission.

The Hudson River Valley Greenway, which exists as both a state agency and a non-profit corporation, has been a vital partner to the Reserve. It has administered NOAA annual monitoring grants for over a decade, as well as other research and education projects supported with non-State funding. The Greenway also collaborates with the Reserve on matters of waterfront access, water and land trails, and training.

The New England Interstate Water Pollution Control Commission (NEIWPC) has also been an

important administrative partner to the Reserve. NEIWPC is a not-for-profit interstate agency that serves and assists its member states -- Connecticut, Maine, Massachusetts, New Hampshire, New York, Rhode Island, and Vermont -- in matters related to surface water protection, wetlands restoration, nonpoint source pollution, water allocation, and underground storage tanks. Several Reserve staff members are NEIWPC employees through a contract with the NYSDEC, administered by the Hudson River Estuary Program.

Operational Capacity

Staff

The Reserve is staffed by a complement of talented individuals with diverse training and experience that equip them to plan, operate and deliver effective education, training, stewardship, research and monitoring programs. Staff duties, status, and funding are included in Appendix 5. Only two full-time Reserve staff positions are State Civil Service -- the reserve manager (Biologist 2) and education coordinator (Environmental Educator 2), and only one of these is state-funded. The Reserve lost a third (state-funded) Civil Service position (the research coordinator, a Biologist 1) in fall, 2007 when the incumbent left the Reserve and the position was eliminated by NYSDEC. The remaining four full-time Reserve staff positions are filled by contract employees, who are hired through a state contract with the New England Interstate Water Pollution Control Commission (NEIWPC), based in Lowell, MA; the contract is administered by the NYSDEC Hudson River Estuary Program. One of the NEIWPC contract employees, the research assistant, was promoted to fill the research coordinator position, eliminating the research assistant position, a full-time contract position. The Reserve is also staffed by a part-time, seasonal Civil Service maintenance position, a part-time NEIWPC contract research assistant position, two 10-month and one 5-month Student Conservation Association interns, and a half-time employee hired through a NYSDEC contract with Cornell University. Two other staff positions, the benthic mapping coordinator and the habitat restoration coordinator, are NEIWPC contract employees of the NYSDEC Hudson River Estuary Program who are assigned to the Reserve.

The Reserve needs the following additional staff to meet our NOAA obligations. First, a Research Assistant/System-Wide Monitoring Program (SWMP) technician is needed to fulfill the requirements of the SWMP program. In addition, NOAA requires that all core positions be state funded. At present, the Research Coordinator and Education Coordinator positions are on the federal grant. This has been a continuing issue in NOAA evaluations. At the last NOAA evaluation, December 2008, DEC executive staff identified two possible strategies for short-term solutions including use of private/trust funds and enforcement penalties to meet these shortfalls. New York State's dire budget situation may preclude progress in the near term.

The Reserve relies on state funding (e.g., general fund, environmental protection fund, invasive species management funds) and state resources (e.g., staff of the Division of Operations and Division of Fish, Wildlife, and Marine Resources) to operate NYSDEC-managed sites at Stockport Flats, Tivoli Bays, and Piermont Marsh. In addition Reserve operational capacity is supplemented by the staff and resources of other land management agencies that oversee lands at Stockport Flats (Hudson River Islands State Park, out of the OPRHP Saratoga-Capital District Region), Iona Island (Bear Mountain State Park, out of the OPRHP Palisades Region), and Pier-

mont Marsh (Tallman Mountain State Park, also out of the OPRHP Palisades Region).

Facilities

With the Reserve's move to the Norrie Point Environmental Center in January, 2007, and the completion of the research laboratory in spring, 2008, the Reserve at long last has the space and facilities it needs to accomplish its mission and goals. At the Norrie Center, two large meeting rooms, a wet classroom, and access to outdoor field laboratory areas enable the Reserve to operate diverse public, K-12, post-graduate, training and professional development activities. All staff members now have offices. Research and monitoring programs are expanding with the addition of a long-term monitoring station at Norrie and sufficient work space for staff, interns, and visiting scientists. Over the next two years, the Reserve will take steps to conserve energy and add sustainable energy sources, including installation of insulation, motion detectors for lights, and solar panels. The Reserve occupies the Norrie Point Environmental Center under the terms of a memorandum of understanding between NYSDEC and NYS OPRHP (Appendix 6). Both the OPRHP Taconic Region and the Margaret Lewis Norrie State Park are important partners in the operation and maintenance of the Norrie Point Environmental Center.

The Reserve maintains three boats and a fleet of canoes, and has three trucks and one car provided by the NYSDEC Region 3 office. One of the boats is berthed at the Norrie Point marina, located ¼ mile north of the Norrie Point Environmental Center and operated by the Margaret Lewis Norrie State Park. The Reserve currently lacks adequate storage facilities for its boats.

The Reserve maintains a presence in the Tivoli Village Hall at the Tivoli Bays Visitor Center, located just north of the Tivoli Bays site, under the terms of a letter of agreement (Appendix 7) with the Village of Tivoli. The Tivoli Bays Visitor Center houses the *Doorway to the Bays* interpretive exhibit and a collection of Hudson River books, and is the venue for a monthly public lecture series (Tivoli Bays Talks), "Live Wednesdays", and other programs.

Lastly, the Reserve continues to have a presence at the Bard College Field Station, the Reserve's headquarters from 1985 to 2007. The Reserve maintains a weather station, oversees limited research activity by staff and visiting scientists who use the Reserve's office and field station laboratories, and stores canoes used primarily for public programs at Tivoli North Bay inside the Field Station's security fence.

Reserve Site Descriptions

Site descriptions of the four Reserve sites appear below, however addition details about the sites and the Hudson River ecosystem may be found in the *Ecological Profile of the Hudson River National Estuarine Research Reserve*, by Yozzo et al., 2005.

Stockport Flats

Location and Ownership -- Stockport Flats is the northernmost site in the Reserve, located in Columbia County, a few miles north of the city of Hudson, in the towns of Stockport and Stuyvesant. Most of this site lies west of the east shore railroad line. Nearly all of the Stockport Flats'

1543 acres is in New York State ownership under the jurisdiction of the NYSDEC, OPRHP, and OGS. Three small parcels are private land inholdings. (See Figure 3). Stockport Flats and Nutten Hook appear on the U.S.G.S. 7.5 minute series Hudson North topographic quadrangle. Portions of the site are adjacent to the Hudson River Federal Navigation Channel.

Description -- Stockport Flats is a five-mile, narrow mosaic of landforms on the east side of the Hudson River, about 125 miles north of Manhattan. The north end of the site consists of Nutten Hook, a bedrock outcropping that juts into the river, sheltering a large, high-quality non-tidal swamp and adjoining freshwater tidal wetlands. The Scott Ice House, a barn and a caretaker's house, are located at Nutten Hook. Between Nutten Hook and Little Nutten Hook is nearly a mile of rich, floodplain forest bordered by vegetated tidal flats. The next two miles encompass Gay's Point and Stockport Middle Ground Island, both reforested dredge spoil deposits that are comprise the Hudson River Islands State Park. Proceeding south is the mouth of Stockport Creek, a large tributary stream; a portion of the upland bluff south of Stockport Creek; the dredge spoils and expansive tidal wetlands between Stockport Creek and Priming Hook; and the northern end of Priming Hook, another dredge spoil feature. Figure 7 depicts land types and land use within and adjacent to this site. Details about public access appear in Appendix 8.

Special Designations – Stockport Flats includes, or is included in, many specially designated areas.

- The Scott Ice House at Nutten Hook is listed on both the National Register of Historic Places and the State Register of Historic Places. The site and an access lane from Route 9J are protected by a conservation easement held by Scenic Hudson Land Trust.
- The Hudson River Islands State Park lies wholly within the Stockport boundary. It is managed in accordance with the OPRHP's "Hudson River Islands State Park Interim Management Guide".
- Stockport Flats was identified by New York Audubon as the Stockport Flats Important Bird Area because it supports significant populations of bird species that require freshwater tidal marshes, as well as species listed as endangered, threatened, or of special concern.
- The Stockport Creek and Flats Significant Coastal Fish and Wildlife Habitat, designated by the NYS DOS, includes most of this Reserve site, as well as areas to its south and east. It is recognized for its vast expanses of shallows and flats, and its inclusion of the tidal Stockport Creek, the second largest unobstructed tidal and freshwater stream on the Hudson River. It is characterized as a high diversity habitat of excellent quality that has experienced limited disturbance.
- Stockport Flats is part of the Columbia-Green North Scenic Area of Statewide Significance, which is also designated by the DOS.

Tivoli Bays

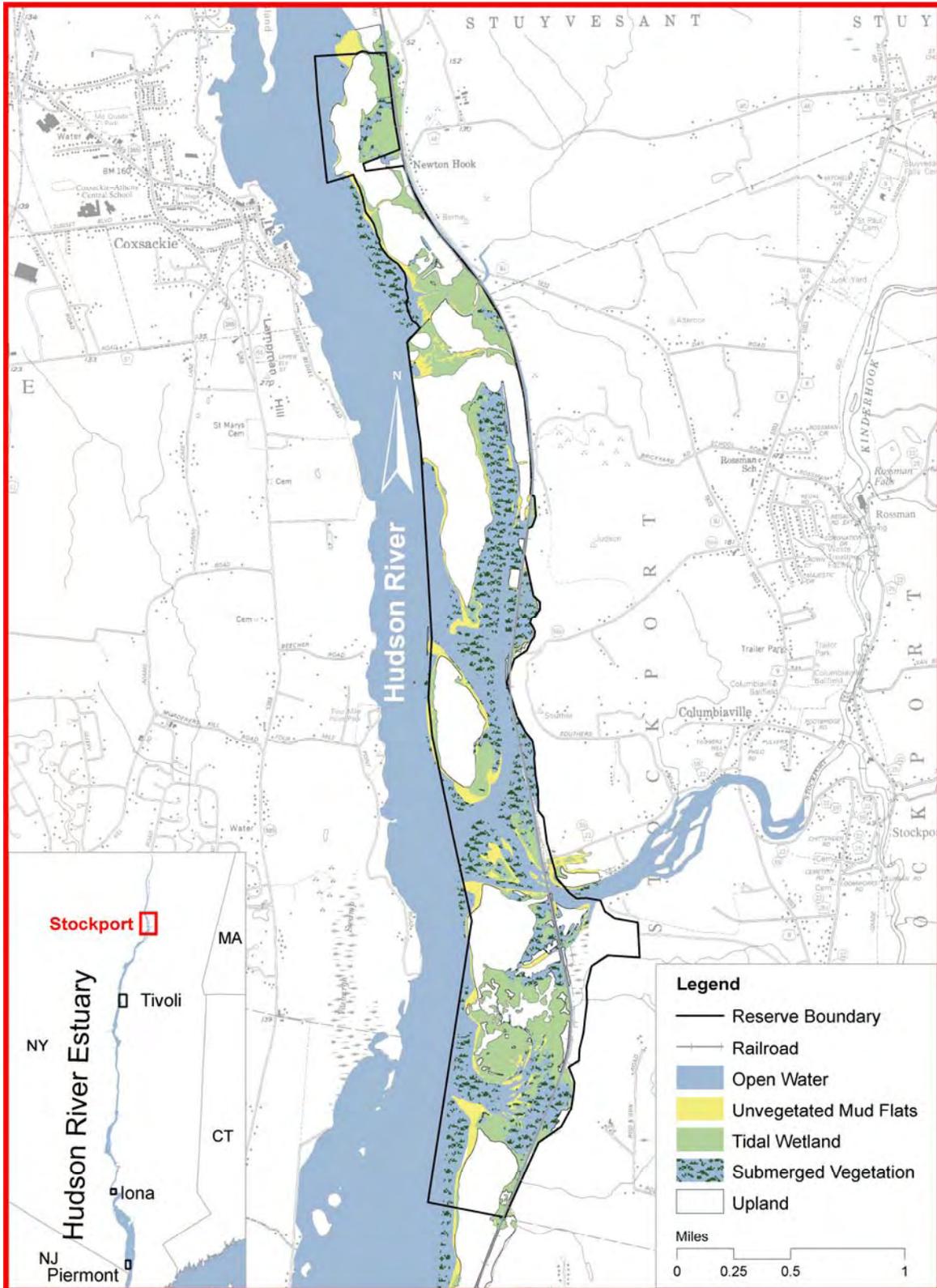
Location and Ownership -- Tivoli Bays is a 1722-acre site in the Dutchess County Town of Red Hook that extends two miles along the east shore of the Hudson River between the villages of Tivoli and Barrytown, about 100 miles north of Manhattan. The Hudson is tidal freshwater at the Tivoli Bays, with an average tidal range of 3.9 feet. The Stony Creek has a watershed area of 22.2 square miles draining into Tivoli North Bay and the Saw Kill has a watershed area of 22.0 square miles draining into Tivoli South Bay. This site is managed by NYSDEC as the Tivoli Bays Wildlife Management Area, the Tivoli Bays State Nature and Historical Preserve, and as part of the Reserve. Two parcels of the site are private lands with a conservation easement. In addition, one parcel is a private land inholding. (See Figure 4).

Description -- The Tivoli Bays site includes two large coves on the east shore of the Hudson River inside the railroad tracks, including Tivoli North Bay, a large intertidal marsh, and Tivoli South Bay, a large, shallow cove with mudflats exposed at low tide. The site also includes an extensive upland buffer area bordering Tivoli North Bay; sections of upland shoreline along Tivoli South Bay; Cruger Island and Magdalen Island, two bedrock islands west of the railroad; extensive subtidal shallows, and the mouths of two tributary streams, the Stony Creek and Saw Kill. Figure 8 depicts land types and land use within and adjacent to this site. Details about public access appear in Appendix 8. From 1985 to 2007, the Reserve was headquartered at the Bard College Field Station, located at the mouth of the Saw Kill where it enters Tivoli South Bay.

Special Designations – The Tivoli Bays has many special designations.

- The Tivoli Bays is a large and diverse habitat for many migratory and resident dabbling ducks, raptors, songbirds, and wading birds, some of which are threatened or endangered. As a result, it has been designated by New York Audubon as the Tivoli Bays Important Bird Area, based on the documented occurrence of several breeding marsh birds. It was also designated by NYSDEC a New York Bird Conservation Area in recognition of its unique breeding marsh bird community, its prominence as a staging area for migrating waterfowl, and its upland forest and shrub areas which provide migratory stopover habitat for many songbirds.
- The Tivoli Bays is part of the North and South Tivoli Bays Significant Coastal Fish and Wildlife Habitat, designated by the NYS DOS. It is recognized as being a large mosaic of freshwater tidal habitats, including shallows, lower marsh, upper marsh, tidal swamp forest, rocky shore, and tidal creek that are important to a variety of fish, turtles, birds, and mammals.
- In 2007, on the 25th anniversary of the Reserve, the Tivoli Bays was designated by NYSDEC as the first Natural Heritage Area in New York State. The designation of the Tivoli Bays Natural Heritage Area made the protection of rare plants, fauna, and natural habitats a key management priority of the site.

Figure 7
 Land Type and Use in and Near Stockport Flats.



- Tivoli Bays is part of the Estates District Scenic Area of Statewide Significance, which is also designated by the NYS DOS. The Tivoli Bays sub-unit is recognized as an “unspoiled landscape of marsh and islands, offering extensive views of the Hudson and western shore.” The Tivoli Bays is also included in the Mid-Hudson Historic Shorelands Scenic District designated under Article 49 of the Environmental Conservation Law.
- The Tivoli Bays is part of the Hudson River National Historic Landmark District, and is included in the Sixteen Mile Historic District, which is listed in the National and State Registers of Historic Places. Most of the estates within this historic corridor were associated with the Livingston family.

Iona Island

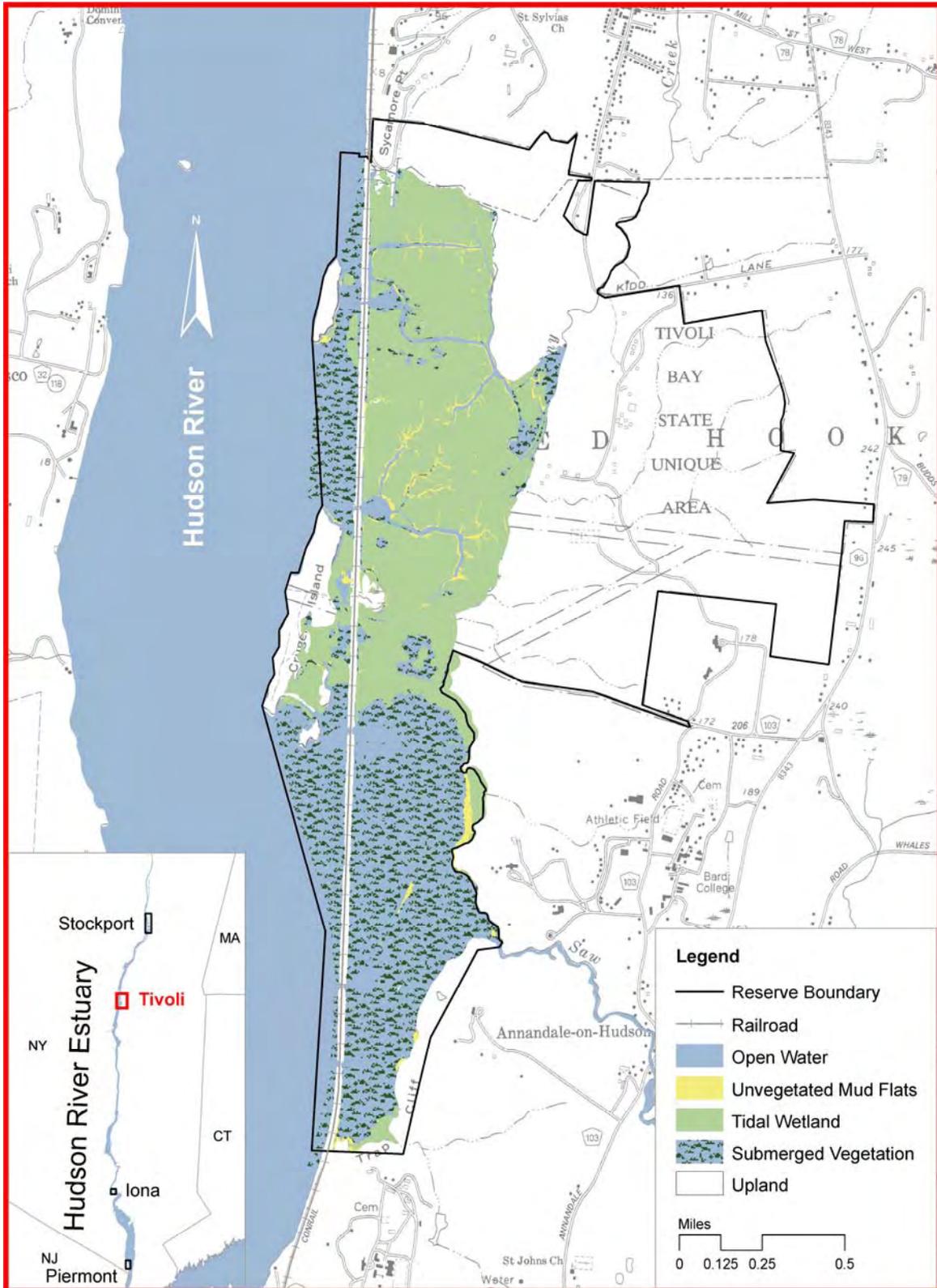
Location and Ownership -- Iona Island is located in the Town of Stony Point in Rockland County, six miles south of West Point. The 556-acre site is part of Bear Mountain State Park, an element in the Palisades Interstate Park System. Iona Island and its associated tidal wetlands have been designated a National Natural Landmark by the National Park Service, and as a New York State Important Birding Area. This site is under the jurisdiction of the Palisades Interstate Park Commission. Iona Island appears on the Peekskill U.S.G.S. 7.5 minute series topographic quadrangle.

Description -- Iona Island is a rocky, bedrock island in the midst of the Hudson Highlands bordered to the west and southwest by 270 acres of wetlands -- Salisbury and Ring Meadows, two large tidal marshes; the mouth of Doodletown Brook, a high gradient freshwater stream; and Doodletown Bight, an expanse of shallows and mudflats. A separate island, Round Island, was attached to the south end of Iona Island with fill in the early 20th century. The marshes and shallows occupy about one mile of river bed between Iona Island and the west shore. The salinity of the Hudson River at Iona ranges from slightly brackish (6 ppt) to fresh water. Although the adjacent Hudson River channel is over 140 feet deep, most of the site is very shallow, ranging from 1 to 3 feet deep. The tidal range here is about 2.8 feet. Doodletown Brook is the principal tributary to the site, and drains 2.9 square miles. Figure 9 depicts land types and land use within and adjacent to this site. Details about public access appear in Appendix 8.

Special Designations – Iona Island has many special designations.

- Iona Island and its environs support marsh-nesting birds, waterfowl, warblers, shorebirds, bald eagles, amphibians, reptiles and fish spawning and nursery areas. It was designated a bird sanctuary in 1947 by the Palisades Interstate Park Commission to protect wintering bald eagles. In 1997, it was designated by the National Audubon Society as the Doodletown and Iona Island Important Bird Area, based on the importance of the site for wintering bald eagles, songbirds, and marsh birds. It was also designated by NYSOPRHP the Iona Island/Doodletown Bird Conservation Area in 1998 for its habitat for eagles and migratory birds.

Figure 8
Land Type and Use in and Near Tivoli Bays.

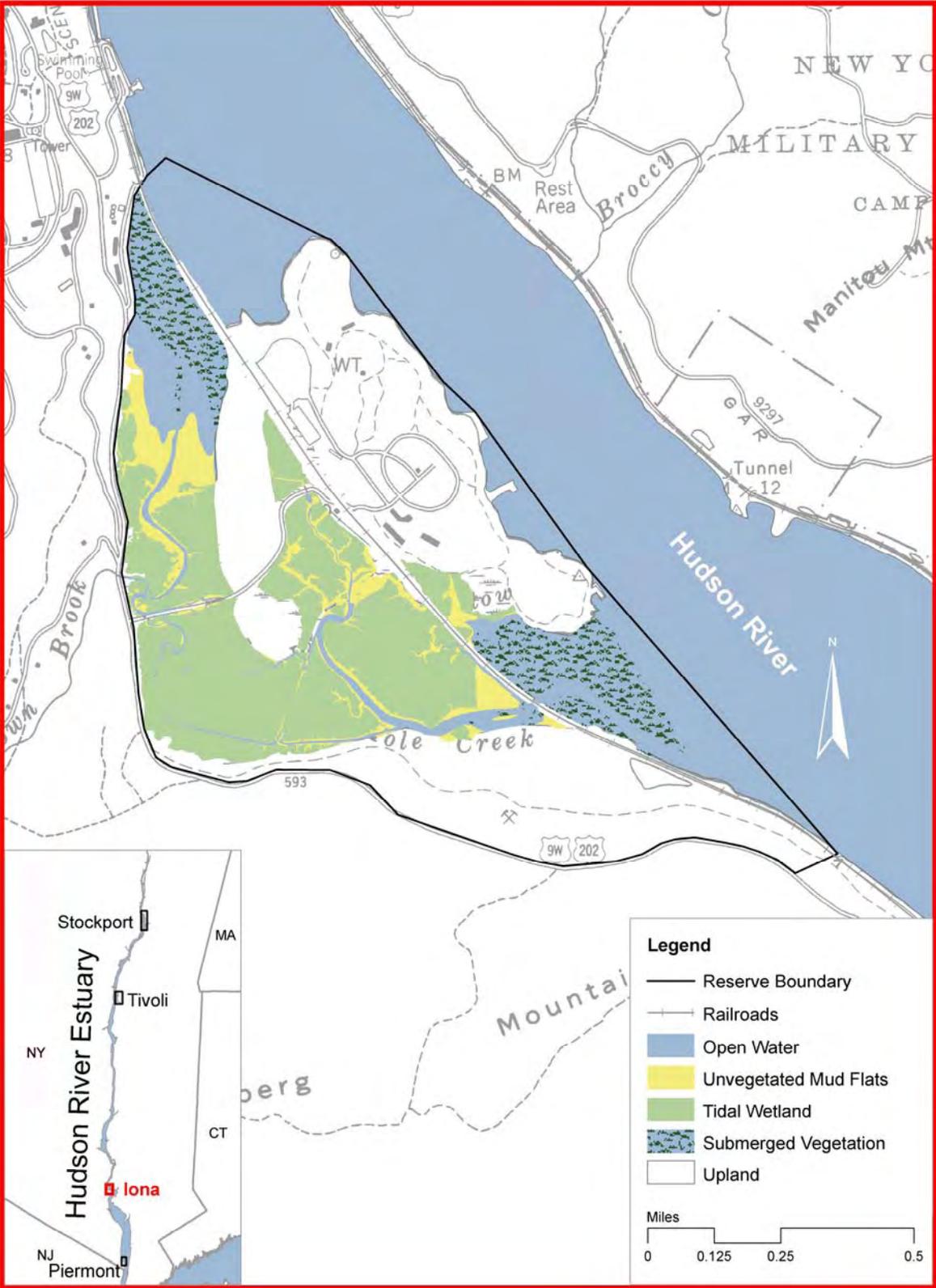


- The marshes included in the Iona Island Reserve site are part of the Iona Island Marsh Significant Coastal Fish and Wildlife Habitat, designated by the NYS DOS. This tidal marsh complex is the third largest in the lower estuary. At the time of designation, it was recognized as being important as nesting habitat for marsh and other birds, as well as being highly diverse habitat of excellent quality that had experienced modest disturbance.
- Iona Island is a National Natural Landmark, designated by the National Park Service.
- Iona Island is part of the Hudson Highlands Scenic Area of Statewide Significance, designated by the NYS DOS. The Iona Island Marsh and Iona Island sub-units are recognized for the juxtaposition of expanses of water and wetlands and rugged rocky island topography, all against a backdrop of steep mountain slopes. The road across Iona Island is designed a scenic road under Article 49 of the Environmental Conservation Law.

Other Issues – For the first half of the 20th Century, the United States operated the Iona Island Naval Ammunition Depot, with over a hundred buildings assembling and shipping arms for both world wars. Because of these operations and the associated risk of residual contamination, the United States Army Corps of Engineers (USACE) investigated the site under the Defense Environmental Restoration Program in 2007-2008, with particular attention to a 1903 explosion site. Surface soil and sediment samples were collected and analyzed for select metals and explosives. Surface soil samples had concentrations of lead that surpassed those suitable for human health criteria and lead was deemed a chemical of potential concern (COPC). Antimony, copper, and lead exceeded background surface soil concentrations and ecological screening criteria, and were labeled chemicals of potential ecological concern (COPECs). The sediment samples showed antimony and lead to be COPC and that antimony, copper, lead, nickel, and zinc were COPECs. There were no explosives found in any surface soil or sediment samples.

A more detailed investigation into soil and sediment analysis will be conducted in future site assessments. Neither time critical removal action nor non-time critical removal action was necessary for materials at the 1903 explosion site. Site inspections preceding 2007 have revealed munitions related items and munitions debris however; additional inspection as of December 2007 indicated no Munitions and Explosives of Concern or Munitions Debris. Additional studies are recommended to focus on munitions, but not Hazardous Toxic and Radiological Waste issues. No immediate human health risk has been identified.

Figure 9
 Land Type and Use in and Near Iona Island.



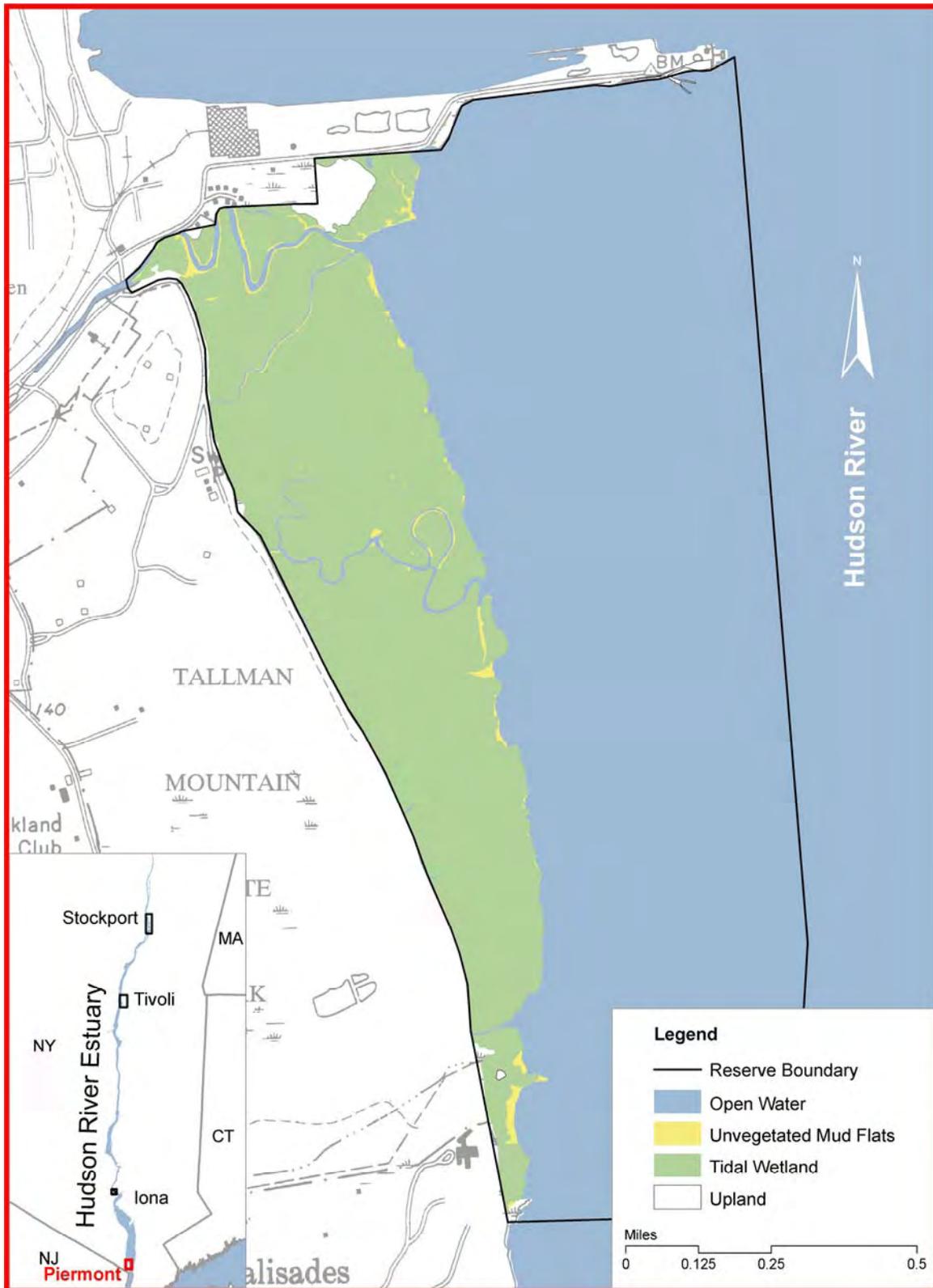
Piermont Marsh

Location and Ownership -- Piermont Marsh is located on the west shore of the Tappan Zee in the Town of Orangetown in Rockland County, about 25 miles north of Manhattan. The site lies at the southern edge of the Village of Piermont, four miles south of Nyack, and occupies two miles of shoreline south of the mile-long Erie Pier. Most of Piermont Marsh is part of Tallman Mountain State Park, an element of the Palisades Interstate Park system. The small section of marsh north of the Sparkill Creek is under DEC jurisdiction. Piermont Marsh appears on the Nyack U.S.G.S. 7.5 minute topographic quadrangle. Figure 10 depicts land types and land use within and adjacent to this site. Details about public access appear in Appendix 8.

Description – Piermont Marsh’s 1,017 acres include the mouth of Sparkill Creek, an extensive brackish marsh dominated by *Phragmites australis*, and extensive adjacent tidal shallows. The salinity of the Hudson River at Piermont is generally brackish, although it ranges from fresh water to 12 ppt. The average tidal range is 3.2 feet. The Sparkill Creek discharges into the north end of the marsh, draining 11.1 square miles of developed watershed.

Special Designations – Piermont Marsh is designated the Piermont Marsh Significant Coastal Fish and Wildlife Habitat by the NYS DOS for its extensive brackish tidal marsh bordered by shallows and mudflats that are important for resident, breeding, and migratory birds and a host of other vertebrates and invertebrates.

Figure 10
 Land Type and Use in and Near Piermont Marsh.



II. FEDERAL PROGRAM GUIDELINES

Research and Monitoring Plan [§921.50]

The reserve 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. Reserve research and monitoring activities are guided by the reserve system research and monitoring plan 2006-2011 which identifies goals, priorities, and implementation strategies. 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. Research at the Hudson River Reserve is designed to fulfill the Reserve System goals as defined in program regulations. These include:

- Address coastal management issues identified as significant through coordinated estuarine research within the System;
- Promote Federal, state, public and private use of one or more reserves within the System when such entities conduct estuarine research; and
- Conduct and coordinate estuarine research within the System, gathering and making available information necessary for improved understanding and management of estuarine areas.

Reserve System Research Funding Priorities

Federal regulations, 15 C.F.R. 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 policy-makers, and
- Improve public awareness and understanding of estuarine ecosystems and estuarine management issues.

The reserve system has identified the following five priority research areas to complement the funding priorities outlined above:

1. Habitat and ecosystem processes
2. Anthropogenic influences on estuaries
3. Habitat conservation and restoration
4. Species management
5. Social science and economics

Reserve System Research Goals

The reserve system research goals are embedded in Goal 2 of the Reserve System Strategic Plan 2005-2010, 'Increase the use of reserve science and sites to address priority coastal management issues,' and are outlined in the 2006-2011 Reserve System Research and Monitoring Plan. They

include:

- Biological, chemical, physical, and ecological conditions of reserves are characterized and monitored to describe reference conditions and to quantify change.
- Scientists conduct research at reserves that is relevant to coastal management needs and increases basic understanding of estuarine processes.
- Scientists have access to NERRS datasets, science products and results.
- The scientific, coastal management and education communities, as well as the general public, use data, products tools, and techniques generated at the NERRS.

Currently, there are two reserve system-wide efforts to fund estuarine research. The Graduate Research Fellowship Program (GRF) supports students to produce high quality research in the reserves. The fellowship provides graduate students with funding for 1-3 years to conduct their research, as well as an opportunity to assist with the research and monitoring program at a reserve. Projects must address coastal management issues identified as having regional or national significance; relate them to the reserve system research focus areas; and be conducted at least partially within one or more designated reserve sites. Proposals must focus on the following areas: 1) Eutrophication, effects of non-point source pollution and/or nutrient dynamics; 2) Habitat conservation and/or restoration; 3) Biodiversity and/or the effects of invasive species; 4) Mechanisms for sustaining resources within estuarine ecosystems; or 5) Economic, sociological, and/or anthropological research applicable to estuarine ecosystem management.

Students work with the research coordinator or manager at the host reserve to develop a plan to participate in the reserve's research and/or monitoring program. Students are asked to provide up to 15 hours per week of research and/or monitoring assistance to the reserve; this training may take place throughout the school year or may be concentrated during a specific season.

Secondly, research is funded through the Cooperative Institute for Coastal and Estuarine Environmental Technology (CICEET), a partnership between NOAA and the University of New Hampshire (UNH). CICEET uses the capabilities of UNH, the private sector, academic and public research institutions throughout the U.S., as well as the 27 reserves in the reserve system, to develop and apply new environmental technologies and techniques.

System-Wide Monitoring Program

It is the policy of the Hudson River Reserve to implement each phase of the System-Wide Monitoring Plan initiated by ERD in 1989, and as outlined in the reserve system regulations and strategic plan:

- Phase I: Environmental Characterization, including studies necessary for inventory and comprehensive site descriptions;
- Phase II: Site Profile, to include a synthesis of data and information; and
- Phase III: Implementation of the System-wide Monitoring Program.

The System-wide Monitoring Program provides standardized data on national estuarine environmental trends while allowing the flexibility to assess coastal management issues of regional

or local concern. The principal mission of the monitoring program is to develop quantitative measurements of short-term variability and long-term changes in the integrity and biodiversity of representative estuarine ecosystems and coastal watersheds for the purposes of contributing to effective coastal zone management. The program is designed to enhance the value and vision of the reserves as a system of national references sites. The program also takes a phased approach and focuses on three different ecosystem characteristics.

1. **Abiotic Variables:** The monitoring program currently measures pH, conductivity, salinity, temperature, dissolved oxygen, turbidity, water level and atmospheric conditions. In addition, the program collects monthly nutrient and chlorophyll *a* samples and monthly diel samples at one System-Wide Monitoring Program (SWMP) data logger station. Each reserve uses a set of automated instruments and weather stations to collect these data for submission to a centralized data management office.
2. **Biotic Variables:** The reserve system is focusing on monitoring biodiversity, habitat and population characteristics by monitoring organisms and habitats as funds are available.
3. **Watershed and Land Use Classifications:** This component attempts to identify changes in coastal ecological conditions with the goal of tracking and evaluating changes in coastal habitats and watershed land use/cover. The main objective of this element is to examine the links between watershed land use activities and coastal habitat quality.

These data are compiled electronically at a central data management “hub”, the Centralized Data Management Office (CDMO) at the Belle W. Baruch Institute for Marine Biology and Coastal Research of the University of South Carolina. They provide additional quality control for data and metadata and they compile and disseminate the data and summary statistics via the Web (<http://cdmo.baruch.sc.edu>) where researchers, coastal managers and educators readily access the information. The metadata meets the standards of the Federal Geographical Data Committee.

Education Plan [§921.13(a)(4)]

The reserve system provides a vehicle to increase understanding and awareness of estuarine systems and improve decision-making among key audiences to promote stewardship of the nation’s coastal resources. Education and interpretation in the reserves incorporates a range of programs and methodologies that are systematically tailored to key audiences around priority coastal resource issues and incorporate science-based content. Reserve staff members work with local communities and regional groups to address coastal resource management issues, such as non-point source pollution, habitat restoration and invasive species. Through integrated research and education programs, the reserves help communities develop strategies to deal successfully with these coastal resource issues.

Formal and non-formal education and training programs in the NERRS target K-12 students, teachers, university and college students and faculty, as well as coastal decision-maker audiences such as environmental groups, professionals involved in coastal resource management, municipal and county zoning boards, planners, elected officials, landscapers, eco-tour operators and professional associations.

K-12 and professional development programs for teachers include the use of established coastal and estuarine science curricula aligned with state and national science education standards and frequently involves both on-site and in-school follow-up activity. Reserve education activities are guided by national plans that identify goals, priorities, and implementation strategies for these programs. Education and training programs, interpretive exhibits and community outreach programs integrate elements of NERRS science, research and monitoring activities and ensure a systematic, multi-faceted, and locally focused approach to fostering stewardship.

Reserve System Education Goals

The National Estuarine Research Reserve System's mission includes an emphasis on education, interpretation, and outreach. Education policy at the Hudson River Reserve is designed to fulfill the reserve system goals as defined in the regulations (15 C.F.R Part 921(b)). Education goals include:

- Enhance public awareness and understanding of estuarine areas and provide suitable opportunities for public education and interpretation;
- Conduct and coordinate estuarine research within the system, gathering and making available information necessary for improved understanding and management of estuarine areas.

Reserve System Education Objectives

Education-related objectives in the Reserve System Strategic Plan 2005-2010 include:

1. People are aware of the ecological, economic, historical, and cultural importance of estuarine resources.
2. People understand how human choices and natural disturbances impact social, economic, and estuarine ecological systems.
3. People apply science-based information when making decisions that could impact coastal and estuarine resources.

Reserve System Coastal Training Program

The Coastal Training Program (CTP) provides up-to-date scientific information and skill-building opportunities to coastal decision-makers who are responsible for making decisions that affect coastal resources. Through this program, National Estuarine Research Reserves can ensure that coastal decision-makers have the knowledge and tools they need to address critical resource management issues of concern to local communities.

Coastal Training Programs offered by reserves relate to coastal habitat conservation and restoration, biodiversity, water quality and sustainable resource management and integrate reserve-based research, monitoring and stewardship activities. Programs target a range of audiences, such as land-use planners, elected officials, regulators, land developers, community groups, environmental non-profits, business and applied scientific groups. These training programs provide

opportunities for professionals to network across disciplines, and develop new collaborative relationships to solve complex environmental problems. Additionally, the CTP provides a critical feedback loop to ensure that professional audiences inform local and regional science and research agendas. Programs are developed in a variety of formats ranging from seminars, hands-on skill training, participatory workshops, lectures, and technology demonstrations. Participants benefit from opportunities to share experiences and network in a multidisciplinary setting, often with a reserve-based field activity.

Partnerships are important to the success of the program. Reserves work closely with State Coastal Programs, Sea Grant College extension and education staff, and a host of local partners in determining key coastal resource issues to address, as well as the identification of target audiences. Partnerships with local agencies and organizations are critical in the exchange and sharing of expertise and resources to deliver relevant and accessible training programs that meet the needs of specific groups.

The Coastal Training Program requires a systematic program development process, involving periodic review of the reserve niche in the training provider market, audience assessments, development of a three to five year program strategy, a marketing plan and the establishment of an advisory group for guidance, program review and perspective in program development. The Coastal Training Program implements a performance monitoring system, wherein staff report data in operations progress reports according to a suite of performance indicators related to increases in participant understanding, applications of learning and enhanced networking with peers and experts to inform programs.

III. MISSION, GOALS, AND OBJECTIVES

Mission

Improve the health and vitality of the Hudson River Estuary by protecting estuarine habitats through integrated education, training, stewardship, restoration, and monitoring and research programs.

Goals and Objectives

GOALS OF THE HUDSON RIVER NERR

1. Increase scientific understanding of HR Estuary habitats.
2. Increase estuarine literacy to promote active stewardship and environmentally sustainable behaviors and decisions.
3. Increase informed decision-making to protect and enhance Hudson River habitats.
4. Enhance stewardship of the land and water ecosystems within the Reserve.
5. Enhance Reserve operational capacity and facilities to enable the Reserve to support programmatic goals

1. Increase scientific understanding of HR Estuary habitats

Objective 1: All Hudson River aquatic and shoreline habitats are mapped and inventoried to document their location, distribution and characteristics.

Objective 2: Habitat functions of selected estuarine habitats are characterized to inform resource management decisions.

Objective 3: Spatial and temporal changes in estuarine habitats, as well as tributaries to Reserve sites, are characterized.

Objective 4: Human impacts on Hudson River habitats are identified along with the means to reduce these impacts.

Objective 5: Social science and assessment tools are developed and used to advance habitat protection and ecosystem management.

Objective 6: Scientists, managers and educators are provided access to original data and synthesized scientific information about the Reserve and Hudson River habitats.

Objective 7: Research on Reserve priority topics is conducted at Reserve sites and elsewhere in the estuary.

Objective 8: Reserve research programs are coordinated with those of key research partners.

Objective 9: Reserve research programs are coordinated with and supportive of other Reserve programs.

2. Increase estuarine and climate literacy to promote active stewardship and environmentally sustainable behaviors and decisions.

Objective 1: The general public enjoys, understands and appreciates Hudson River Estuary habitats and realizes that personal choices affect water quality, estuarine ecosystem health and severity of future climate change.

Objective 2: Key community groups understand threats to the Hudson River Estuary's health (particularly the effects of climate change), acquire knowledge for more informed lifestyle choices and act as better estuary stewards.

Objective 3: K-12 students learn about the Hudson River Estuary and make connections between their actions and the health of the estuary and its habitats.

Objective 4: Post-secondary students increase their awareness of issues affecting the Hudson River Estuary ecosystem and learn about resources available, including current scientific research, to address these issues.

Objective 5: Teachers and non-classroom environmental educators routinely incorporate Hudson River issues, lessons, examples, and data into formal instruction for students at all levels.

Objective 6: Reserve education programs are coordinated with those of key education partners.

Objective 7: Reserve education programs are coordinated with and supportive of other Reserve programs.

3. Increase informed decision-making to protect and enhance Hudson River habitats.

Objective 1: Decision-makers have an increased awareness of climate change impacts and increasingly plan for adaptation.

Objective 2: Decision makers include science-based information about protection and restoration of Hudson River habitats in planning and management documents, regulatory decision-making, and project implementation.

Objective 3: Decision-makers have an increased knowledge and capacity to protect upland and aquatic biodiversity.

Objective 4: Estuary Training Program events and activities address the needs of key audiences and result in positive outcomes.

Objective 5: Reserve training programs are coordinated with those of key outreach and training partners.

Objective 6: Reserve training programs are coordinated with and supportive of other Reserve programs.

4. Enhance stewardship of the land and water ecosystems within the Reserve.

Resource Protection Plan

Objective 1: Natural and cultural resources in the Reserve are protected.

Objective 2: Human impacts on Reserve sites are managed.

Objective 3: Reserve stewardship programs are coordinated with those of partners and other Reserve programs.

Habitat Restoration Plan

Objective 1: Selected high priority invasive species are managed at Reserve sites to restore and maintain natural communities.

Objective 2: Ecologically-based shoreline erosion control techniques are applied to enhance shoreline function at Reserve sites.

Objective 3: Secondary channel restoration is implemented where possible to restore or improve vegetated shallow and intertidal habitats.

Land Acquisition Plan

Objective 1: Significant and sensitive natural resources areas in and around the Reserve are protected through land acquisition.

Objective 2: Reserve boundaries are adjusted to reflect recent or future land acquisitions.

5. Enhance Reserve operational capacity and facilities to enable the Reserve to support programmatic goals and objectives

Administration and Operations Plan

Objective 1: The Reserve's staff is of sufficient size and capabilities to administer and deliver effectively its mandated and assigned programs.

Objective 2: Reserve component sites and facilities are managed effectively with adequate inter- and intra-agency coordination at the site level.

Facilities Plan

Objective 1: The Reserve increases the energy efficiency of operations at the Norrie Point Environmental Center.

Objective 2: The Reserve insures effective management of on- and off-site Reserve facilities to support research, education, and resource protection objectives.

Objective 3: The Reserve supports clean-up of deteriorated Reserve facilities.

Access Plan

Objective 1: Public access is provided to Reserve sites to an extent compatible with conservation of the Reserve's natural resources and ecological integrity.

Objective 2: Access to Reserve sites is monitored and managed to minimize negative human impacts.

IV. RESEARCH AND MONITORING PLAN:

Increasing scientific understanding of Hudson River Estuary habitats

Background

The four Reserve sites embrace a diversity of biological and geophysical features, and are influenced by a wide variety of land use and development in surrounding lands throughout the 152-mile span of the estuary. In addition, through its work on habitat elements of the Hudson River Estuary Action Agenda, Reserve inventory and assessment efforts of the past decade have extended to all waters of the Hudson River Estuary, from the Verrazano Narrows Bridge to the Troy Dam. These projects, accomplished through broad collaborations, have targeted real gaps in scientific knowledge of the Hudson and have created a significant legacy and foundation for future management and scientific investigation.

Introduction to Reserve System Research Program

The NERRS research framework 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 foundation of this approach, and are guided by national plans that identify system-wide goals, priorities, and implementation strategies and by the Hudson River Estuary Action Agenda, which focuses on local and regional needs.

Ecological understanding of our ecosystem is gained through research and monitoring, with a special focus on the relationships between ecosystem components and human activities. The latter can be either detrimental (i.e., unchecked development and loss of riparian areas) or restorative (i.e., enhancement of aquatic habitats or management of invasive species). In either case, scientific information is necessary for the best decisions on how to protect and enhance estuarine habitats and resources. This information is conveyed to the public and decision-makers through education and training programs described in more detail in chapters V and VI.

Ecological Profile of the Hudson River NERR

For more than 20 years, the research and monitoring conducted at the Reserve has contributed greatly to our understanding of the Hudson River ecology. Published in 2005, the *Ecological Profile of the Hudson River National Estuarine Research Reserve* provides a synthesis of this information and recommendations for research and monitoring over the next decade. At the same time, we will remain open and flexible to changing coastal management information needs and seek to address these.

Hudson River NERR Research and Monitoring Program

Research and Monitoring Objectives

Objective 1: All Hudson River aquatic and shoreline habitats are mapped and inventoried to document their location, distribution and characteristics.

Objective 2: Habitat functions of selected estuarine habitats are characterized to inform resource management decisions.

Objective 3: Spatial and temporal changes in estuarine habitats, as well as tributaries to Reserve sites, are characterized.

Objective 4: Human impacts on Hudson River habitats are identified along with the means to reduce these impacts.

Objective 5: Social science and assessment tools are developed and used to advance habitat protection and ecosystem management.

Objective 6: Scientists, managers and educators are provided access to original data and synthesized scientific information about the Reserve and Hudson River habitats.

Objective 7: Research on Reserve priority topics is conducted at Reserve sites and elsewhere in the estuary.

Objective 8: Reserve research programs are coordinated with those of key research partners.

Objective 9: Reserve research programs are coordinated with and supportive of other Reserve programs.

Strategies for Completing Baseline Inventory of Estuarine Habitats (Objective 1)

The Reserve has extended its research and monitoring capabilities estuary-wide and has taken the lead on coordinating Hudson River aquatic habitat inventory projects for the state under the Hudson River Estuary Program, in partnership with several public and private research institutions. To date, tidal wetlands larger than ½ acre, vegetated subtidal shallows, and river bottom areas more than 3 meters deep have been mapped using a combination of remote sensing (aerial photography, acoustic techniques) and field investigations. Baseline mapping of shoreline types is complete from the Tappan Zee Bridge north to the Troy Dam. Pilot investigations of shallow water mapping techniques are planned. The following strategies will be used to complete the baseline inventory of Hudson River habitats.

Shallow Water Mapping - The Reserve, in partnership with the Hudson River Estuary Program, will work with the Benthic Mapping Project partners to pilot shallow-water mapping techniques and complete mapping of about one-half of the Hudson's shallows using federal funds administered by the Coastal Services Center. The Reserve will seek funding to complete mapping the Hudson's shallows, which constitute about one-third of the Hudson River bottom, and to promote use of these data in storm surge modeling.

Shoreline and Near-Shore Upland Mapping - The Reserve will seek to complete the detailed mapping of shoreline types throughout the estuary from Manhattan to the Tappan Zee using its field-tested Hudson River Shoreline mapping protocol. The Reserve will also work with the

NYSDEC Division of Water and the Hudson River Estuary Program to foster partnerships that will enable detailed mapping of upland topography in the vicinity of the shoreline in order to improve the resolution of topographic maps. This may involve use of Light Detection and Ranging (LiDAR) tools and products, and associated flood prediction models, which will be used to forecast shoreline and near-shore areas that are vulnerable to increased submergence and flooding associated with climate change. This information will be used to promote conservation of areas that are likely to become estuarine habitats in the future.

Strategies for Determining Hudson River Habitat Functions (Objective 2)

The submerged, inter-tidal and shoreline communities of the Hudson River are rich and diverse, and they provide myriad benefits to creatures that live in and along the estuary. The habitat requirements of these life forms typically vary by species, life stage and season. Although the functions of some habitats are becoming better known, considerable work remains to elucidate many details. While these information needs extend beyond the capacity of the Reserve and its 5-year planning horizon, the following strategies will further our scientific understanding and management framework. All of this work will further habitat protection goals in the Hudson River Action Plan.

Invertebrate Community Maps for the River Bottom – The Reserve will seek funding to map invertebrate communities to identify fish and crustacean food sources. This work will build on pilot studies conducted under the benthic mapping project (by SUNY Stony Brook and Cary Institute of Ecosystem Studies scientists) to link benthic communities to geophysical attributes of the river bottom, as well as on the Hudson River Biocriteria Project, which sought to identify biological indicators of environmental conditions in the estuary.

Definition of Fish Habitats - Reserve staff have been working with the NYSDEC Hudson River Fisheries Unit and other fisheries scientists and ecologists to understand the distribution of sturgeon and crabs in their physical environment. In 2008 the Reserve staff worked with Rutgers University scientists to conduct a pilot survey of sturgeon spawning grounds with the autonomous vehicle REMA. Reserve staff will be working with the NYSDEC Hudson River Fisheries Unit and their contractors to map spawning grounds of several species of interest in the estuary. The Reserve will also seek to advance knowledge of habitat use by fish according to species, life stage and season.

Habitat Functions of Submerged Aquatic Vegetation (SAV) - Reserve staff worked with a team of scientists and educators (Cornell University, Cary Institute of Ecosystem Studies, and New York Sea Grant) to develop a synthesis document that summarizes and details habitat values and characteristics of Hudson River submerged aquatic vegetation. This work is part of the Reserve's biological monitoring phase (Phase II) work under the System Wide Monitoring Program (SWMP). Staff will continue work with this SAV team and others to advance knowledge of submerged aquatic vegetation functions.

Hudson River Tidal Wetlands Habitat Function – Reserve staff will seek to advance knowledge of tidal wetlands habitat function by continued development and verification of the Hudson River Wetland Functional Assessment Method to guide restoration planning and post restoration

success evaluation. This project is also performed in conjunction with Phase II of SWMP.

Hudson River Shorelines Habitat Function – Reserve staff are collaborating with research partners (Cary Institute of Ecosystem Studies) to determine habitat function for fish and invertebrates at several shoreline sites representing six common shoreline types that occur in the Hudson River Estuary. This work is being incorporated into a 6-year project, supported by the Cooperative Institute for Coastal and Estuarine Environmental Technology, to identify best approaches for mitigating shoreline erosion along sheltered coasts.



Reserve research staff sampling fish as part of Shorelines Habitat Function Study. Photo credit: Dan Miller.

Strategies for Assessing Spatial and Temporal Change of Hudson River Habitats (Objective 3)

The Reserve maintains several long-term, continuous data sets to test research hypotheses, identify short-term variability and long-term trends in estuarine ecosystem health, and provide a source of hypotheses on fundamental ecological relationships and coastal management questions. Over the next five years, Reserve staff will seek funding and partners to continue monitoring key attributes.

Monitoring Weather and Water Quality – The Reserve will continue to implement the NERRS SWMP and the Reserve’s monthly water quality sampling program, as well as participating in an estuary-wide observing system launched in 2008.

To capture the natural variability and long-term trends in surface water quality, the four Reserve sites and five major tributaries to the sites will continue to be included in monthly nutrient and water quality monitoring, as they have since 1991. A fifth site, the Norrie Point and its adjacent tributary (the Indian Kill), were added in July, 2008 to the monthly sampling program.

SWMP generates both water quality and weather data at the Tivoli Bays at a higher resolution than the monthly monitoring. Under SWMP, we record parameters continually at 15-minute intervals at two paired locations: Tivoli North Bay and its tributary the Stony Creek, and Tivoli South Bay and its tributary the Saw Kill. At these sites we track the variability of all surface waters entering and leaving the tidal marsh system, and generate information that helps us interpret the trends we have observed in the long-term Reserve data record.



Reserve research staff monitoring water quality. Photo credit: Chris Bowser.

To further characterize weather and water quality conditions at the Reserve, two additional high resolution weather and water quality monitoring sites were established at Norrie Point and Piermont Pier in 2008. The Norrie Point site, located at the Reserve’s headquarters, is operated by Reserve staff. The Piermont Pier site, located at the northern boundary of the Piermont Marsh

reserve site, is operated by Columbia University's Lamont Doherty Earth Observatory. The three high resolution sites are part of the Hudson River Environmental Conditions Observing System (HRECOS), a collaborative partnership among several public and private entities to characterize conditions along the main stem of the Hudson River Estuary. These data are made available to the public through the Hudson River Environmental Conditions Observing System website (<http://www.hrecos.org>).

Wetland Vegetation Monitoring at Reserve Sites - The Reserve will continue to monitor tidal and sub-tidal wetland plant communities at each Reserve site to identify trends in plant community coverage, including the spread of invasive plant species (i.e., common reed, purple loosestrife, and Eurasian water chestnut). Aerial photography acquired in 2005 is being analyzed and used to update the plant community inventory of the Reserve, and used to direct research on and management of tidal wetlands and their invasive species. In addition, if CICEET-funded research at Cornell University demonstrates the feasibility of doing so, we will use satellite imagery in place of aerial photography in future remote sensing efforts. Funding will be sought to collect new data in 2010.

Submerged Aquatic Vegetation (SAV) Monitoring in the Estuary – Air photos acquired in 2007 are being analyzed and used to update the inventory of SAV and assess change in this vital community. If federal or state funding permits, the Reserve will expand the SWMP Phase II biological monitoring component to characterize short-term habitat variability in SAV, especially invertebrate community dynamics and plant biomass in native beds (e.g., those dominated by *Vallisneria americana*). In partnership with the Cary Institute of Ecosystem Studies, the Hudson River Estuary Program and New York Sea Grant, the Reserve will help implement an SAV volunteer field-monitoring program carried out by kayakers.

Fish Population Monitoring at the Tivoli Bays - The Reserve will continue a program at the Tivoli Bays to monitor populations, assess the inter-annual variability and document long-term trends in resident and anadromous fish populations at the freshwater tidal marshes at the Tivoli Bays. This program was begun in 2001 in partnership with Bard College at Simon's Rock.

Crab and Other Invertebrate Monitoring – The Hudson River Estuary is experiencing multiple invasions of invertebrate species, including Chinese mitten crab, Asian clam, and quagga mussel. Chinese mitten crabs (*Eriocheir sinensis*), a highly invasive species in freshwater systems, were first observed in the Reserve in June, 2008. Reserve staff and others will plan and implement a monitoring program to track the presence of various life stages at Reserve sites and their ecological impacts. Asian clam (*Corbicula fluminea*) and quagga mussel (*Dreissena rostriformis bugensis*) were discovered in the freshwater tidal Hudson in 2008, and are expected to compete with native and introduced bivalves. Reserve staff, working with other scientists, will be looking for these species at Reserve sites and documenting their impacts. This work will be closely coordinated with the New York State Invasive Species Office and with regional Partnerships for Regional Invasive Species Management.

Breeding Bird Monitoring at Reserve Sites – In 2004 and 2005, the Reserve oversaw a study that assessed change over an 18-year period in breeding bird communities at four Hudson River tidal marshes, documenting a dramatic decline at one site coincident with expansion of an inva-

sive variant of *Phragmites australis*. The Reserve will seek to monitor change in marsh breeding bird populations at the Iona Island, Tivoli Bays, and Stockport Flats sites in 2010, building on 1987 and 2005 surveys, as resources permit.

Hudson River Estuary Historical Artifacts -- An unanticipated by-product of the benthic mapping project has been the discovery of hundreds of underwater archaeological sites, including shipwrecks. University, state and federal agency partners are collaborating to investigate some of these sites with higher resolution sonars and diving. A pilot study underscored the difficulty of investigating these wrecks in turbid water with extremely poor visibility and 5-knot currents. This information will be used to plan the preservation and interpretation of this rich legacy.

Strategies for Increasing Knowledge of Human Impacts on Habitats (Objective 4)

The Hudson River estuary has a long history of environmental perturbation including shoreline modifications, dredging, filling, and pollution (i.e., organic and inorganic pollutant, nutrients, sediments, heavy metals, and Polycyclic Aromatic Hydrocarbons (PAHs)). Since it was settled by Europeans almost 400 years ago, little of the Hudson ecosystem remains unaffected. The degree of human influence on the aquatic habitats of the Hudson must be understood to help us make future decisions on managing the existing resources and restoring what has been lost or altered.

Watershed Impacts on Hudson River Habitats – The Reserve will seek to increase understanding of watershed impacts on Hudson River habitats by identifying watershed sources of point and non-point surface water pollutants and changes in land use patterns. This will be accomplished through collaborative research and monitoring efforts with other organizations such as USGS and other federal agencies, state agencies, county soil and water districts, and academic and research partners. The Reserve will continue to track the significant increase in chloride concentration in Hudson River tributaries.

Contaminant Effects on Hudson River Habitats – The Reserve will continue monitoring contaminant levels in the Reserve aquatic habitats and biota as resources and opportunities arise. Two Reserve sites are included in the National Mussel Watch, conducted by NOAA. We will also continue to collaborate with other programs (e.g., U.S. Geological Survey, the U.S. Fish and Wildlife Service, and the NYS DEC) to increase scientific understanding of trends and the impacts of contaminants on Hudson River habitats.

Impacts of Phragmites Control on Hudson River Habitats – The Reserve will increase understanding of the feasibility and effects of controlling invasive stands of *Phragmites australis*.

Restoration Science -- Reserve staff will promote consistent and effective strategies to determine feasibility, guide design and implement habitat restoration projects throughout the Hudson River estuary. The Reserve will continue to develop and incorporate research and monitoring efforts aimed at filling restoration science information gaps.

Impacts of Residential Developments – The Reserve will seek partners to study environmental impacts, including biological and water quality impacts, of recent and proposed developments on

the Hudson River Estuary.

Strategies for Advancing Social Science and Assessment (Objective 5)

The Reserve has, in recent years, begun to address the issue of resilient ecosystems, including the human dimensions of resilience, in its work. The Reserve hosted or participated in a series of workshops regarding human-ecosystem interactions, and staff members recognize the value, use, and necessity of incorporating socioeconomic findings into long-term planning and management of the Reserve, the watershed, and the coast.

The Reserve sites occupy an urban-rural gradient, and provide an important research opportunity for social scientists and others who wish to conduct research regarding climate change adaptation in rural and urban communities, as well as a host of other social ecological questions regarding natural resource planning and management in human-dominated ecosystems.

Social Network Analyses and Community Characterizations – The Reserve will seek to engage partners to conduct stakeholder inventory and analyses, generate databases for social network analysis, and undertake network analyses at multiple scales within the watershed. Initial community characterizations have been completed for Reserve sites and may be completed for other tributaries and their sub-watersheds. Key partners for this work are the NOAA Coastal Services Center and researchers at several institutions.

Social Science Research Needs – The Reserve will focus its social science research work on shoreline property owners and shoreline stakeholders, as part of the “Mitigating Shoreline Erosion along the Hudson River Estuary’s Sheltered Coasts” project. Shoreline landowners will be characterized and research conducted to determine values, behaviors and motivations. Research on other shoreline stakeholders will be similarly conducted. The Reserve will also encourage research fellows to pursue social science studies that support Reserve other priority issues.

Building Capacity -- The Reserve, through its Training Program and partners, will seek to develop a network of resource managers who have a greater understanding of the role of social science in ecosystem management and that can use these methods to address climate change, sea level rise and watershed links. An initial training was held in fall 2007, which covered an introduction to social science, community characterization and community based social marketing. Future workshops or roundtables would delve more deeply into these topics, such as data sources and methods for community characterization and the human ecosystem framework. This increased understanding of the value of social science methods and results will create a demand for research.

Workshops may be convened to assess the state of ecosystem management-oriented social science work, identify gaps, and develop an agenda for future work.

Strategies for Ensuring Scientific Information Synthesis, Access, and Dissemination (Objective 6)

The Reserve seeks to convey relevant scientific information in a timely way to decision-makers,

and to maintain its capacity as a reliable resource for current scientific knowledge on Hudson River estuarine aquatic habitat issues. This involves synthesizing much of the work described above. It also entails maintaining contacts with and knowledge of the needs of a range of target audiences, including research scientists, the coastal management community, aquatic resource users, municipal officials, and politicians.

Hudson River NERR Site Profile - The Reserve's Site Profile describes the state of scientific knowledge about the Reserve's long-term research sites as of 2005. This report is available to scientists, Reserve site managers, educators and other interested parties.

Estuary Mapper – The most complete and accessible library of benthic mapping data resides at the New York State Geographic Information System Clearinghouse. To access this, go to <http://www.nysgis.state.ny.us/> and select “New NYSDEC Data”. Benthic Mapper (<http://benthic.info>) also provides on-line access to a subset of the Hudson River bottom mapping information. In partnership with the Hudson River Estuary Program, the NYSDEC Division of Information Services, and mapping project partners, Benthic Mapper will be expanded to include all benthic mapping information that may be released, tidal wetlands and submerged aquatic vegetation coverages, and shoreline data as the new on-line “Estuary Mapper”. When it is completed, the public will be able to create maps of sections of the estuary that are of interest. In addition, the Reserve will seek to expand its website to enable professionals and the public to access all Reserve program data and products.

New York Ocean and Great Lakes Atlas – The Reserve will continue to work with the New York Ocean and Great Lakes Ecosystem Conservation Council staff to include spatial data on Hudson River habitats to increase public access to these data.

Publications List - The Reserve will make the Reserve's research publications list and selected publications more accessible to the scientific community by increasing on-line access.

System-Wide Monitoring Data -- Reserve research staff will submit data and metadata gathered under the NERRS System-Wide Monitoring Program in a timely way. The national SWMP data and related information are available to the public through the Central Data Management Office's website (<http://cdmo.baruch.sc.edu>). High resolution (15 minute) weather and water quality data are also transmitted in real time to the NOAA Geostationary Satellite Server (GOES) satellite from stations at Tivoli Bays and Norrie Point. These data are pooled into an observing network of 4 additional stations that represent a collaborative effort with partner institutions, and are made available to the public through the Hudson River Environmental Conditions Observing System website (<http://www.hrecos.org>).

Publication in Peer-Reviewed Literature – Reserve staff will continue to author, co-author and encourage collaborators to develop manuscripts for publication of significant research and monitoring findings and results. Projects likely to lead to publications include benthic mapping, SAV mapping and functional assessment, tributary trends in chloride transport, historical environmental conditions analysis, shoreline habitat function, and eel distribution and restoration.

Research Forums – The Reserve will continue to convene workshops to tackle cross-cutting questions that will result in syntheses of the state of knowledge on these questions, for example: *Linking Hudson River Fish to Mapped Habitats*.

Presentations at Regional and National Science Forums - Reserve staff will continue to present key research and monitoring findings at regional and national science conferences sponsored by nationally recognized science organizations including the Estuarine Research Federation, Northeast Natural History Society, Restore America's Estuaries, and the American Fisheries Society.

Strategies for Promoting Reserve Sites as Platforms to Conduct Estuarine Research (Objective 7)

The four sites of the Reserve are among only a few places on the Hudson River where both the necessary infrastructure and expertise exist to support both short- and long-term research focusing on priority coastal management issues. The following list identifies necessary elements of this support to ensure we continue to provide opportunities to a wide range of research scientists.

Infrastructure for Research – The Reserve will maintain facilities, equipment, tools, a reference library, databases, and other resources necessary to facilitate research and monitoring. The Reserve has completed a state-of-the-art 1,000 sq. ft. lab facility at Norrie Point, with space for estuarine scientists to conduct research. In addition, the Reserve maintains access to the Bard College Field Station for work related to the Tivoli Bays.

Long-term Monitoring of Habitats, Water and Weather – The Reserve will continue to collect long-term environmental and water quality data to provide the long-term context for short-term hypothesis-driven research.

Research Coordination and Management – Research staff will coordinate and manage research projects at the Reserve sites in order to streamline scientific efforts and avoid research site conflicts and disturbances.

Research Promotion – Reserve staff will promote use of the Reserve by researchers representing public and private research entities for research projects consistent with local and national research priorities and the protection of estuarine resources. The Reserve will facilitate research by providing laboratory space for visiting scientists at the Norrie Point Environmental Center, boat access to reserve sites, and data access through both the Centralized Data Management Office and the Hudson River Environmental Conditions Observing System. Reserve staff will increase awareness of scientific opportunities and research resources through participation in scientific and other meetings, networking through the fellowship programs, publications, and outreach to scientists and their institutions.

Fellowships – Three graduate and undergraduate fellowship programs have contributed greatly to the wealth of research being conducted at the Reserve. These are the NOAA Graduate Research Fellowship Program, the Tibor T. Polgar Fellowship Program, and the New York Sea Grant / Hudson River NERR Cooperative Fellowship Program.

Since its inception, the NOAA Graduate Research Fellowship Program has supported graduate

students in research on national priority topics or relevant to regional ecosystem management.

The Polgar Fellowship Program was established in 1985 and is a cooperative program between the Reserve and the Hudson River Foundation. Eight undergraduate and graduate students have been supported each year to conduct original research in the Hudson River estuary. In 2009, the 25th anniversary of the Polgar Fellowship Program, 200 research projects will have been supported.

The New York Sea Grant / Hudson River National Estuarine Research Reserve Cooperative Fellowship program has been jointly funded to support one graduate student per year to conduct thesis research at Reserve sites.

Strategies for Promoting Coordination with Key Research Partners (Objective 8)

The Reserve will continue to maintain and expand partnerships that are integral to the success of the research and monitoring programs. These have been critical for directing our research focus, attracting research science and funding, implementing research and monitoring programs, and extending research and monitoring results to decision-makers and managers.

Hudson River Estuary Program -- Through its research and monitoring programs, the Reserve seeks to further the NYSDEC Hudson River Estuary Program's Hudson River Action Plan Goal 2, River and Shoreline Habitats: "*Conserve, protect, and where possible, enhance critical river and shoreline habitats to assure that the life cycles of key species are supported for human enjoyment and to sustain a healthy ecosystem.*" Estuary Program financial support and project collaboration has enabled substantial work on the identification, mapping, change analysis, and functional assessment of key aquatic habitat types, such as submerged aquatic vegetation, tidal wetlands, shoreline, and river bottom.

Other Agency Partners – Several other NYSDEC staff and NYS agency partners play an important role in planning, stimulating, funding, conducting or overseeing research and monitoring at the Reserve, for instance marsh breeding bird studies (NYSDEC, PIPC), invasive species studies (OPRHP, PIPC), sediment contaminant sampling (NYSDEC). Scientific staff and interns at the PIPC Trailside Museum and Zoo have been active in conducting biodiversity-related research at Iona Island.

Cary Institute of Ecosystem Studies - Cary Institute of Ecosystem Studies staff have advised and supported Reserve research and monitoring programs for over two decades, serving in leadership roles on the Reserve's research advisory committee, providing access to the analytical laboratory's services and equipment for water monitoring, undertaking independent work, and collaborating on specific projects, such as monitoring of submerged aquatic vegetation and functional assessment of shoreline habitats. The Rachel L. Carson Analytical Facility of the Cary Institute processes all nutrient samples for the Reserve's System Wide Monitoring Program. Cary Institute also hosts the Polgar Fellowship Program's final presentations once a year.

Hudson River Foundation – The Hudson River Foundation has served a vital role in the Reserve's research program as co-sponsor and underwriter of the Polgar Fellowship Program,

which has supported a remarkably wide-ranging body of Hudson River research, much of it at Reserve sites. Many of these projects were continued as masters or PhD theses, or stimulated separately funded research programs.

The Nature Conservancy – The Reserve has partnered with the Nature Conservancy on valuable work on future scenario development and sea level rise adaptation planning. The project *Rising Waters* is a collaborative planning effort led by the Nature Conservancy that is designed to highlight all the interests that will be affected by climate change and find solutions that will protect both people and the environment, using a scenario-building methodology. The Nature Conservancy is also collaborating with the Reserve on the shoreline erosion project, described above.

New York Sea Grant Program – New York Sea Grant (NYSG) has also been an important partner as co-sponsor and underwriting partner of the New York Sea Grant / Hudson River National Estuarine Research Reserve graduate fellowship program. NYSG’s research agenda has informed development of the Reserve’s research agenda, and NYSG has supported other projects in the Hudson that have contributed to knowledge of Reserve sites.

Other Research Partners -- The Reserve staff has also collaborated with scientists from a host of other research institutions doing work in the Hudson River Estuary. These are too numerous to name in entirety, but include: Bard College Center for Environmental Policy; Columbia University’s Lamont-Doherty Earth Observatory and other divisions; Cornell University’s Center for the Environment, Institute for Resource Information Systems, and Department of Natural Resources; Hudsonia, Ltd.; Marist College; Queens College; Rensselaer Polytechnic Institute; Rutgers University; State University of New York (SUNY) College of Environmental Science and Forestry; SUNY New Paltz; SUNY Stony Brook Marine Sciences Research Center; Stevens Institute of Technology; University of Illinois; University of New Brunswick’s Environment and Sustainable Development Research Centre; and Yale School of Forestry and Environmental Studies, New Haven, CT.

Strategies for Integrating Research with Other Hudson River Reserve Programs (Objective 9)

Collaboration and Integration with Environmental Education – Reserve research staff will work closely with the Reserve education staff to ensure the latest scientific information is available to them in formats appropriate for multiple audiences. The Reserve will also ensure that in all research projects managed by Reserve staff, educators will be represented on the project teams. Reserve education staff and other partners such as New York Sea Grant Extension and Cornell Cooperative Extension, and the Hudson River Estuary Program will represent these interests.

Collaboration and Integration with Coastal (Estuary) Training Program - Reserve research staff will also work closely with the Reserve training staff to ensure the latest scientific information is available for decision maker training activities. The Reserve will also ensure that in all research projects managed by Reserve staff, training interests will be represented on the project teams.

Collaboration and Integration with Stewardship Program – Reserve research staff will work

closely with stewardship staff to ensure current scientific understanding is applied to invasive species management, such as monitoring the results of the removal of the common reed, *Phragmites australis* at Tivoli North Bay. Research staff will also collaborate on resource protection projects, such as managing human impacts on trails by monitoring the spread of terrestrial invasive species.

V. EDUCATION AND INTERPRETATION PLAN:

Increasing estuarine and climate literacy to promote active stewardship and environmentally sustainable behaviors and decisions

Background

The Hudson River Valley is the acknowledged birthplace of environmental awareness and public advocacy in the United States and supports a rich community of public and private organizations devoted to protecting the Hudson River Estuary. In keeping with this legacy, the Hudson River Research Reserve seeks to meet the critical challenges facing the Hudson's tidal habitats, including global climate change, as well as invasive species and development. The Reserve's education program will capitalize on its network of four field sites, a new waterfront headquarters at the Norrie Point Environmental Center, the program's ready access to emerging estuarine science, and the supply of excellent collaborators who share this mission. The education program strives to encourage environmental literacy in students and the public at large by providing opportunities for direct experience with the Hudson River Estuary. In an era of decreased human connection with the natural world, the education program chooses to provide high quality, in-depth programming rather than high quantity, large-scale events.

The Reserve's goal is to increase estuarine and climate literacy in order to promote active stewardship and environmentally sustainable behaviors and decisions. While realizing that behavior change is a slow and incremental process, the Reserve encourages self-awareness about sustainable behavior choices as part of our routine program evaluations. To this end, the Reserve will continue to use evaluation tools and data to refine our programs and more tightly couple our programming with the desired outcomes.

Introduction to Reserve System Education Program

The National Estuarine Research Reserve System (NERRS) provides a vehicle to increase understanding and awareness of estuarine systems and improve decision-making among key audiences to promote stewardship of the nation's coastal resources. Education and interpretation in the reserves incorporates a range of programs and methodologies that are systematically tailored to key audiences around priority coastal resource issues and incorporate science-based content. Reserve staff members work with local communities and regional groups to address coastal resource management issues, such as non-point source pollution, habitat restoration and invasive species. Through integrated research and education programs, the reserves help communities develop strategies to deal successfully with these coastal resource issues.

Formal and non-formal education and training programs in the NERRS target K-12 students, teachers, university and college students and faculty, as well as local community members and coastal decision-maker audiences such as environmental groups, professionals involved in coastal resource management, municipal and county zoning boards, planners, elected officials, landscapers, eco-tour operators and professional associations.

K-12 and professional development programs for teachers include the use of established coastal and estuarine science curricula aligned with state and national science education standards and

frequently involve both on-site and in-school follow-up activity. Reserve education activities are guided by national plans that identify goals, priorities, and implementation strategies for these programs. Education and training programs, interpretive exhibits and community outreach programs integrate elements of NERRS science, research and monitoring activities and ensure a systematic, multi-faceted, and locally focused approach to fostering stewardship.

Hudson River NERR Education Program

Education Objectives

Objective 1: The general public enjoys, understands and appreciates Hudson River Estuary habitats and realizes that personal choices affect water quality, estuarine ecosystem health and severity of future climate change.

Objective 2: Key community groups understand threats to the Hudson River Estuary's health (particularly the effects of climate change), acquire knowledge for more informed lifestyle choices and act as better estuary stewards.

Objective 3: K-12 students learn about the Hudson River Estuary and make connections between their actions and the health of the estuary and its habitats.

Objective 4: Post-secondary students increase their awareness of issues affecting the Hudson River Estuary ecosystem and learn about resources available, including current scientific research, to address these issues.

Objective 5: Teachers and non-classroom environmental educators routinely incorporate Hudson River issues, lessons, examples, and data into formal instruction for students at all levels.

Objective 6: Reserve education programs are coordinated with those of key education partners.

Objective 7: Reserve education programs are coordinated with and supportive of other Reserve programs.

Strategies for General Public Education (Objective 1)

Programs and products for the general public will increase awareness of estuarine habitats in the Hudson and highlight the Reserve's core research topics such as water quality monitoring, tidal wetlands and submerged aquatic vegetation, river bottom communities, invasive species, habitat restoration, and climate change impacts. The following types of programs will be offered:

Public Canoe Programs -- Guided canoe trips will be offered at three or more Hudson River tidal wetlands to provide a memorable introduction to these Hudson River habitats. In addition, canoe trips will be scheduled for organized groups, such as summer campers, scouts, senior citizens and other audiences, as resources permit

Norrie Point Education Programs -- Monthly weekend public programs will be offered at Norrie Point, including an annual science fair for National Estuaries Day. Periodic evening lectures will be offered to enhance public knowledge of Hudson River history and current scientific research.

Norrie Point Interpretive Exhibits -- Existing indoor exhibits will remain accessible during regular office and meeting hours. Outdoor exhibits are planned to allow full-time public access to interpretive information. As future staffing allows, we will explore the value of expanding public weekend hours at Norrie Point Environmental Center during the summer months.



Interpretive exhibits at the Norrie Point Environmental Center. Photo credit: Chris Bowser.

Tivoli Bays Visitor Center Interpretive Exhibits and Education Programs -- The Tivoli Bays Visitor Center will be staffed for regular programs such as: monthly Tivoli Bays Talks and Family Saturdays, weekly seasonal Live Wednesdays and the Tivoli Summer Recreation Program. Service to the community is enhanced through close coordination with the Village of Tivoli and the Tivoli Free Library. The Reserve will strive to maintain the visitor center as a viable community center and, as resources permit, expand the audiences served.

Interpretive Panels and Kiosks at Reserve Sites -- Coordinated signage is critical to stressing a common identity for the four Reserve sites, stretched out over 100 miles and managed by a variety of state and interstate agencies. Efforts continue to develop a uniform 'look' to each kiosk

and add additional site-specific interpretation, particularly at Norrie Point.

Interpretive Materials – Public demand continues for select printed information including program calendars, site maps, and science bulletins and the Reserve will continue to produce these for distribution at Reserve centers and events. However, recognizing that demand is shifting to web-based information and in an effort to conserve resources, the Reserve is putting less emphasis on printed materials.

Web Sites – The Reserve maintains an on-line presence via both NYSDEC and NERRS web sites. The NYSDEC Reserve page (<http://www.dec.ny.gov/lands/4915.html>) provides a basic introduction to the Reserve's four sites, and detailed information about education and research programs. The NERRS web page (<http://www.nerrs.noaa.gov/HudsonRiver>) includes information about the Reserve's four sites, programs, and opportunities. Reserve will seek to expand and update content on both web sites.

Regional Festivals and Events -- The Hudson River Estuary is home to a number of regional festivals and events sponsored by government agencies and private environmental organizations. Prime examples are: "A Day in the Life of the Hudson River Estuary", the Great Hudson River Paddle, the Hudson River Valley Ramble, and National Estuaries Day. The Reserve will participate in a reduced number of events as staffing allows. Particular attention will be paid to the Hudson-Fulton-Champlain Quadricentennial in 2009 because it is the largest regional event of this decade.

Strategies for Community Education (Objective 2)

Climate change poses one of the largest threats to the health and viability of the Hudson River Estuary, with predictions of more severe episodes of flooding and drought, loss of shallow water habitat due to sea level rise, and decrease in biodiversity. Community education will focus on climate change mitigation and adaptation efforts, using the following strategies:

Collaboration with Key Partners -- The Reserve will coordinate closely with the Hudson River Estuary Program and the DEC Climate Change Office to identify core concepts necessary for public understanding of climate change in the Hudson Valley, and will coordinate climate change outreach to audiences pivotal to effective community response.

Norrie Point Energy Conservation Model – The Norrie Point Environmental Center was one of the first significant projects of Franklin Delano Roosevelt's Civilian Conservation Corps program in the 1930s. The Reserve plans to continue this legacy of innovation by collaborating with NYS DEC and the NYS Office of Parks, Restoration and Historic Preservation to model significant, effective ways to conserve energy while maintaining a historic structure.

This emphasis on responsible use of energy and resources will also be modeled in conferences and workshops held at Norrie Point Environmental Center for many constituencies.

Waterfront Community Education – The Reserve will target waterfront communities with information about river habitats and shoreline management options in order to promote protection

of river habitats and community adaptation to sea-level rise and other climate change impacts.

Strategies for K-12th Grade Education (Objective 3)

Place-based education has been shown to be effective in providing a meaningful context for student learning. Today's students, both traditional and home-schooled, will need to understand basic connections between human and natural systems in order to navigate environmental and economic challenges. The Reserve will provide direct student access to the Hudson River Estuary and relevant estuary data in the following ways:

Emphasis on Middle/High School Program Development: The Reserve will use market analyses and needs assessments of Hudson River based middle/high school programs to identify gaps in available services. In particular, the Reserve will coordinate program development with the DEC Hudson River Estuary Program (currently creating interdisciplinary, standards-based K-12 Hudson River lesson plans), the Cary Institute of Ecosystem Studies (currently creating a web-based, high school curriculum called The Changing Hudson), and local school district administrators and teachers. The Reserve will not focus on elementary education as this audience is already well-served by other Hudson River education providers and is less appropriate for research-based programming.

Education programs will routinely reference the wide array of Hudson River Estuary research projects undertaken within the Hudson River Research Reserve and estuary-wide. Specific lessons will develop case studies of recent and current Hudson River Estuary challenges which will utilize water quality and weather monitoring data generated by the NERRS System Wide Monitoring Program (SWMP), the broader partnership of the Hudson River Environmental Conditions Observing System (HRECOS), and data generated by other Hudson River Estuary organizations such as the Beacon Institute and the Beczak Environmental Center.

Student Science -- The Reserve will collaborate with the DEC Hudson River Estuary Program to create meaningful student science opportunities. Reserve educators help coordinate the estuary-wide monitoring event, "A Day in the Life of the Hudson River Estuary", and coordinate high school research on migratory fish in Hudson River tributaries.

The Citizen-Science Eel Project gives students and community members the chance to become scientists by tracking the migration of juvenile American eels each spring. Tiny "glass eels" are caught in nets, counted, weighed, and released, plus other environmental factors like temperature and tides are measured. The project's methods are based on current scientific research, and the American eel is of particular interest because of noted declines all along the east coast.

A short video of the project is available at DEC-TV: <http://www.dec.ny.gov/dectv/dectv76.html>

Site-based Programs at Norrie Point Environmental Center -- Norrie Point combines outstanding access to shallow water habitats of the Hudson River Estuary with excellent educational facilities. Spring and fall site visits for middle and high school students stress a hands-on look at the physical, chemical and biological parameters in the estuary.



I Fish NY program at the Norrie Point Environmental Center. Photo credit: Chris Bowser.

Distance Learning Opportunities -- The Reserve recognizes that constraints of time and budget increasingly limit student access to educational field trips. The Reserve is exploring different options for bringing science and the estuary into the classroom. The Reserve will expand on pilot efforts to videoconference with local classrooms. This will position the Reserve to join a growing videoconferencing network among school districts and Hudson Valley education facilities, such as Beczak Environmental Center in the lower estuary and Esopus Meadows Environmental Center in the upper estuary.

Use of Hudson River Monitoring Data in Education – The Reserve will continue its efforts to translate and produce new educational resources that integrate monitoring and research results. The Reserve developed *SWaMPing the Classroom*, web-based access to System Wide Monitoring Program (SWMP) data for middle school students which is set in a watershed context to allow students to connect land use with water quality. As new data acquisition projects arise, the Reserve will continue to develop new applications of these data, for instance from the Hudson River Environmental Conditions Observing System (HR ECOS). As opportunities arise, data will be highlighted in exhibits, lesson plans, and distance learning modules.

Strategies for Post-secondary Education (Objective 4)

The Environmental Consortium of Hudson Valley Colleges and Universities serves to focus attention on the Hudson River Estuary as a study area. The Reserve will continue to serve post-

secondary audiences, with increased capacity resulting from access to Norrie Point Environmental Center. In particular, the Reserve will enhance collaborations with Dutchess County Community College and Marist College, which have resumed use of Norrie Point for Hudson River studies.

Field Opportunities -- Reserve staff will provide field trips into tidal habitats at Reserve sites for institutions hosting Hudson River courses.

Lecture Opportunities -- Reserve research staff will provide post-secondary students with access to up-to-date scientific data and emerging scientific issues through presentations at scientific symposia and college classes.

Student Research Opportunities -- The Reserve will provide several research fellowship opportunities to post-secondary students (see Research chapter). These opportunities will be enhanced by the addition of Norrie Point Environmental Center as a platform for student research and study.

Strategies for Professional Development of Educators (Objective 5)

Within the context of teaching to state and national education standards, Reserve education staff will encourage a sense of place among teachers by providing local data and connection with the Hudson River Estuary. This goal will be accomplished through the following means:

Field-based Experiences for Teachers -- The Reserve has been an integral partner in various Hudson River summer teacher institutes, due to its access to the full range of tidal habitats on the estuary and a fleet of canoes to allow access to those habitats. The Reserve will continue to partner with organizations such as Hudson River Sloop Clearwater, Inc., NYS Sea Grant, NYS Department of Environmental Conservation, the National Park Service Teaching the Hudson Valley, and others.

Partnerships in Hudson River Professional Teacher Development -- The Reserve will collaborate with partners such as Cornell University and NYS Sea Grant and NYS Department of Environmental Conservation to deliver professional development opportunities for teachers, such as workshops on Hudson River Submerged Aquatic Vegetation. In addition, we anticipate that the wet classroom and conference rooms at Norrie Point will be valuable training platforms for other Hudson River programs, such as the Hudson River Educator Workshops offered by the Hudson River Estuary Program.

Teachers on the Estuary -- Our improved facilities at Norrie Point Environmental Center enable the Reserve to participate more fully in the emerging program requirements of NERRS Teachers on the Estuary (TOTE) program.



Teachers learning to collect core samples at the Norrie Point Environmental Center. Photo credit: Brittany Burgio.

Strategies for Promoting Coordination with Key Education Partners (Objective 6)

Reserve education programs are coordinated with those of key education partners, including local school districts and state and county agencies, and a rich community of environmental organizations devoted to protecting the Hudson River through research, education and advocacy. The Reserve has developed its education program in collaboration and coordination with several key players in Hudson River education, including:

Hudson River Estuary Program -- The Reserve enjoys a very close relationship with the NYSDEC Hudson River Estuary Program. Through its education programs, the Reserve seeks to further the Estuary Program’s Hudson River Action Plan Goal 8: *“Promote public understanding of the Hudson River, including the life it supports and its role in the global ecosystem, and ensure that the public understand the challenges the Hudson River faces and how they can be met.”*

The Reserve contributes to Action Plan Goal 8 in the following ways. The Reserve coordinates closely its K-12 education program development with the Hudson River Estuary Program to avoid duplication of effort and enhance the level of service available to schools in the region. The Reserve education coordinator participates in the Estuary Program’s education advisory committee, which meets 2-3 times per year. The Reserve education coordinator also participates in the review of education grant applications submitted to the Estuary Program on an annual basis. Reserve staff members frequently attend Estuary Program staff meetings, and co-sponsor

programs. Reserve staff members are active participants and organizers of the Estuary Program's "Day in the Life of the Hudson River Estuary".

DEC Environmental Education Facilities -- The Reserve collaborates with the two DEC education centers in the Hudson River Valley: the Five Rivers Environmental Education Center and the Stony Kill Farm Environmental Education Center, providing field experiences and ecological information on Hudson River habitats for teachers via professional development programs. Most recently, the Reserve has joined a work group of DEC educators to advance educational efforts on climate change.

Other Hudson River Education Programs -- In the last decade, the Reserve has collaborated with the following educational and/or scientific organizations in the Hudson River Estuary, either providing training for staff members, serving as a resource for program development or coordinating joint program efforts: Columbia University's Lamont Doherty Earth Observatory, Hudson River Sloop Clearwater, New York Sea Grant, Scenic Hudson, Dutchess County Board of Cooperative Educational Services (BOCES), Ulster County BOCES, Cary Institute of Ecosystem Studies, Cornell University Center for the Environment, Bard College Center for Environmental Policy, National Audubon Society, Greene County Soil and Water Conservation District, Hudson River Maritime Museum, and others. The Reserve will continue to explore opportunities to support excellent environmental education in the Hudson River Estuary, for instance working with emerging partners such as the Beacon Institute for Rivers and Estuaries.

Strategies for Integrating Education with Other Hudson River Reserve Programs (Objective 7)

Among regional education partners in the Hudson Valley, the Reserve's education program is unique in its direct access to emerging estuarine research and stewardship programs that affect Hudson River tidal habitats. The Reserve education program integrates with other Reserve programs in a variety of ways. Educators routinely identify education topics by consulting with and engaging Reserve research and stewardship staff and partners. In addition, where possible, education programs are designed to generate data that may be useful to scientific, stewardship, and training programs. For example:

- Reserve educators routinely inform the public about current research and stewardship projects during guided canoe programs.
- Non-education staff members attend public canoe programs as 'expert guests' to allow better public understanding of science and the work of scientists.
- Scientists and stewards are invited to give public lectures to improve public understanding of their work and gain insight into their connection to the larger community.
- Glass eel surveys by high school students and community volunteers in four Hudson River Estuary tributaries help inform our stewardship efforts to evaluate the impacts of dam removal and the introduction of eel ladders. In addition, students gain an appreciation of and enthusiasm for the value of scientific study.
- Our formal education programs target middle/high school and post secondary students who are more receptive to and capable of understanding the Reserve's water quality and weather monitoring programs.

- Estuary Training Program efforts to encourage local control of invasive species such as Mile-a-Minute weed include visits to local schools.
- Collaboration with willing teachers on enhanced experiences for their students, such as glass eel surveys and videoconference sessions, are advancing the development of estuarine literacy among key role models in the education community.

VI. ESTUARY TRAINING PROGRAM:

Increasing informed decision-making to protect and enhance estuarine habitats

Background

The Hudson River Valley embraces diverse ecosystems that support extraordinary biodiversity and ecosystem richness. A collection of public agencies, private organizations, communities, and individuals promote the health of the Hudson River Estuary, and the choices made by a wide range of decision-makers within and beyond the estuary influence it profoundly. The Hudson River Estuary Training Program seeks to enhance the scientific knowledge, technical capacity, and skills of professionals involved in making decisions that affect the habitats, shore lands, water quality and other natural resources of the Hudson River Estuary.

Introduction to Reserve System Coastal Training Program

The NERRS Coastal Training Program (CTP) provides up-to-date scientific information and skill-building opportunities to coastal decision-makers who are responsible for making decisions that affect coastal resources. Through this program, National Estuarine Research Reserves can ensure that coastal decision-makers have the knowledge and tools they need to address critical resource management issues of concern to local communities.

Coastal Training Programs offered by reserves relate to coastal habitat conservation and restoration, biodiversity, water quality and sustainable resource management and integrate reserve-based research, monitoring and stewardship activities. Programs target a range of audiences, such as land-use planners, elected officials, regulators, land developers, community groups, environmental non-profits, business and applied scientific groups. These training programs provide opportunities for professionals to network across disciplines, and develop new collaborative relationships to solve complex environmental problems. Additionally, the CTP provides a critical feedback loop to ensure that professional audiences inform local and regional science and research agendas.

Programs are developed in a variety of formats ranging from seminars, hands-on skill training, participatory workshops, lectures, and technology demonstrations. Participants benefit from opportunities to share experiences and network in a multidisciplinary setting, often with a reserve-based field activity.

Partnerships are important to the success of the program. Reserves work closely with State Coastal Programs, Sea Grant College extension and education staff, and a host of local partners in determining key coastal resource issues to address, as well as the identification of target audiences. Partnerships with local agencies and organizations are critical in the exchange and sharing of expertise and resources to deliver relevant and accessible training programs that meet the needs of specific groups.

Hudson River NERR Estuary (Coastal) Training Program

The Hudson River Estuary Training Program (ETP) was created in 2002, and involves collaboration among the Reserve's training, education, stewardship, research, and monitoring staff. It is guided by a steering committee and supported by many partners to create and offer its programs. The goal of the ETP is to enhance informed decision-making on priority estuarine issues by providing training and access to scientific and technical information to audiences that influence the management of estuary resources. Estuary training program priorities closely parallel the habitat protection and management priorities of the Reserve and the NYSDEC Hudson River Estuary Program. ETP priorities include: promoting adaptation to climate change, protecting and restoring Hudson River aquatic and shoreline habitats, protecting biodiversity, and reducing watershed impacts on Hudson River habitats. The ETP maintains flexibility to address newly emerging issues or unexpected changes in priorities when appropriate.

Providing training and access to scientific and technical information includes not just the biogeo-physical sciences but also the social sciences, so that decision makers understand the human side of estuarine issues. The Reserve has, in recent years, begun to address the issue of resilient ecosystems, including the human dimensions of resilience, in its work. Staff recognizes the value, use, and necessity of incorporating socioeconomic findings into long-term planning and management of the Reserve, the coast, and the watershed.

Besides scientific content training, decision makers need the process and technical skills to help them do their jobs, in areas such as project design and evaluation, ecosystem based management, meeting facilitation, conflict management and geo-spatial skills. These needs will be identified by both informal and formal needs assessments. The ETP works with its partners, including NOAA CSC to provide all its training activities.

Training Objectives

Objective 1: Decision-makers have an increased awareness of climate change impacts and increasingly plan for adaptation.

Objective 2: Decision makers include science-based information about protection and restoration of Hudson River habitats in planning and management documents, regulatory decision-making, and project implementation.

Objective 3: Decision-makers have an increased knowledge and capacity to protect upland and aquatic biodiversity.

Objective 4: Estuary Training Program events and activities address the needs of key audiences and result in positive outcomes.

Objective 5: Reserve training programs are coordinated with those of key outreach and training partners.

Objective 6: Reserve training programs are coordinated with and supportive of other Reserve programs.

Strategies for Promoting Awareness of Climate Change Impacts and Adaptation Planning (Objective 1)

In the last few years, the region has seen a growing public recognition of climate change threats and the urgency of need for effective planning, mitigation, and adaptation. Climate change poses one of the largest threats to the health and viability of the Hudson River Estuary, with predictions of more severe episodes of flooding and drought, loss of shallow water habitat due to sea level rise, and decrease in biodiversity. The Training Program staff will continue to work with community of organizations who are seeking to raise climate literacy and to engage organizations and individuals to take action for adaptation.

There is a need for technical information dissemination, process and content training, audience needs assessments, coordination with other providers, forums on topics to advance scientific consensus (for instance in how to model projected sea levels and storm surges). Audiences for this work include watershed coordinators, municipal officials, natural resources managers, shoreline stakeholders, planners and engineers.

Shoreline Erosion Mitigation Project – The Reserve has undertaken a significant climate change adaptation project, entitled: “Mitigating Shoreline Erosion along the Hudson River Estuary’s Sheltered Coasts”. The ETP will work on tasks described under the project’s Goal 2, “*Transfer new knowledge and tools to relevant stakeholders.*” The Reserve will assess the needs of shoreline property owners and other stakeholders, develop communication and training programs to enhance awareness of shoreline and sea level issues, and communicate through workshops, the results of the joint fact-finding process to refine the shoreline erosion mitigation research agenda to shoreline stakeholders, constituencies, and policy-makers. Shoreline stakeholders include experts, consultants, regulators, property owners and managers, planners, municipal officials and the general public.

Hudson Valley Climate Partnership – The Reserve participates in a coordinated group of state agencies, nonprofits and local government leaders committed to climate change awareness, adaptation and mitigation. Training staff will collaborate with the partnership in providing relevant training. All Reserve staff members have roles in addressing some aspect of climate change awareness and response. The manager and training staff participate in training about climate change and climate adaptation for decision-makers and in the Rising Waters scenario planning project of The Nature Conservancy. The Reserve manager chairs the climate research partnership and serves on the New York State Sea Level Rise Task Force. The Reserve co-sponsors meetings and workshops on these initiatives.

NERRS Climate Change Strategy -- Training staff will participate in nationwide NERRS initiatives on climate change, including promoting and delivering training to decision makers and assessing the knowledge and resource gaps of decision-maker audiences.

Strategies for Promoting River and Shoreline Habitat Protection (Objective 2)

Protection of Hudson River habitats is accomplished through a broad array of programs and entities. The individuals and organizations that make decisions that affect habitats require science-based information and products in order to develop and implement land management, waterfront revitalization, habitat restoration, and watershed plans; ecosystem management frameworks; climate change adaptation and mitigation measures; and best management practices.

The Estuary Training Program is included in the NYSDEC Hudson River Action Agenda, under Goal 2, River and Shoreline Habitats. Under this goal, ETP has the task of providing training to 1000 decision makers by 2009 and 3000 by 2015, in collaboration with other NYSDEC outreach staff.

River Habitat Training -- Reserve staff conduct workshops every 2-3 years for federal, state, and local regulators and resource managers on Hudson River habitats. In these workshops, Reserve staff trainers provide the latest scientific information about the location, ecological functions, and status of Hudson River tidal wetlands, submerged aquatic vegetation, river bottom, and shorelines. Workshop presenters discuss protection strategies, and encourage participants to apply this information to regulatory and management decisions.

Shoreline Erosion Mitigation Project – As described above, the Reserve has undertaken a substantial project, entitled: “Mitigating Shoreline Erosion along the Hudson River Estuary’s Sheltered Coasts”. Implementation of this project is also a significant strategy for promoting river and shoreline habitat protection. The Reserve will continue to evaluate non-structural alternatives for shoreline stabilization and provide outreach and education to communities on their benefits.

River and Shoreline Habitat Restoration – Reserve scientists are involved in feasibility studies for restoration of river habitats (such as natural shoreline and marshes), resources (such as oysters) and access to habitats for migratory fish (including American eel) by tributary barrier mitigation. As these feasibility studies are completed, trainers will establish workshops targeting restoration practitioners and resource managers to disseminate the results. Stewardship staff and partners will pursue funding to construct restoration demonstration sites to illustrate designs, construction techniques, and methods for monitoring ecological function. These sites will be used in training programs for shoreline stakeholders, consultants, regulators, watershed coordinators, and land and resource managers.

Access to Information and Data about Hudson River Estuary Habitats – The Reserve and many other entities in the Hudson Estuary have geographic databases of Hudson River habitats and information on Hudson River habitat inventories, ecosystem values of habitats, and habitat trends.

Strategies for Increasing Protection of Upland and Aquatic Biodiversity (Objective 3)

Managers of lands in the watershed of the Hudson Estuary, and especially those who manage lands along and near the estuary, have indicated their interest in the following training topics: invasive and native species management, habitat restoration, protecting biodiversity, sustainable

practices, natural resource inventory and stewardship, visitor use conflict resolution, land management planning, and communication and outreach. The Reserve’s training programs will seek to protect biodiversity by increasing the capacity of land and natural resource managers to recognize and protect Hudson habitats and control invasive and nuisance species.

Land Manager Capacity Building -- The training program will continue to use formal and informal needs assessments to refine our understanding of the training needs of managers of lands on or near the Hudson River Estuary. Training programs will focus on both expanding their knowledge of resources and management issues, including ecosystem-based management, and enhancing organizational and process skills that will help them accomplish projects more effectively.

Visitor Use – Many Hudson Valley land managers have participated in the NOAA Coastal Services Center course, “*Managing Visitor Use*”, when it was offered by the Reserve and partners. Visitor use impacts on the resources of both the Reserve and other lands continue to be an issue, and training on this topic will be offered periodically as needed.



Visitor Impact Assessment field training. Photo credit: Emilie Hauser

Invasive Species Partnerships -- Under the guidance of the New York State Invasive Species Council, formed in 2007, regional partnerships are being formed throughout the state to implement initiatives to protect native species and prevent the spread of invasive plants and animals. Reserve staff has been active in the establishment of the Lower Hudson and Capital District Partnerships for Regional Invasive Species Management (PRISM). The training program will partner with these PRISMs on training and outreach efforts.

Invasive Species Response – Land managers, a key audience of the Estuary Training Program, have a need for training and information on invasive species management. The training program supports the mile a minute vine project of the Hudson Valley, a collaboration of state agencies and non-profits dedicated to controlling the spread of this vine, which has invaded the lower Hudson estuary, including Iona Island. Resident Canada geese, though not technically an invasive species, affect visitor experiences and can affect biodiversity and water quality. Land managers benefit from an understanding of control strategies based on geese biology. Phragmites control on Reserve lands can serve as case studies for training programs. The training program will maintain flexibility to provide science based information and training on newly discovered invasive species, such as the Chinese mitten crab (*Eriocheir sinensis*), working in collaboration with the PRISMs.

Biodiversity Protection – The training program collaborates with the Hudson River Estuary Program outreach staff to provide training on biodiversity protection. Trainings on native plants and protection of small wetlands are planned.

Technical Assistance – The Training staff provides technical assistance to land managers on implementing invasive plant and nuisance wildlife management efforts and conducting outreach programs. Technical assistance includes answering inquiries by telephone and email, participating in working groups, list serves and other forums, providing additional current information, research results and translated science and other support which helps training audiences carry out their work.

Strategies for Attaining Estuary Training Program Relevance and Excellence (Objective 4)

We seek to provide decision-makers with activities and forums which are targeted to their needs and help fulfill the goals and priorities of the Hudson River NERR. The ETP will provide well planned, timely, informative training activities which give participants a chance to learn from and network with peers and experts. As a result of the trainings, participants will apply the knowledge and skills they learn in the training activities to their work or volunteer activities and will recommend the Training Program to others.

Market Surveys – A formal training market analysis was performed in 2003. Reserve training staff will remain up-to-date on the training market by networking and literature review, in order to avoid duplication, fill training gaps and identify partners.

Needs Assessments – Audience needs assessments are essential to planning and developing training activities. The Reserve will conduct needs assessments to acquire necessary data on audience knowledge and experience levels, barriers and bridges to applying new techniques and

skills, duration and time of year for activities and other logistical information. Needs assessment data may be found in the literature or collected by Reserve staff or consultants. Audiences can be assessed formally through online surveys, telephone interviews, focus groups or facilitated workshops, or less formally through observation and networking and surveys attached to workshop evaluations.

Evaluation – Program evaluation provides feedback on successes and failures and informs adaptive management of the ETP. Performance data will be collected for training activities and technical assistance based on the NERRS CTP Performance Monitoring Manual. Periodically evaluations will be conducted by follow-up survey or interviews with participants and partners to measure the effectiveness of the training program; including how participants applied the knowledge and skills they learn in the training activities.

Advisory Committees – As required by the NERRS CTP implementation phase guidelines, the training program is advised by a steering committee. The steering committee is comprised of the Reserve Manager and staff from Hudson River Estuary Program, NYS Sea Grant, NYS Department of State Coastal Resources Division and Hudson River Valley Greenway. Members of the committee provide expertise in planning and evaluating training activities, promote the program, and provide guidance are target audiences and issues and topics. In addition, workshop committees are periodically created to advise ETP staff on specific training activities. Members help in the planning the agenda and activities, recommend or provide expert speakers, promote the event. They may provide venues and logistical assistance.

Professional Development of Training Staff -- Staff members are encouraged to enhance their professional development through training and attendance at professional meetings at the national and regional level and by reading relevant literature.

Strategies for Promoting Coordination with Key Training Partners (Objective 5)

The ETP will continue to partner with a variety of organizations that provide training content and instructors, training venues, connection to audiences and expertise in planning and designing training activities.

NYSDEC Hudson River Estuary Program -- The Reserve training staff provides training workshops to further the NYSDEC Hudson River Estuary Program’s Hudson River Action Plan Goal 2, River and Shoreline Habitats: “*Conserve, protect, and where possible, enhance critical river and shoreline habitats to assure that the life cycles of key species are supported for human enjoyment and to sustain a healthy ecosystem.*” Training staff members collaborate with Estuary Program outreach staff on training programs such as biodiversity, watershed protection and climate change. Reserve training staff also provide technical assistance on audience needs assessment and program evaluation. The Estuary Program sits on the ETP advisory committee.

Other Agency Partners - Several other NYSDEC staff and New York State (NYS) agency partners play or will play important roles in the evolution and implementation of the Estuary Training Program. Within NYSDEC, this includes the Division of Fish, Wildlife and Marine Resources; the Division of Lands and Forests; the Division of Water; and the New York State Cli-

mate Office. Other agency partners include the NYS Division of Coastal Resources and Waterfront Revitalization; the NYS Office of Parks, Recreation, and Historic Preservation; the Palisades Interstate Park Commission; the NYS Sea Level Rise Task Force; the NYS Ocean and Great Lakes Ecosystem Conservation Council; and the Hudson River Valley Greenway.

NOAA Coastal Services Center – The Coastal Services Center’s has excellent training courses and tools that the Training Program has and will continue to use. These tools and courses either address priority issues or help decision makers achieve objectives associated with priority issues. The ETP will utilize these courses as needed and as available, refer decision makers to the support tools, and when necessary arrange for CSC staff to provide information sessions on the use of these tools.



NOAA Coastal Services Center train Hudson River Estuary Program in evaluation tools and techniques.
Photo credit: Emilie Hauser

New York Sea Grant Program -- The ETP will continue to collaborate with the New York Sea Grant program, especially the Hudson Estuary Specialist, on social sciences and collaborative processes issues for the shoreline erosion mitigation project and on other social and natural science training projects.

Other Training Partners -- The Reserve has collaborated with many other organizations in an effort to bring quality training programs to the Hudson Estuary; these include Hudson River Environmental Society, The Nature Conservancy and Sustainable Hudson Valley. Future collaborations may include Partnerships for Regional Invasive Species Management, Cary Institute of Ecosystem Studies, Coastal Training Programs at other Reserves and New England Interstate Water Pollution Control Commission.

Strategies for Integrating Training with Other Hudson River NERR Programs (Objective 6)

Collaboration and Integration with Education Program – The Reserve training staff works with education staff to ensure that the content of training workshops is utilized in educational programs and displays. Some training programs, particularly on invasive plants and nuisance wildlife are attended by members of the community. Training program efforts to encourage local control of invasive species such as mile-a-minute vine include visits to local schools. Education staff attends training program activities.

Collaboration and Integration with Stewardship Program – Reserve training staff will work closely with stewardship staff to ensure current scientific understanding that is applied to Reserve management, can be highlighted in training for other land managers, such as monitoring human impacts on trails; the results of the removal of the common reed at Tivoli North Bay and Iona Island; and pilot bio- control of mile-a-minute vine at Iona Island.

Collaboration and Integration with Research Program – Reserve training staff also work closely with the Reserve research staff to ensure the latest scientific information is available for decision maker training activities. The Reserve will also ensure that in all research projects managed by Reserve staff, training interests will be represented on the project teams. Examples include results of water quality monitoring and river observing, habitat function and trends, fish passage and invasive species monitoring, control and management.

VII. STEWARDSHIP PLAN:

Enhancing stewardship of the land and water ecosystems within the Reserve

Background

Stewardship of the Hudson River Reserve's land and water ecosystems rests in the hands of a host of management agencies and public users who undertake a wide variety of actions to promote stewardship of Reserve sites and resources. This Stewardship Plan groups these activities into three sub-plans: the Resource Protection Plan, the Habitat Restoration Plan, and the Land Acquisition Plan, which appear as separate sections below.

Resource Protection Plan

The regulations of the NERRS allow for multiple uses of Estuarine Research Reserves to the degree compatible with each reserve's management plan and consistent with the mission and goals of the NERRS. This management plan focuses on maintaining Reserve sites as field laboratories to support research and education.

Public access is encouraged on those parts of the Reserve that are publicly owned or that have received private landowner permission for access, as long as it is not to the detriment of the resource, or does not interfere with approved research. Public access is restricted in key resource protection areas. Future identification of resources of concern may result in delineation of areas of additional protection based on need to maintain natural conditions and preserve resources.

Resource Protection Objectives

Objective 1: Natural and cultural resources in the Reserve are protected.

Objective 2: Human impacts on Reserve sites are managed.

Objective 3: Reserve stewardship programs are coordinated with those of partners and other Reserve programs.

Strategies for Protecting Natural and Cultural Resources at Reserve Sites (Objective 1)

Resource Protection Policies and Authorities -- The Reserve's boundaries include areas that fall under a number of different jurisdictions of local, State and federal agencies, coordination and cooperation among all authorities is essential. Some of the state and federal authorities and policies directly affecting the Reserve are listed in Appendix 3.

Allowable Uses -- Allowable public uses of the Reserve vary by site and management authority. Tables 1 and 2 list public uses and whether they are allowable uses, uses requiring a permit and restrictions on use. On-site signs and kiosks and Reserve brochures inform the public of existing area use regulations.

Surveillance and Enforcement -- State agencies with jurisdiction over lands within Reserve sites coordinate enforcement of state regulations for those lands. For enforcement purposes, DEC will enact area use regulations on all New York State Office of General Services (OGS) lands within the Reserve, except those within the Hudson River Islands State Park, which will be overseen by OPRHP. Reserve and other agency staff (and site stewards, where present) will assist in surveillance by notifying the enforcement authorities about any public use problems or criminal actions at the Reserve sites observed during the course of their duties.

State agencies with jurisdiction over lands within Reserve sites have designated enforcement units to patrol sites and enforce public use regulations and other applicable laws. On DEC lands, State Forest Rangers routinely patrol sites and enforce all applicable laws. Under the Criminal Procedures Law, forest rangers are sworn peace officers who have the authority to enforce all laws of the state, but are principally involved in natural resources enforcement on DEC lands.

**Table 1
Public Use Regulations at the Stockport Flats Reserve**

	Nutten Hook	Hudson River Islands State Park ¹	Stockport Marshes
Nature study	A	A	A
Hiking	A	A	A
Canoeing	A	A	A
Boating	A	A	A
Picnicking	A	A	A
Camping	NP	A	NP
Swimming	NP	NP	NP
Fires	NP	A ²	NP
Hunting	A,SL	A,SL	A,SL
Trapping	A,SL	NP	A,SL
Fishing ³	A,SL	A,SL	A,SL
Collecting ⁴	P	P	P
All-terrain vehicles	NP	NP	NP
Personal watercraft	NP	NP	NP
Off-road biking	NP	NP	NP

- Key: A Allowed, no permit needed
P By permit only
SL Requires New York State license
NP Not permitted or allowed
1 Day use sanitary facilities available
2 Fires allowed only in picnic grills
3 State fishing license required on tributaries to the Hudson River
4 Collection of plants, animals, artifacts, or other materials is strictly controlled and requires one or more New York State permits.

Table 2
Public Use Regulations at Tivoli Bays, Iona Island, and Piermont Marsh

	Tivoli Bays	Iona Island	Piermont Marsh
Nature study	A	A	A
Hiking	A	P ¹	A ¹
Canoeing	A	P	A
Boating	A ²	NP	A
Picnicking	A	NP	A ³
Camping	NP	NP	NP
Swimming	NP	NP	NP
Fires	NP	A ⁴	A ⁴
Hunting	A,SL	NP	NP
Trapping	A,SL	NP	NP
Fishing ⁵	A,SL	NP	A,SL
Collecting ⁶	P	P	P
All-terrain vehicles	NP	NP	NP
Personal watercraft	NP	NP	NP
Off-road biking	A	NP	A ⁷

- Key: A Allowed, no permit needed (unless posted otherwise)
P By permit only
SL Requires New York State license
NP Not permitted or allowed
1 On trails only
2 Mechanical power only
3 Day use and grill facilities are located in Tallman Mountain State Park
4 Fires allowed only in picnic grills
5 State fishing license required on tributaries to the Hudson River
6 Collection of plants, animals, artifacts, or other materials is strictly controlled and requires one or more New York State permits.
7 Along Tallman Mountain bike trail

New York State Park Police are sworn police officers who have the authority under the Criminal Procedures Law to enforce all laws of the state. Park Police are principally involved in parks and recreation enforcement on State Park lands within the Reserve. Environmental Conservation

Officers are principally involved in enforcement of Environmental Conservation Law on all lands in New York State. Similarly, State Police and County Sheriffs enforce general criminal laws statewide. A seasonal part-time assistant forest ranger patrols the Tivoli Bays component during the summer season. The assistant ranger is an important presence for the public as both an enforcement authority as well as site contact for questions and assistance. This seasonal position is provided at the state's discretion and levels of service have recently been reduced. Continued state support for this position is a high priority.

Strategies for Managing Human Impacts on Sites (Objective 2)

Human use of and alterations to Reserve sites must be managed wisely to avoid negative impacts on the natural and cultural resources present at Reserve sites, ecological values, and visitor experiences. Human impact assessment is a new area of inquiry for the Reserve. Staff members are in the process of building expertise and developing approaches for monitoring and managing human impacts. Through Estuary Training Program workshops on visitor impact assessment and management, the Reserve is also seeking to build capacity within its partners and other land managers within the Hudson Valley. This ongoing initiative is being jointly undertaken with the NOAA Coastal Services Center, the National Park Service Rivers and Trails Program, and the Hudson River Estuary Program.

Trail Assessment and Repair -- Reserve stewardship staff, in partnership with the National Park Service Rivers and Trails Program, developed a methodology and completed an assessment of the trail conditions at the Tivoli Bays. A baseline database of trail conditions was established, and will be used to evaluate future trail conditions. Student Conservation Association staff and community volunteers will be used to monitor and repair trails as needed.

Historical Assessment – Reserve stewardship staff members, working with the NYSDEC Agency Historic Preservation Officer, encourage and support professional work on inventories and research about archaeological and historic resources at Reserve sites.

Adopt-a-Resource Agreements – NYSDEC has a policy that provides for volunteers to adopt a resource and maintain it according to the terms of an agreement with DEC. Adopt-a-resource agreements will be used in the future at the Reserve to secure stewardship of specific resources and areas, and to provide clarity for volunteers and law enforcement officials about their respective roles. In September 2008, NYSDEC established an adopt-a-resource agreement with an existing set of dedicated volunteers for monitoring of archaeological sites at the Tivoli Bays.

Volunteer Clean-ups -- The Reserve will welcome and promote community-based on-site trash clean-up on an annual basis. These events will be promoted by interns and carried out by volunteers.

Strategies for Coordinating Stewardship Projects with other Partners and Programs (Objective 3)

The Reserve land management and restoration staff will work with other DEC, OPRHP, PIPC agency staff and non-profit and citizen partners to coordinate stewardship projects and programs at Hudson River NERR sites. Much of this work will center on invasive species management, discussed in more detail in the next section, as well as public access management. Reserve land management and restoration staff will also coordinate with other Reserve staff internally to insure that current scientific information is being used to plan stewardship projects, stewardship activities become integrated with education and training programs, and stewardship-related research opportunities are identified.

Habitat Restoration Plan

Reserve sites have been affected negatively by invasive plant species, altered hydrology, land use patterns, and dredging and filling activities associated with construction of the federal navigation channel and railroad dikes. While many of these effects are irreversible, three types of restoration present opportunities for enhancing ecosystem function in the Reserve. These are control of selected invasive plant species, application of soft shoreline techniques and establishment of vegetated shallow and intertidal habitats through secondary channel restoration at Reserve sites.

Restoration Objectives

Objective 1: Selected high priority invasive species are managed at Reserve sites to restore and maintain natural communities.

Objective 2: Ecologically-based shoreline erosion control techniques are applied to enhance shoreline function at Reserve sites.

Objective 3: Secondary channel restoration is implemented where possible to restore or improve vegetated shallow and intertidal habitats.

Strategies for Managing Invasive Species at Reserve Sites (Objective 1)

Invasive Species Inventory at Reserve Sites -- Reserve staff and contractors will complete an inventory of invasive species at Reserve sites in 2009. Staff will identify those species whose spread is most detrimental to estuary habitat function and upland ecosystem integrity, and those that are most likely to be manageable at Reserve sites. Based on this work and an assessment of available resources, control strategies will be articulated in annual work plans. This work will also be informed by previous marsh inventories that indicate that the common reed, *Phragmites australis*, has spread at an exponential rate through Piermont Marsh and Iona Island, resulting in a loss of biodiversity and alteration of ecosystem functions. Although *Phragmites australis* is native to the eastern U.S., scientists have documented the presence of an exotic and more invasive genetic variant from Europe.

Invasive Upland Plants at Iona Island – Two aggressively invasive plants have become established on the uplands at Iona Island. Black swallow-wort (*Cynanchum louiseae*) is a perennial, twining, herbaceous vine that forms extensive patches and crowds out native plants. In shady uplands at Iona Island, it is threatening the occurrence of the state rare small-flowered crowfoot, *Ranunculus micranthus*. Although hand removal will be attempted, effective control of large stands will need to be developed, and may include repeated mowing and herbicides, followed by over-seeding with native grasses.

Mile-a-minute vine (*Persicaria perfoliata*) is an herbaceous, annual, trailing vine that has become established at the south end of Iona Island over the last decade. PIPC staff and Reserve will seek to map, promote scientific investigation of, and manage these plants at Iona Island to avoid their further spread and associated loss of biodiversity.

Alternative Methods for Control of Mile-a-Minute Vine - Several biological control experiments were begun in 2009 to explore alternate methods for controlling the invasive mile-a-minute vine at Iona Island, including two grazing projects and a host-specific weevil.

The goal of targeted grazing is to bring the plants to a non-dominant state in highly infested areas so that other native species can grow. Under the supervision of Ed McGowan at PIPC, a goat grazing project was initiated using goats provided by Ken Kleinpeter of the Glynwood Center. Goats placed in fenced-in plots where mile-a-minute is present fed on the vines. A similar grazing experiment using Romney sheep is also planned for Iona Island. Caroline Girard, a Polgar fellowship recipient under the supervision of Gary Kleppel from SUNY Albany, plans to study the impact of targeted sheep grazing on mile-a-minute, and compare the effectiveness of sheep and goat grazing.

A highly host-specific biological control method will be employed at Iona Island in summer, 2009. Native to Eastern Asia, the weevil *Rhinoncomimus latipes* Korotyaev feeds on mile-a-minute vine. Research at the University of Delaware has demonstrated the feeding specificity of this insect, and it was approved for release in New York in 2009. Much like the targeted grazing experiments, the goal is to bring mile-a-minute to a non-dominant state to allow native plant species to once again grow in these heavily infested areas.

Phragmites Removal at Tivoli North Bay -- Experimental removal of three stands of *Phragmites* in Tivoli North Bay began in summer, 2006. Three additional stands were treated in 2007, with minor spot treatments in 2008. The project is designed to eradicate non-native *Phragmites* in the bays and to monitor the recovery of native marsh plant species following removal. NYSDEC staff members are now able to conduct low-intensive management of stray plants on an annual basis. Documentation of the recovery of the marsh, post-removal will provide important information for designing the removal and managing the recovery of future *Phragmites* removal projects within Reserve boundaries.



Treated *Phragmites* stand at Tivoli North Bay.

Future Phragmites Removal at Reserve Sites -- With information gained from the pilot *Phragmites* removal project at Tivoli North Bay, staff will seek to engage state agency partners in the development of *Phragmites* control projects in tidal wetlands at all Reserve sites. Recovery goals for each site will vary as native vegetation communities vary among the component sites from brackish water marsh to freshwater wetland plant communities. In 2007, a NYSDEC Aquatic Invasive Species Control grant was awarded to the Friends of the Palisades Park for control of 10 acres of *Phragmites australis* at Iona Island in 2008-2010, following management and monitoring protocols piloted at the Tivoli Bays. Exponential expansion of *Phragmites* at Iona Island has been coincident with dramatic declines in marsh bird populations and nesting (Wells et al., 2008).

Strategies for Shoreline Function Enhancement at Reserve Sites (Objective 2)

Assessment of Shoreline Restoration Potential -- Shorelines in the Hudson River Estuary from the Tappan Zee Bridge to the Federal Dam at Troy have been mapped and classified by Reserve staff. Classification includes identifying natural, engineered, stable and eroding shoreline reaches. Reserve staff will identify reaches of engineered and eroding shore within the Reserve, and evaluate the potential at these sites for restoration of natural shoreline ecosystem function. This work will draw on the Reserve's ongoing research project to identify the ecosystem functions of different types of estuarine shoreline, and to develop recommendations for shoreline management along the Hudson River Estuary's relatively sheltered coasts in the context of accelerated sea level rise.

Pilot Shoreline Restoration Projects -- Where the assessment described above identifies a potential for enhancement of habitat function, the Reserve will seek funds to implement restoration projects. These will serve as demonstration projects for other shoreline managers. These projects will be closely monitored to determine net environmental benefit of each project. Information obtained through these efforts will be applied to regional shoreline restoration and enhancement efforts.

Strategies for Restoring Vegetated, Shallow and Intertidal Habitats at Reserve Sites (Objective 3)

Identification of Candidate Sites for Secondary Channel Restoration -- Analysis of historic channel morphology dating to 1890 has identified secondary channels as a structural component of the upper Hudson River Estuary that was virtually eliminated by dredge and fill activities. These habitats were predominately shallow and intertidal areas which were likely among the most productive in the estuary. Restoration of secondary channels is a logical means of restoring shallow and intertidal vegetated habitats because the channels are isolated from higher energy regimes of the main channel and offer on-site restoration dredge spoil disposal alternatives. This work will identify navigation dredge spoil areas within the Reserve that could support secondary channel habitat restoration. Analysis of sites will be used in information sessions to build stakeholder agreement on restoration potential and subsequent actions.

Restoration of Vegetated, Shallow and Intertidal Secondary Channel Habitats -- With information developed from candidate site selection processes, restoration of secondary channel habitat

will be pursued through a process involving regional, state, federal and NGO stakeholders. An advisory team composed of stakeholders will direct restoration research, design and implementation of at least one project. Restoration projects conducted with the Reserve will serve as a model for secondary channel restoration throughout the upper Hudson River Estuary.

Land Acquisition Plan

The Reserve encourages the protection of essential habitat within its sites, as well as essential buffer and habitat adjoining such essential habitat. Reserve boundaries are periodically adjusted to reflect current ownership patterns. The Reserve seeks to encompass an adequate portion of key land and water areas of the natural system to approximate an ecological unit and to represent the range of natural diversity in the Hudson River Estuary. Because of the magnitude of the Hudson River Estuary system, Reserve sites necessarily represent sub-units of the larger ecological setting.

Reserve System Acquisition Policies

Boundaries for HRNERR component sites must include "an adequate portion of the land and water areas of the natural system to approximate an ecological unit and to insure effective conservation" (Federal Register, Vol. 52, No. 209, Section 921.11). These areas must be discrete enough to be effectively managed, but large enough to make long-term research possible.

Core areas are defined in NOAA's *Guidelines for Establishing Proposed Boundaries for National Estuarine Reserves* (Section 921.11) as areas which contain "critical estuarine ecological units for research purposes, encompassing a full range of physical, chemical, and biological factors contributing to the diversity of fauna, flora, and natural processes occurring within the estuary." The core area 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...[These areas] should encompass resources that are representative of the total ecosystem which, if compromised, could endanger the research objectives of the reserve."

Hudson River NERR Core and Buffer Areas

Within HRNERR, core areas include all inter-tidal and subtidal lands, and critical area buffers along stream corridors and estuarine shorelines, especially those with slopes greater than 10 percent. These buffers will be delineated as part of the site management planning process. Buffer widths will be calculated using the Wong and McClune model (or a similar model) that takes into account slope, soil type and particle size, filtration efficiencies and vegetation cover in calculating appropriate wetland buffer widths.

Under NOAA guidelines, a reserve buffer zone is defined as an area adjacent to or surrounding the core area on which the integrity of the core depends. The reserve buffer area protects the core and provides additional protection for estuarine-dependent species, including those that are rare or endangered. It may include areas suitable for research and/or education facilities. Within HRNERR, buffer lands include all upland areas above mean high tide that are not part of the core area.

Land Acquisition Objectives

Acquisition strategies at the Hudson River NERR will ensure adequate management oversight and protection for resources within reserve boundaries. Expenditure of federal and state funds will be minimized by giving priority to non-fee acquisition strategies, such as conservation easements, management agreements, and memoranda of understanding, provided a sufficient level of management control may be established with the fee owner.

The Reserve boundary embraces a mosaic of ownerships, including lands owned in fee by New York State and under the jurisdiction of one of four custodial state agencies; private lands encumbered by conservation easements held by the DEC; one parcel of state land encumbered by a conservation easement held by Scenic Hudson, Inc.; and lands in private ownership that the state wishes to acquire in fee. Current ownership boundaries and jurisdictions at the sites are identified on figures 3- 6.

Objective 1: Significant and sensitive natural resources areas in and around the Reserve are protected through land acquisition.

Objective 2: Reserve boundaries are adjusted to reflect recent or future land acquisitions.

Strategies for Land Acquisition (Objective 1)

Either fee ownership or conservation easement encumbrances are sought on several parcels of core and buffer lands associated with Stockport Flats and the Tivoli Bays to ensure adequate protection and management oversight. In addition, DEC will request from OGS transfers of jurisdiction on two parcels of underwater lands and formerly underwater filled lands pursuant to Article 2, Section 3(4) of the Public Lands Law. The Fordham Point parcel is at Stockport Flats and a second parcel is at Piermont Marsh. These parcels are described below.

Stockport Flats -- The Reserve boundary at Stockport Flats was extended one mile north of Gay's Point in 1989. The site now includes Little Nutten Hook, Nutten Hook, and the lands between. About half of the 260-acre expansion is upland, accessible via two at-grade railroad crossings; the remainder is tidal or formerly tidal wetlands. Most of the expanded area is state-owned under the jurisdictions of DEC and OGS. DEC was able to acquire an in-holding in 2005 of 38.4 acres of core area at Priming Hook, plus about 200 acres of upland buffer. DEC also received a transfer of jurisdiction of two parcels of land presently and formerly underwater at Nutten Hook, including a 32.34 acre parcel that abuts the west shore of Nutten Hook, and an 8.37-acre parcel that abuts the northeast shoreline.

DEC will seek to acquire in fee approximately 81.2 acres of shoreline between Nutten Hook and Little Nutten Hook, primarily west of the railroad and within the boundary of the Reserve. This parcel is part of a Significant Coastal Fish and Wildlife Habitat, and is included in the Nutten Hook boundary expansion. It will provide exceptional opportunities and access for on land and shoreline education programs. These opportunities are not present to the south at the Stockport Flats component because of water or railroad barriers. Fee simple acquisition is sought to ac-

quire full, unrestricted access to the uplands, and to ensure that no development occurs west of the railroad. Although no appraisal has been conducted by the DEC, the cost is estimated to be about \$200,000-\$400,000. While a conservation easement would preclude development, liability issues would limit the extent of public access if ownership remains private.

DEC will seek to acquire three core area parcels east of Gay's Point. These are also known as the Gay Grant (83.8 acres), the Judson Grant (13.1 acres), and the Alvord Grant (6.3 acres). These areas were described in detail in the 1982 Final Environmental Impact Statement (FEIS) for the Reserve. Current owners are not willing sellers, however DEC will attempt to re-open negotiations on a periodic basis. These parcels remain important core area parcels for research purposes. Fee simple ownership is required to insure the long-term availability and accessibility of these areas for research. Although no appraisals have been conducted by the DEC, the costs are estimated as follows: 1) Gay Grant, about \$75,000 to \$125,000; 2) Judson Grant, about \$20,000 to \$30,000; and Alvord Grant, about \$15,000 to \$25,000.

DEC also will seek to acquire by fee simple acquisition three parcels adjacent to and across the river from Stockport Flats: the 124-acre Rasmussen property at Vosburgh Swamp (Greene County), the 112-acre Tafano property north of Vosburgh Swamp, and the 37-acre Bock property located west of Vosburgh Swamp. These properties may become candidates for inclusion in the Reserve in the future.

In addition, DEC will seek a transfer of jurisdiction from OGS on approximately 120 acres of underwater lands immediately west of the proposed 81.2 acre fee acquisition between Little Nutten Hook and Nutten Hook, described above. This transfer may take place once DEC is the riparian land owner of the 81.2 acres.

Tivoli Bays – In the last decade, the NYS OGS transferred jurisdiction to DEC of underwater lands at the Tivoli Bays, including approximately 590 acres east and west of the railroad tracks at Tivoli North Bay and about 335 acres east and west of the railroad tracks and adjacent to the existing conservation easement south of the Saw Kill.

DEC is in the process of acquiring lands in-holdings at the Tivoli Bays that are currently owned by Central Hudson Energy Group, Inc. The lands are comprised of four parcels that total approximately 62.5 acres as are as follows: 4.3 acres, 51.85 acres, 5.26 acres, and 1.09 acres that together form a 200-foot wide, Y-shaped strip traveling west from NYS Route 9G through the Wildlife Management Area to North Bay and across Cruger Island to the Hudson River. It is anticipated that a land trust will pre-acquire the parcels and hold the lands until the DEC is able to purchase them. Although no appraisal has been conducted by the DEC, the cost is estimated to be about \$250,000.

DEC proposes to acquire a conservation easement on approximately 70 acres of upland along the shore of Tivoli South Bay, north of the Saw Kill. DEC also proposes to acquire a conservation easement on approximately 10 acres of underwater lands and upland buffer at the extreme south end of Tivoli South Bay. Once easements are acquired, DEC will seek to include these key lands in the Reserve boundary.

Conservation easements have been identified as the most cost-effective means of attaining a sufficient level of long-term control over these shoreline properties, which are part of the Reserve's core area. The uplands are adjacent to intensively-studied wetlands and are currently the focus of research on upland impacts on the wetlands. Management agreements will not provide a sufficient level of control. Although the owner is an unwilling seller, DEC will attempt to re-open negotiations on a periodic basis. Conservation easements cost about 90% of the full fee value.

Piermont Marsh -- DEC will be initiating a request to OGS for a transfer of jurisdiction of approximately 100 acres of its underwater lands south of Piermont Pier, between the lands currently under DEC and PIPC jurisdiction.

Strategies for Boundary Expansion (Objective 2)

No boundary expansion is being sought at present.

VIII. ADMINISTRATION, OPERATIONS, FACILITIES, & ACCESS: Enhancing Reserve operational capacity and facilities to support program objectives

Background

The successful implementation of Reserve goals and objectives rests on an effective administrative structure, which provides for adequate staffing, facilities, and funding, as well as the cooperation of public and private agencies involved in Reserve operations, facility management, and provision of access to Reserves sites. Administrative of the Reserve is both enriched and complicated by the fact that it consists of four sites, subsections of which are administered by different public agencies. Interagency collaboration is an essential underpinning of effective Reserve operations. This chapter includes three sub-plans: the Administration and Operations Plan, the Facilities Plan, and the Public Access Plan, which appear in separate sections below.

Introduction to Reserve System's Operational and Facility Requirements

The National Estuarine Research Reserve System (NERRS) program required New York State to commit to funding and filling core staff positions adequate to carry out the System's mission and national programs, and to deliver the programs described in this management plan.

Administration and Operations Plan

The New York State Department of Environmental Conservation is the lead state agency for the Reserve. The mutual commitment of NYSDEC and NOAA to long-term operation of the Reserve is described in a memorandum of understanding, which is included as Appendix 3. State and Federal agency roles are described in Appendix 4. Within the State, the Reserve is a regionalized NYSDEC program with activities in both NYSDEC Region 3 (where Piermont Marsh, Iona Island, and Tivoli Bays are located) and NYSDEC Region 4 (where Stockport Flats is located). Day-to-day supervision of the Reserve Manager is by the Region 3 Supervisor of Natural Resources, who reports to the NYSDEC Regional Director.

Because NYSDEC is a "matrix" organization, the Reserve also has a programmatic home in the Division of Fish, Wildlife and Marine Resources, which is part of the Office of Natural Resources in the Central Office in Albany, New York. Within the Division, the Reserve falls under the Bureau of Marine Resources, in the Marine Habitat Protection Section, both of which are located on Long Island in East Setauket. Budget services are principally the domain of central office staff. Policy direction is jointly provided by the central office and the region. Organizational charts for the Reserve are provided in Appendix 5.

Administration and Operations Objectives

Objective 1: The Reserve's staff is of sufficient size and capabilities to administer and deliver effectively its mandated and assigned programs.

Objective 2: Reserve component sites and facilities are managed effectively with adequate inter- and intra-agency coordination at site the level.

Strategies for Adequate Reserve Staff Capacity (Objective 1)

An adequate Reserve staff is essential to implement the management plan and to achieve the Reserve's program objectives. As of 2009, the Reserve staff includes 10 permanent positions. Funding for Reserve staff is secured through annual federal and state funding sources. Staff positions, primary responsibilities and funding source as of 2009 are described in Appendix 5.

The Reserve needs the following additional staff to meet our NOAA obligations. First, a Research Assistant/System-Wide Monitoring Program (SWMP) technician is needed to fulfill the requirements of the SWMP program. In addition, NOAA requires that all core positions be state funded. At present, the Research Coordinator and Education Coordinator positions are on the federal grant. This has been a continuing issue in NOAA evaluations. At the last NOAA evaluation, December 2008, DEC executive staff identified two possible strategies for short-term solutions including use of private/trust funds and enforcement penalties to meet these shortfalls. New York State's dire budget situation may preclude progress in the near term.

Sufficient Staff to Attain Program Objectives – The Reserve will continue to seek NOAA operations funding and state funds to support selected technical staff and interns. The Reserve will also continue its relationship with the NYSDEC Hudson River Estuary Program for support of selected technical staff and SCA interns. With the move to Norrie Point Environmental Center, we anticipate the need to create a volunteer coordinator position to facilitate volunteer participation in the Center's programs, as well as in other research, education and stewardship activities.

Staff Capacity Development -- Reserve staff capacity will be developed through professional training in safety, project management, and technical skills. Staff members are encouraged to enhance their professional development through training and attendance at professional meetings at the national and regional level. Seminars and thematic staff meetings are held to immerse staff in important topics and issues. Safety training remains a very high priority, and all staff members are expected to attend a 2-day wilderness first aid training every two years.

Strategies for Increasing Agency Collaborations on Site Management (Objective 2)

Interagency and Intra-agency Coordination on Site Management – The Reserve will seek to promote good inter- and intra-agency communication and enhanced collaboration on site management by instituting bi-annual meetings of management partners for each site. Reserve staff will seek to participate in site management planning activities at each site and to involve appropriate partner agency staff in its site management activities. The Reserve manager will seek to meet regularly with the NYS Office of Parks, Recreation, and Historic Preservation (OPRHP) Taconic Region staff regarding Norrie Point management.

Facilities Plan

Facilities Objectives

Objective 1: The Reserve increases the energy efficiency of operations at the Norrie Point Environmental Center.

Objective 2: The Reserve insures effective management of on- and off-site Reserve facilities to support research, education, and resource protection objectives.

Objective 3: The Reserve supports clean-up of deteriorated Reserve facilities.

Strategies for Increasing Energy Efficiency at Norrie Point (Objective 1)

The Norrie Point Environmental Center was renovated with substantial financial and logistical support from NOAA, NYSDEC and OPRHP from 2005 to 2008. Phase 1 of the renovation was completed in January, 2007, enabling the Reserve to relocate its headquarters to this building. Phase 2 of the renovation, the research laboratory, was completed in May, 2008. Next the Reserve seeks to undertake a series of improvements to install alternative energy sources and to conserve energy.



Norrie Point Environmental Center, Staatsburg, New York. Photo credit: Dan Miller

Norrie Point Energy and Other Enhancements -- The highest priority for Reserve facilities is to install solar power (and possibly geothermal power) and undertake a series of modifications to conserve energy. Other future construction projects include parking area renovation, storage unit maintenance, and the creation of boat storage facilities.

Construction Plan and Estimated Costs – Phase III of the construction is to enhance the building’s energy efficiency and install alternative energy sources in order to reduce our carbon footprint, diminish our operating costs, and add a new interpretive and educational component to our education and training programs. NOAA funding (\$300,000) was received in 2008 to install solar panels on the building’s south-facing roof, new energy-efficient (architectural, low E) windows, insulating shades to reflect sun in summer and retain heat in winter, additional wall and ceiling insulation, and replacement exterior siding at the Norrie Point Environmental Center.

Photovoltaic System: An initial plan for photovoltaic cells provided for a 25 kilowatt system installed on the south facing roof, with PV modules laid out in 2 rows of 38 PV modules in portrait, covering an area of about 12 feet x 103 feet. Specifications will be finalized according to the final project plan; engineering plans and bid documents will be produced by NYS engineering staff and/or a contractor to New York State. A 2007 cost estimate indicated that the total PV share will cost \$250,000, with half of the cost reimbursed by NYSERDA, leaving a federal share of \$125,000.

Windows & Shades: Existing old windows (76 casement windows) will be modified to provide better heat retention. Double-cell shades with an R value of at least 4 will be acquired. The estimate for windows and shades is \$67,120.

Siding & Insulation: Norrie Point currently loses substantial heat due to deteriorated wood siding and insufficient insulation. Added insulation for walls and ceilings, including an air seal for under the roof, is estimated to cost \$35,000. Replacement siding (cedar shake or board and batten) is estimated to cost \$65,000. The subtotal for siding and insulation is \$100,000.

Lighting: Existing building lighting is a combination of new and old recessed fluorescent fixtures, with some decorative globe lights. Old fixtures will be replaced with new, high energy efficiency fluorescents, and light sensors will be installed where feasible to enable automatic dimming of lights in unoccupied rooms. The lighting cost estimate is \$7,880.

Construction Schedule --

<u>Project Element</u>	<u>Completion Date</u>
Complete final energy plan	September 1, 2008
Develop bid documents (drawings, specifications, & transmittals)	February 28, 2009
Solicit proposals and award construction contracts	October 1, 2009
Construction	June 30, 2010
Performance monitoring (outside award period)	June 30, 2011

Future Construction Needs – Additional state and federal funding will be sought by OPRHP and NYSDEC to renovate the parking area and other auxiliary facilities at the Norrie Point Environmental Center to insure staff safety, efficient operations and continued public access; and to provide sufficient storage space for reserve boats, including the whaler, the skiff, the electro-shocking boat, and the canoe fleet.

Strategies for Insuring Effective Management of Existing Facilities (Objective 2)

The Reserve's other construction and facility development priorities include the following. State and/or federal funds will be sought to accomplish these projects, if needed. Estimated costs appear in parentheses.

Bard College Field Station -- The Reserve will continue to maintain office and lab space at the Bard College Field Station, albeit at a reduced level. This space will be used for Reserve related activities, especially research and monitoring activities, including work by Reserve staff and research fellows and interns. The Reserve manager and/or research coordinator will meet at least twice a year with the Bard College Field Station Director to insure ongoing communication about field station usage and participate in any Bard College Field Station committee meetings. Continued use of this facility is by virtue of the 1984 NOAA and NYSDEC contractual agreement that governed the investment of public funds in the renovation and expansion of the original building, and specified the long-term use of the building.

Tivoli Bays Visitor Center -- The Reserve will continue to maintain exhibits in the Tivoli Bays Visitor Center, according to the terms of the letter of agreement (Appendix 7) between the Village of Tivoli and NYSDEC. Reserve staff will meet bi-annually with Village of Tivoli officials to maintain effective communications. In addition, Reserve education staff will continue to host public programs and maintain staff on a part-time basis in the visitor center. The Reserve may seek state and/or federal funds to make improvements as necessary to the exhibit space. Lastly, the Reserve will continue to partner with the Tivoli Free Library to augment the Hudson River Collection of books and other library materials.

Nutten Hook Ice House and Barn -- The R. and W. Scott Ice House was one of the largest independently owned ice houses on the Hudson River. The ice house foundation and powerhouse chimney are considered to be the most intact and interpretable examples of this once-dominant water-based Hudson River industry. The Ice House is on the National Register of Historic Places, as well as its NYS counterpart, and is encumbered by conservation easement held by the non-profit environmental organization Scenic Hudson, Inc.

Since 1991, substantial State, Federal, and volunteer resources have been dedicated to stabilizing the ice powerhouse, the shoreline, the ice house perimeter, and the barn. The shoreline was stabilized with riprap and trees, and the surface below the powerhouse was stabilized with a concrete grout. The powerhouse masonry walls were stabilized and capped, and security fencing was installed in powerhouse windows and doorways to prevent access and reduce the potential for injury and vandalism. Five crack monitors are maintained on the powerhouse structure to detect shifts and changes. Two interpretive panels were installed to depict the history of the ice house and ice harvesting industry. Vegetation is routinely cleared around the 200' x 300' peri-

meter of icehouse foundation. New roof, windows, and doors were installed on the barn, and the exterior siding is maintained. The Reserve will continue to maintain and interpret these structures with NYSDEC operational funding.

Nutten Hook Ferry Landing – The Nutten Hook to Coxsackie ferry operated in the 19th century from the south end of Nutten Hook. Today the site is a wooded parcel underlain by fill contained by deteriorated timber cribbing. Funds will be needed in 2009-2011 to support site improvements and shoreline stabilization (\$100,000).

Strategies for Addressing Deteriorated Reserve Facilities (Objective 3)

Investigation of Iona Island Naval Munitions Depot – Iona Island was used from 1900 to 1947 by the U.S. Navy as the main supply and preparation ammunition depot in the New York District. In 2007, the U.S. Army Corps of Engineers' Military Munitions Response Program initiated a site investigation of Iona Island to explore the potential for munitions constituents, munitions and explosives of concern, and other related hazards. The initial reconnaissance phase of the site investigation, which included literature research and site sampling, concluded that while there appear to be no explosives at the site, both soil and sediments are contaminated with several metals at levels that exceed human health, ecological, and background screening criteria. Given these potential risks to humans and "ecological receptors", the site report recommended that additional studies focus on both munitions constituents, and munitions and explosives of concern. The Reserve will continue to monitor the performance of this work, and to coordinate it with ongoing stewardship and research programs.

Hamersley Barn -- A prominent structure on the Tivoli Bays uplands off Kidd Lane is the large masonry barn, which was constructed circa 1918 for L. Gordon Hamersley, and later became part of the Ward Manor retirement community. The building is listed on the National Register of Historic Places as a contributing feature in the Hudson River National Historic Landmark District. Demolition of the Hamersley Barn at the Tivoli Bays is a priority project due to liability and contamination associated with this historic, but derelict, structure. Its historic status stems from its presence in a historic shore lands district. Portions of the structure have previously burned, and the building contains asbestos. The estimated cost for asbestos abatement, demolition, and removal of the barn was \$600,000 in 1998. The structure has been formally documented and has met state and federal requirements for mitigation of loss of a historic structure.

Access Plan

Public access provisions for the Reserve are established on a site-by-site basis, as the Reserve is a multi-component site. This allows for balanced access to the Reserve with all sites contributing in aggregate. The existing Memorandum of Understanding among the five involved New York State agencies stipulate that "Multiple uses of Reserve lands are encouraged to the extent such uses are compatible with the program and its purpose as expressed in the management plan. These areas are being managed to facilitate ecological research and education. Uses and/or levels of use which are not compatible with the use of the Reserve as a natural field laboratory shall be prohibited or limited, to the greatest extent feasible, by the agency having jurisdiction."

Access Objectives

Objective 1: Public access is provided to Reserve sites to an extent compatible with conservation of the Reserve's natural resources and ecological integrity.

Objective 2: Access to Reserve sites is monitored and managed to minimize negative human impacts.

Strategies for Providing Public Access (Objective 1)

Public access to Reserve sites will be controlled in order to protect each site's ecological integrity and provide a stable environment for research and public education. Traditional uses which do not conflict with Reserve goals will be encouraged, and will be allowed to continue as permitted under local and state laws, and according to the current access rules and schedules established by site property owners. Lands in private ownership within the Reserve are not open to the public unless expressly allowed by the owner, nor are they subject to Reserve access rules and schedules.

For properties which are not adequately protected, the Reserve will work with the site property owner to document needs and develop modified access rules and schedules on a temporary, seasonal, or permanent basis in order to curtail any activity that threatens to disturb natural conditions or ongoing research and education activities.

Further detail about access to Reserve sites is provided in Appendix 8.

Strategies for Managing Human Impacts (Objective 2)

The Reserve will seek to build its capacity and that of its management partners in visitor impact assessment and management related to upland and aquatic habitats in the Reserve.

Training for Land Managers -- The Reserve, through the Estuary Training Program and collaboration with its partners, will continue to build land manager capacity to manage resources using an ecosystem-based management approach, control invasive species, and assess visitor impacts.

Human Impacts on Reserve Trails -- Recent work by Reserve stewardship staff established standards and a baseline for monitoring the degree of human impacts on trails at the Tivoli Bays. The standards are based on current trail conditions at the Tivoli Bays, and were created because of the site's highly erosive clay soils. A monitoring plan was established for Tivoli Bays' trails, and conditions will be monitored every 3-5 years. Stewardship staff members have identified potential mitigation strategies for visitor use impacts to be used in the event of trail deterioration. This protocol may be modified for use at other Reserve sites in the future.

Recreational Impacts on Reserve Wetlands and Waterways -- The Reserve has funded initial work on recreational impacts of visitors to Reserve sites. One graduate project assessed the impacts of different densities of recreational kayaking on visitor experience. The Reserve will seek

to attract other research that will better establish the range and magnitude of a variety of visitor impacts, and to guide future access decisions. In addition, the Estuary Training Program has hosted three workshops conducted by the NOAA Coastal Services Center that seek to build internal staff expertise, regional interest, and a learning community around visitor impact assessment.



Tivoli North Bay public canoe launch. Photo credit: Dan Miller.

IX. HUDSON RIVER NERR PROGRAM INTEGRATION

Key Focus

The Hudson River NERR seeks to integrate its myriad activities and resources to promote wise estuary habitat stewardship – both at Reserve sites and estuary-wide.

Habitat stewardship issues are prioritized through examination of our own research, emerging issues, exploration of community needs, and agency priorities, such as those articulated in the 2005 New York State DEC Hudson River Action Plan, which states:

“The diverse and varied habitats of the estuary have changed dramatically since 1609, when Henry Hudson first sailed up the river to Albany. Wetlands and shallows have been filled, miles of shoreline have been altered, and changing land use patterns in the watershed have contributed to degraded water quality. The key habitats of the estuary -- the wetlands, the aquatic plant beds, the shoreline, and the very bottom of the river itself -- need to be characterized, and, where necessary, conserved or restored. In addition, invasive species, such as water chestnut and zebra mussels have displaced native species, disrupting food webs and the complex ecosystem. Preventing the introduction of invasive species is critically important, because once they are established, it is difficult or impossible to eradicate them.”

How Integration Happens

Integration among Reserve staff and program areas occurs very deliberately, often in response to emerging opportunities and partnerships. In addition, Reserve staff members seek to have a high level of integration with other partners, including state agency partners, private entities, municipalities, scientists, educators, non-profits, and others. Chapters 4-7 each have concluding sections that describe how Reserve programs are integrated both internally and externally. In addition, the Reserve uses the following mechanisms of cross-program integration:

- Thematic staff meetings allow for cross program integration, information exchange and collaboration in order to promote estuary-wide and site-specific habitat stewardship.
- Teams of research, education, outreach, and stewardship staff members participate in development of integrated habitat projects that embrace several aspects of our programs, typically including communications, education programs and products, decision-maker workshops, and stewardship decision-making that is geared toward specific end users.
- Teams of Reserve staff and outside researchers and educators join forces and meet regularly to develop and implement strategies to carry out large, estuary-wide habitat projects.
- Significant research findings, such as rapidly rising salt levels in representative Hudson River tributaries, are recognized by Reserve staff and swiftly integrated into Reserve communication and outreach programs to be conveyed to decision-makers and the public.

- Reserve staff and partners host interdisciplinary forums to clarify scientific information needs, explore stewardship and management challenges, focus attention on emerging issues, and identify communication and education priorities.
- Stewardship, research, and outreach staff jointly develop guidance and training on shoreline treatments, habitat protection, and invasive species management.
- Education staff solicit technical input and program participation in public lecture series, exhibit development, and educational curricula and programs.
- Reserve staff identify technical information needs among regulators and managers and seek to develop the requisite information through Reserve programs, partnerships and outside researchers to support habitat stewardship.

Program Integration to Support Hudson River Habitat Stewardship

The following examples highlight the Reserve's efforts to integrate its programs in order to achieve habitat stewardship both at its sites and estuary-wide:

Reduction of Visitor Impacts on Reserve Trails – Begun as a few graduate research projects, this effort grew into a continuing Estuary Training Program workshop series for Hudson River land managers. It is also incorporated on an ongoing basis into site management and stewardship activities. In future years, visitor impacts on trails at the Tivoli Bays will be mitigated by seasonal stewardship staff.

Phragmites Management -- Research and monitoring identified rapid spread and negative effects of an invasive strain of the common reed, *Phragmites australis*, and is being used to justify control and management of *Phragmites* at Reserve sites. The *Phragmites* story has been and will continue to be integrated into canoe and field programs, Tivoli Bays Visitor Center exhibits, and workshops on invasive species. Future workshops for land managers will make use of the Tivoli Bays control site as a demonstration project, and project monitoring data will inform future research and adaptive management of common reed.

Hudson River Estuary Submerged Aquatic Vegetation (SAV) Protection – A regional workshop on the state of knowledge of SAV was convened by the Institute of Ecosystem Studies in the early 1990s. Workshop participants highlighted the lack of information about Hudson River SAV distribution, patterns of change, ecological importance, and vulnerability to human impacts. In response to this, the Reserve helped establish a long-term partnership to address these gaps. A multi-disciplinary team of four institutions has worked together to integrate research, monitoring, education, outreach, and management. The team focusing on submerged aquatic vegetation was recently recognized with a state award for its integrated efforts.

As a result of coordinated outreach and training, many federal and state regulators have an enhanced appreciation of SAV resource values, and the tools to protect them, as evidenced by survey and workshop evaluation results. Also, members of the public are becoming aware that these are not mere “weed beds”, but vitally important to fisheries and the Hudson River ecosystem.

Future work will involve monitoring of and communication about change in SAV bed distribution, composition, and function, and the management implications of these changes. Support will continue for a volunteer monitoring program recently established by the SAV team.

Benthic Habitat Protection -- With the invasion of zebra mussels in the Hudson River Estuary, an increase in in-river development projects, and the need to identify critical fish habitat, the Reserve determined there was a need for a comprehensive inventory of the river bottom and its attributes. Associated with this was the need to raise the level of public awareness of the largely invisible river bottom, and to provide decision-makers with tools and information to manage the bottom well.

The Reserve hosted a seminal workshop on river bottom mapping, and several staff have participated in a multi-party, long-term partnership dedicated to building this information and putting it into play in management, education, scientific, and historic preservation arenas. Future projects are likely to include the development of on-line and place-based education tools and exhibits about the river bottom, as well as guidance for river bottom project review.

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