NEW YORK STATE OF OPPORTUNITY | Department of Environmental Conservation

Hudson River National Estuarine Research Reserve Management Plan

OCTOBER 1, 2019–OCTOBER 1, 2024

Andrew M. Cuomo, Governor | Basil Seggos, Commissioner

Acknowledgments

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Acronyms

CDMO – NERRS Centralized Data Management Office

CRRA – Community Risk and Resilience Act

CZMA – Coastal Zone Management Act of 1972

DEC – New York State Department of Environmental Conservation

DOS – New York State Department of State

Estuary Program – Hudson River Estuary Program

ETP – Estuary Training Program

GRF – NERRS Graduate Research Fellowship

HRECOS – Hudson River Environmental Conditions Observing System

HRSSP – Hudson River Sustainable Shorelines Project

IRIS – Cornell Institute for Information Sciences

NEIWPCC – New England Interstate Water Pollution Control Commission

NERRS – National Estuarine Research Reserve System

NOAA – National Oceanic and Atmospheric Administration

NSC – NERRS Science Collaborative

NWLON – National Water Level Observing Network

Parks – New York State Office of Parks, Recreation and Historic Preservation

PIPC – Palisades Interstate Parks Commission

PPT – Parts per Thousand

SAV – Submerged Aquatic Vegetation

SCA – Student Conservation Association

SET – Surface Elevation Table

SHAD – Shorelines Habitat Adaptation Dialogue

SSAM-1 – Sentinel Site Application Module 1

SUNY – The State University of New York

SWMP – System-Wide Monitoring Program

TLP – Thin Layer Placement

TOTE – Teachers on the Estuary

Executive Summary

The Hudson River National Estuarine Research Reserve (Reserve) was designated in 1982 and is one of 29 reserves established by the National Oceanic and Atmospheric Administration (NOAA) to promote informed management of the Nation's estuaries and coastal habitats. The National Estuarine Research Reserve System (NERRS) works with existing federal and state authorities to establish and operate research reserves and provide for long-term protection and stewardship. The New York State Department of Environmental Conservation (DEC) is the lead state agency for the Reserve. The Reserve includes 5,000 acres of subtidal, intertidal, and upland habitats distributed across four component sites. From south to north, the sites are Piermont Marsh, Iona Island, Tivoli Bays, and Stockport Flats. The Reserve headquarters is located at the Norrie Point Environmental Center.

This plan is a revision of the 2009–2014 Management Plan and was developed in accordance with federal regulations and follows established NERRS management plan guidelines. It is consistent with Section 315 of the Coastal Zone Management Act of 1972 (CZMA) and the New York State Coastal Management Program and seeks to address pressing coastal management issues, including climate change and its impacts on:

- coastal ecosystems and communities;
- development pressures and land use changes, especially in near-shore areas and floodplains;
- habitat fragmentation and degradation, including invasive species-caused declines in native biodiversity; and
- water quality degradation.

The Reserve is committed to improving the health and vitality of the Hudson River estuary by protecting estuarine habitats through integration of its core programs in education, estuary training, research and monitoring, and stewardship and restoration. This plan is the primary guidance document for the operation of the Reserve's core programs. It also includes important background on the Reserve's history, setting, organizational framework, facilities, and rules and regulations. New York State's implementation of this plan will be evaluated by NOAA during required program evaluations every three years.

The plan sets four programmatic goals and several objectives in support of each goal. The goals are:

1. Reserve science enhances understanding of the Hudson River estuary ecosystem, and the results of research are conveyed to decision makers to meet management needs and support resilient habitats and communities.
2. Resource managers have enhanced capacity to protect, manage, and restore floodplain, shoreline, watershed, and river habitats.
3. People of the Hudson Valley appreciate the estuary and the multitude of benefits it provides, understand how to responsibly enjoy and use the river, and engage in multiple levels of stewardship to sustain these resources.
4. Hudson River Reserve sites are models for restoration and stewardship that foster understanding of ecological connections among land, water, and people.

Over the next five years, the Reserve is committed to working with partners within the DEC, Hudson River Estuary Program, New York State Office of Parks, Recreation and Historic Preservation, Hudson River Greenway, and New England Interstate Water Pollution Control Commission to achieve these goals.

Introduction

The Reserve

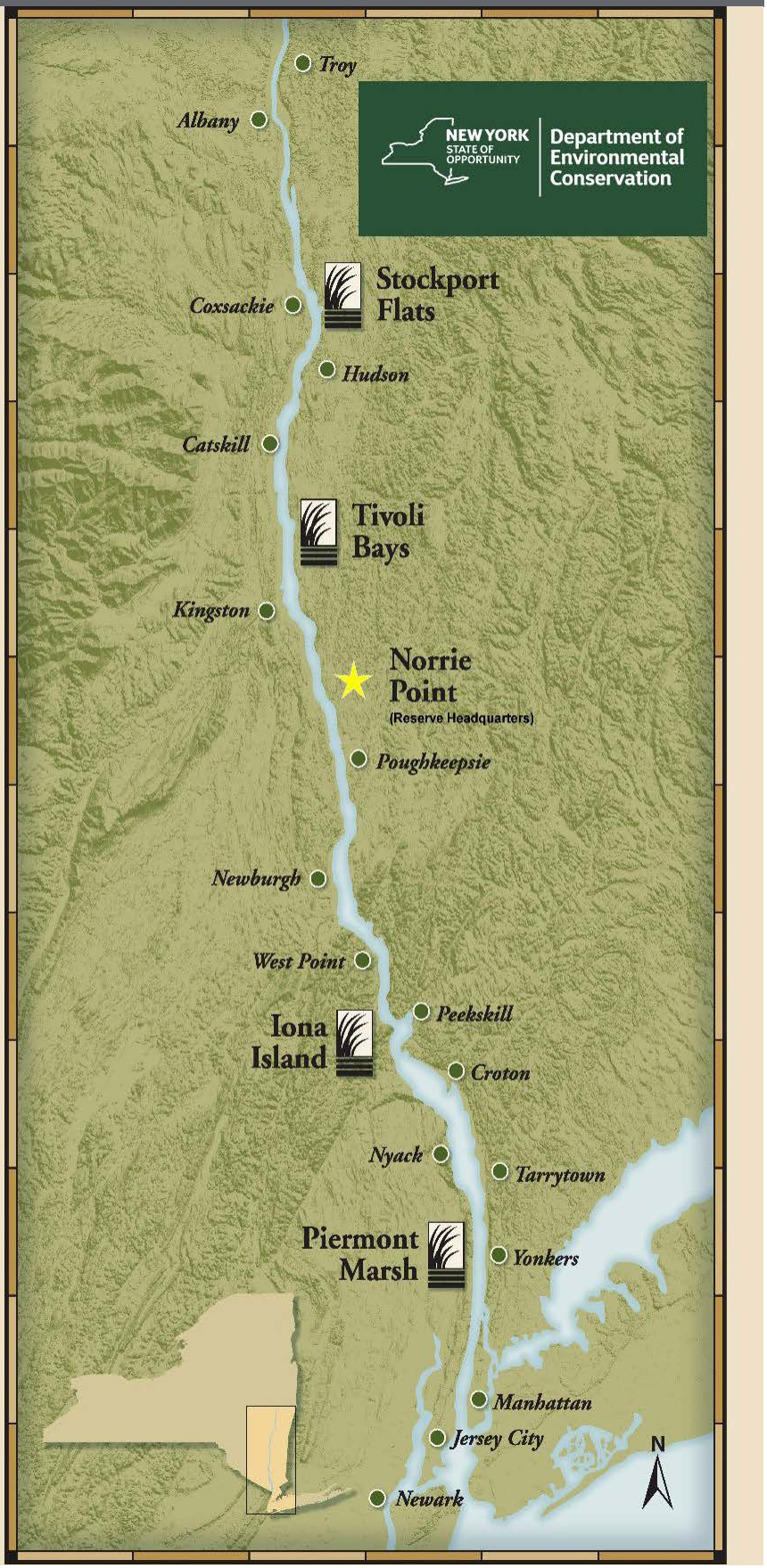
The Hudson River National Estuarine Research Reserve (the Reserve) had its beginnings in the 1972 Coastal Zone Management Act, which recognized the need for conserving high-quality, representative coastal wetlands as long-term field laboratories for research and education to guide coastal management. In 1982, the National Oceanic and Atmospheric Administration (NOAA) and New York State designated four Hudson River Reserve sites (Piermont Marsh, Iona Island, Tivoli Bays, and Stockport Flats) the Hudson River National Estuarine Sanctuary. The four component sites were chosen following an in-depth site selection and environmental review process, in recognition of their relatively large size and the ecological importance of their globally rare brackish and freshwater tidal wetlands. Each site contains different kinds and combinations of tidal habitats, and together they represent gradients found within the Hudson River estuary, including salinity and degree of watershed development. In 1986, Congress changed the national program name to the National Estuarine Research Reserve System (NERRS), and the Hudson River National Estuarine Sanctuary was renamed the Hudson River National Estuarine Research Reserve.

The Reserve was based at the Bard College Field Station in Red Hook, NY, from 1985 through 2006 and still maintains a weather station at this site. Since 2007, the Reserve has been based at the Norrie Point Environmental Center in Staatsburg, NY. The center has a lab, classrooms, visitor center, and offices housing education, stewardship, research, and training staff.

The Reserve is the only National Estuarine Research Reserve in the state of New York and is one of a few reserves in NOAA's Virginian Biogeographic Region. The Reserve's four sites encompass 5,000 acres of freshwater, brackish tidal wetlands, and uplands spanning the middle 100 miles of the Hudson River estuary (Figure 1).

Conservation lands within the Reserve are owned by New York State, under the jurisdiction of the Department of Environmental Conservation (DEC); the Office of Parks, Recreation and Historic Preservation (Parks); the Office of General Services (OGS); and the Palisades Interstate Park Commission (PIPC). Each Reserve component site is administered by one or more land-owning agencies. DEC is the lead state agency for the Reserve, in collaboration with the other state agencies previously mentioned, and with jurisdiction over the lands within the four component sites and in partnership with NOAA. The Reserve is operated under a NOAA-DEC Memorandum of Understanding and this management plan.

Figure 1: Map of the Hudson River National Estuarine Research Reserve Sites



Purpose and Scope of Plan

The Hudson River National Estuarine Research Reserve Management Plan is the primary guidance document for the operation of the Hudson River Reserve's programs. It describes the Reserve's major programs, including objectives and strategies for the next five years. It seeks to address pressing coastal management issues, which closely mirror those of other NERRS, including climate change and its impacts on:

- coastal ecosystems and communities;
- development pressures and land use changes, especially in near-shore areas and floodplains;
- habitat fragmentation and degradation, including invasive species-caused declines in native biodiversity; and
- water quality degradation.

This plan updates the Reserve's previous management plan (Hudson River National Estuarine Research Reserve Revised Management Plan 2009–2014). In the last decade, the Hudson River Reserve has advanced important stewardship, science, training, and education objectives. This is a result of strong relationships with NOAA and other key partners, dedicated staff and agency colleagues, and successful pursuit of competitive grants. These efforts have added significant value and provided useful services, tools, and information to Hudson River communities, resource managers, consultants, educators, researchers, river commercial interests, and coastal managers. The Reserve has had a number of key achievements since the publication of the 2009–2014 plan and established or strengthened many partnerships with communities and organizations. Since 2009, the Reserve has:

- established climate change sentinel sites and a nationally accredited tide station;
- monitored river habitat changes;
- expanded citizen science programs;
- developed a Teachers on the Estuary program;
- partnered on significant habitat restorations;
- created new research collaborations to inform shoreline and tidal wetland management;
- shared information with coastal managers and decision-makers throughout New York and in other states;
- created a new information kiosk and interpretive trail; and
- helped partners acquire key inholdings of conservation lands.

Introduction to the Federal National Estuarine Research Reserve System

The National Estuarine Research Reserve System

The National Estuarine Research Reserve was created by the Coastal Zone Management Act of 1972, as amended (16 U.S.C. § 1461), to be a network of representative estuarine ecosystem areas suitable for long-term research, education, and stewardship. More than one million acres of estuarine lands and waters are currently included within the 29 federally designated national estuarine research reserves (Figure 2).

NERRS is administered by the Office for Coastal Management (OCM) of NOAA as a federal-state partnership. NOAA and coastal state partners collaborate to set common priorities and to develop system-wide programs. Additionally, NOAA provides support for state partners, and a national network of NERRS state partners carry out locally relevant and nationally significant programs at individual reserves and provide day-to-day management of resources and programs.

Figure 2: Map of the National Estuarine Research Reserve System

Individual national estuarine research reserves represent specific biogeographic regions of the United States. A biogeographic region is an area with similar plants, animals, and climate. There are 11 major biogeographic regions around the coast and 29 sub-regions. NERRS is designed to include sites representing all 29 biogeographic sub-regions, with additional sites representing different types of estuaries. NERRS currently represents 21 of those sub-regions. Each reserve implements education, research, and stewardship programs relevant to its biogeographic sub-region and to the state in which it is located.

The NERRS mission, as stated in the NERRS regulations, 15 C.F.R. § 921.1(a), 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. National Estuarine Research Reserves are established to provide opportunities for long-term research, education, and interpretation.*"

Federal regulations, 15 C.F.R. § 921.1(b), provide five specific goals for NERRS:

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.

Introduction to the Hudson River National Estuarine Research Reserve

Estuary Setting

The Hudson River estuary extends from the Federal Lock and Dam in Troy south to the Verrazano Narrows outside New York City. The estuary's surrounding watershed, known as the Hudson Valley, includes the tidal 153-mile 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 is 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 (SAV), constitute essential habitat that supports 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 NYS Department of State. DEC's

New York Natural Heritage Program has identified numerous sites where rare plant and animal species and exemplary natural communities occur. In the last 30 years, bald eagles have returned to nest and raise their young, and more recently, osprey have followed suit. The estuary also serves as an important resting and feeding area for other migratory birds such as osprey, a variety of songbirds, and waterfowl (Hudson River Estuary Program 2016).

Threats and Stressors

The Reserve's programs are intended to help address pressing coastal management issues. The following threats and stressors are significant concerns for the Reserve, and shape both site management and the program's goals, objectives, and activities.

Climate Change

The rate of sea level rise nearly tripled in the New York region in recent years, and is projected to increase for the foreseeable future, threatening the persistence of tidal wetlands (Horton et al. 2014). Also, the strength of tropical depressions is increasing with warming oceans, resulting in more powerful storms, larger storm surges, and heavier rainfall. The storm surges flood coastal communities, cause compaction of marsh surfaces, and deposit debris in tidal wetlands. Heavy rainfall causes significant erosion of sediments in watersheds. Prolonged pulses of high flows and high turbidity in streams and the estuary then damages stream habitats and submerged aquatic plant communities. However, sediments from these storms are deposited in tidal wetlands, helping with marsh surface accretion. Although natural debris such as uprooted trees supports vital ecological functions, human-created debris is a form of pollution.

Coastal Development

Development in the 500-year flood zone along the estuary removes lands that would otherwise be available as pathways for tidal wetland migration as sea level rises. Development in the watershed creates more impermeable surfaces, resulting in less infiltration and more runoff into streams. This may cause more downstream damage and flooding and imperil life and property. It is critical to identify and conserve pathways that maintain a continuum of future tidal wetlands as sea level rises (Tabak et al. 2016).

Communities at Risk

Human communities are at risk from storm waves and waterborne debris. Tidal wetlands and shorelines should be managed in balance with natural ecosystem needs to help buffer adjacent communities from storm impacts and other risks.

Introduction and Spread of Non-native and Invasive Species

The biodiversity and ecological functions of Hudson River habitats have been altered by the introduction and spread of non-native invasive plants, fish, and invertebrates into the watershed and estuary. These have resulted in significant ecological shifts, loss of native species and communities, and changes to recreational uses of the estuary. New introductions continue to occur, and, where these are invasive, they compound the problem.

Water Quality

Declines in water quality in tributaries and the estuary result from aging and overloaded wastewater infrastructure, combined stormwater and sewer overflows during heavy rains, and warming waters. These have the potential to affect both natural communities and human health.

Sites

Overview

The Reserve's 5,000 acres of freshwater and brackish tidal wetlands and uplands are distributed among four sites that span the middle 100 miles of the Hudson River estuary (Figure 1). From south to north, the sites are Piermont Marsh and Iona Island (Rockland County), Tivoli Bays (Dutchess County), and Stockport Flats (Columbia County). The Reserve sites are managed at the Norrie Point Environmental Center headquarters for the Reserve in Staatsburg, New York. The sections below introduce the national system's land acquisition policies, define the Hudson River Reserve's core and buffer areas, and provide short descriptions of the four Hudson River Reserve sites. (For more information about the sites, see Yozzo et al.'s 2005 *Ecological Profile of the Hudson River National Estuarine Research Reserve* https://coast.noaa.gov/data/docs/nerrs/Reserves_HUD_SiteProfile.pdf or visit the links provided within this section.)

National Estuarine Research Reserve System Acquisition Policies

Boundaries for NERRS sites 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" (15 C.F.R. § 921.11). These areas must be discrete enough to be effectively managed, but large enough to make long-term research possible. Key land and water areas ("core areas") are defined in 15 C.F.R. § 921.11(c)(3) as areas within the Reserve that are so vital to the functioning of the estuarine ecosystem that they must be under a level of control sufficient to ensure the long-term viability of the Reserve for research on natural processes. Core areas are those "critical estuarine ecological units of a natural estuarine system which preserves for research purposes 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 "should encompass resources representative of the total ecosystem, and which, if compromised, could endanger the research objectives of the Reserve" (15 C.F.R. § 921.11(c)(3)).

Core and Buffer Areas

All lands within a reserve must be designated either core or buffer areas, pursuant to federal guidelines. Within the Hudson River Reserve, core areas include all intertidal and subtidal lands. NOAA describes a reserve buffer zone as an area adjacent to or surrounding the core area, and upon which the integrity of the core depends. The reserve buffer zone 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, education, and, if consistent with Reserve protection, public access facilities. Within the Reserve, buffer lands include all upland areas above mean high tide.

Stockport Flats

Location, Key Features, and Land Ownership

Stockport Flats is a narrow, five-mile mosaic of several different landforms on the east side of the Hudson River, about 125 miles north of Manhattan. The site is in Columbia County and spans the towns of Stockport and Stuyvesant, mostly west of the east shore railroad line. Nearly all the 1,543-acre site is in New York State ownership, with a few private land inholdings (Figure 3).

From north to south, the site's primary geographic features are:

- Nutten Hook (a bedrock outcropping),
- Gay's Point and Stockport Middle Ground (dredge spoil features created during the deepening of the federal navigation channel in the early twentieth century),

- The mouth of Stockport Creek,
- The Stockport marshes, and
- Priming Hook (another dredge spoil feature).

Stockport Creek, one of the largest tributaries to the lower Hudson River, drains about 500 square miles. The average tide range at this freshwater site is 4.5 feet.

Natural Resources

The Stockport Flats site includes a variety of upland and wetland habitats that support significant and rare ecological communities of estuaries, including freshwater tidal swamp, freshwater tidal marsh, freshwater intertidal mudflats, freshwater intertidal shore, and freshwater subtidal aquatic bed (Edinger et al. 2014). Many rare plants and animals are found in these communities and elsewhere at the site. Rich floodplain forests and reforested dredge spoil deposits are bordered by vegetated tidal flats and shallows. At Stockport Middle Ground Island, sand cliffs are used by nesting belted kingfishers and bank swallows. Overall, the site is well used by diverse nesting, wintering, and migratory birds. Figure 4 depicts land cover at this site.

Special Designations

Stockport Flats includes, or is included in, several specially designated areas:

- The Scott Ice House at Nutten Hook is listed on both the New York State and National Registers of Historic Places. The large icehouse barn and modest caretaker's house have been preserved. A Scenic Hudson Land Trust conservation easement protects the ice house and an access lane from Route 9J.
- The Hudson River Islands State Park lies wholly within the Stockport boundary. It has been managed in accordance with New York State Parks, Recreation and Historic Preservation's (Parks) *Hudson River Islands State Park Interim Management Guide*. For more information, see https://parks.ny.gov/parks/98/details.aspx.
- New York Audubon designated the Stockport Flats as an 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. For more information, see https://www.audubon.org/important-bird-areas/stockport-flats.
- The Stockport Creek and Flats Significant Coastal Fish and Wildlife Habitat, designated by the New York State Department of State (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 the tidal Stockport Creek. It is characterized as a high-diversity habitat of excellent quality that has experienced limited disturbance. See https://www.dos.ny.gov/opd/programs/consistency/Habitats/HudsonRiver/Stockport_Creek_and_Flats_and_Marsh_FINAL.pdf.

Stockport Flats is part of the Columbia-Greene North Scenic Area of Statewide Significance, which is also designated by DOS. See https://www.dos.ny.gov/opd/programs/consistency/scenicass.html.

Figure 3: Land Ownership at Stockport Flats

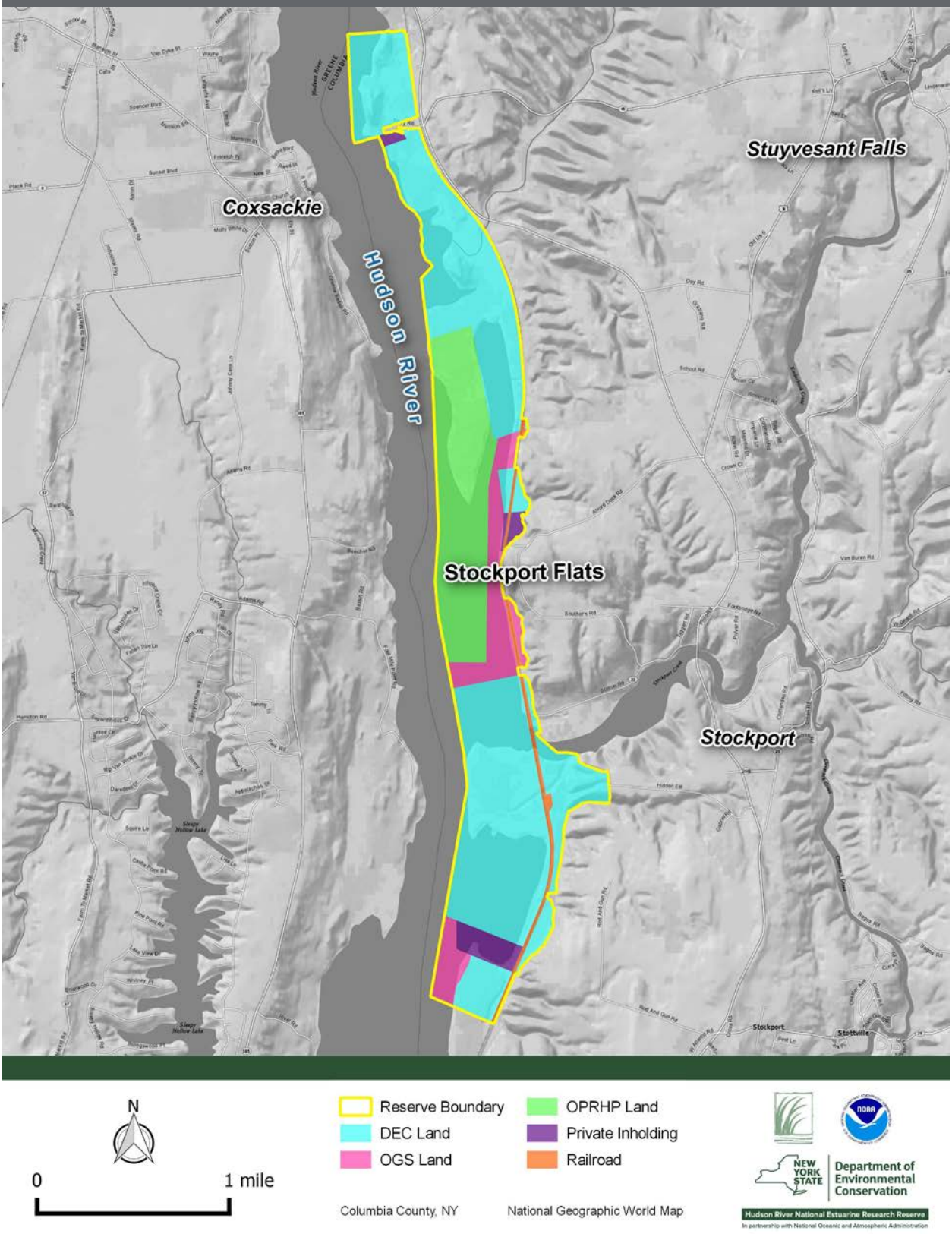
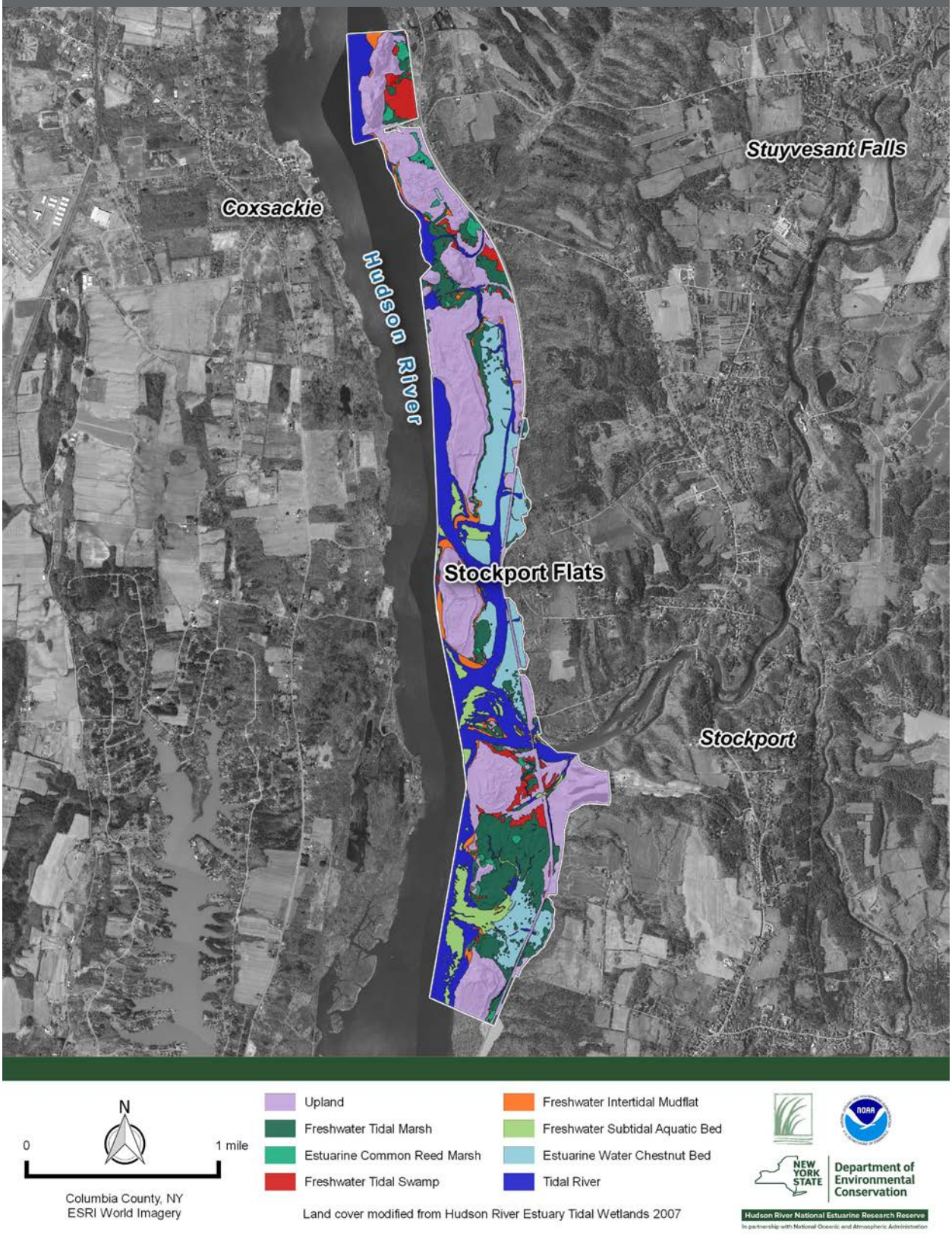


Figure 4: Land Cover at Stockport Flats



Tivoli Bays

Location, Key Features, and Land Ownership

The Tivoli Bays site spans two miles of the eastern shore of the Hudson River in the Dutchess County Town of Red Hook, between the villages of Tivoli and Barrytown. This site is managed by DEC as the Tivoli Bays Wildlife Management Area, the Tivoli Bays State Nature and Historical Preserve, and as part of the Reserve. The entire site, except for two conservation easements, is under the jurisdiction of DEC (Figure 5). The 1,722-acre site is dominated by two large river coves partially separated from the main river by a north-south railroad causeway that has five openings to connect the bays to the river. To the west lie Cruger and Magdalen Islands and extensive vegetated shallows that border the Hudson River channel. To the east, the coves are surrounded by wooded clay bluffs and forested uplands and fields.

Two main tributaries feed into the bays. Stony Creek drains 22.2 square miles into Tivoli North Bay, and the Saw Kill has a watershed of similar size draining into Tivoli South Bay. This freshwater site has an average tide range of 3.9 feet.

Natural Resources

Tivoli Bays has exceptional tidal freshwater wetlands that encompass significant and rare ecological communities, including:

- Freshwater tidal swamp,
- Freshwater tidal marsh,
- Freshwater intertidal mudflats,
- Freshwater intertidal shore, and
- Freshwater subtidal aquatic beds.

Many rare plants and animals are found in these communities and elsewhere at the site. The site is well used by diverse bird species for nesting, wintering, and migration; and by several species of turtles, among many other forms of wildlife. Figure 6 depicts land cover at this site.

Special Designations

Tivoli Bays has several special designations.

- 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. New York Audubon designated it as the Tivoli Bays Important Bird Area, based on the documented occurrence of several breeding marsh species. DEC designated it 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 stop-over habitat for many songbirds. See https://www.audubon.org/important-bird-areas/tivoli-bays https://www.dec.ny.gov/animals/32051.html.
- Tivoli Bays is part of the North and South Tivoli Bays Significant Coastal Fish and Wildlife Habitat, designated by DOS. As a large mosaic of freshwater tidal habitats, including shallows, lower marsh, upper marsh, tidal swamp forest, rocky shore, and tidal creek, it is important to a variety of fish, turtles, birds, and mammals. See https://www.dos.ny.gov/opd/programs/consistency/Habitats/HudsonRiver/North_and_South_Tivoli_Bays_FINAL.pdf.
- In 2007, on the 25th anniversary of the Reserve, the Tivoli Bays Natural Heritage Area was the first Natural Heritage Area designated in New York State, making the protection of rare plants, fauna, and natural habitats a key management priority of the site. For more information, see https://www.dec.ny.gov/animals/36997.html.

- Tivoli Bays is part of the Estates District Scenic Area of Statewide Significance, designated by the DOS. It is recognized as an “unspoiled landscape of marsh and islands, offering extensive views of the Hudson and western shore.” Tivoli Bays is also in the Mid-Hudson Historic Shorelands Scenic District, https://www.dos.ny.gov/opd/programs/consistency/scenicass.html.
- Tivoli Bays is part of the Hudson River National Historic Landmark District, and in the Sixteen Mile Historic District, listed in the National and State Registers of Historic Places. Most estates in this corridor belonged to the Livingston family.

Figure 5: Land Ownership at Tivoli Bays

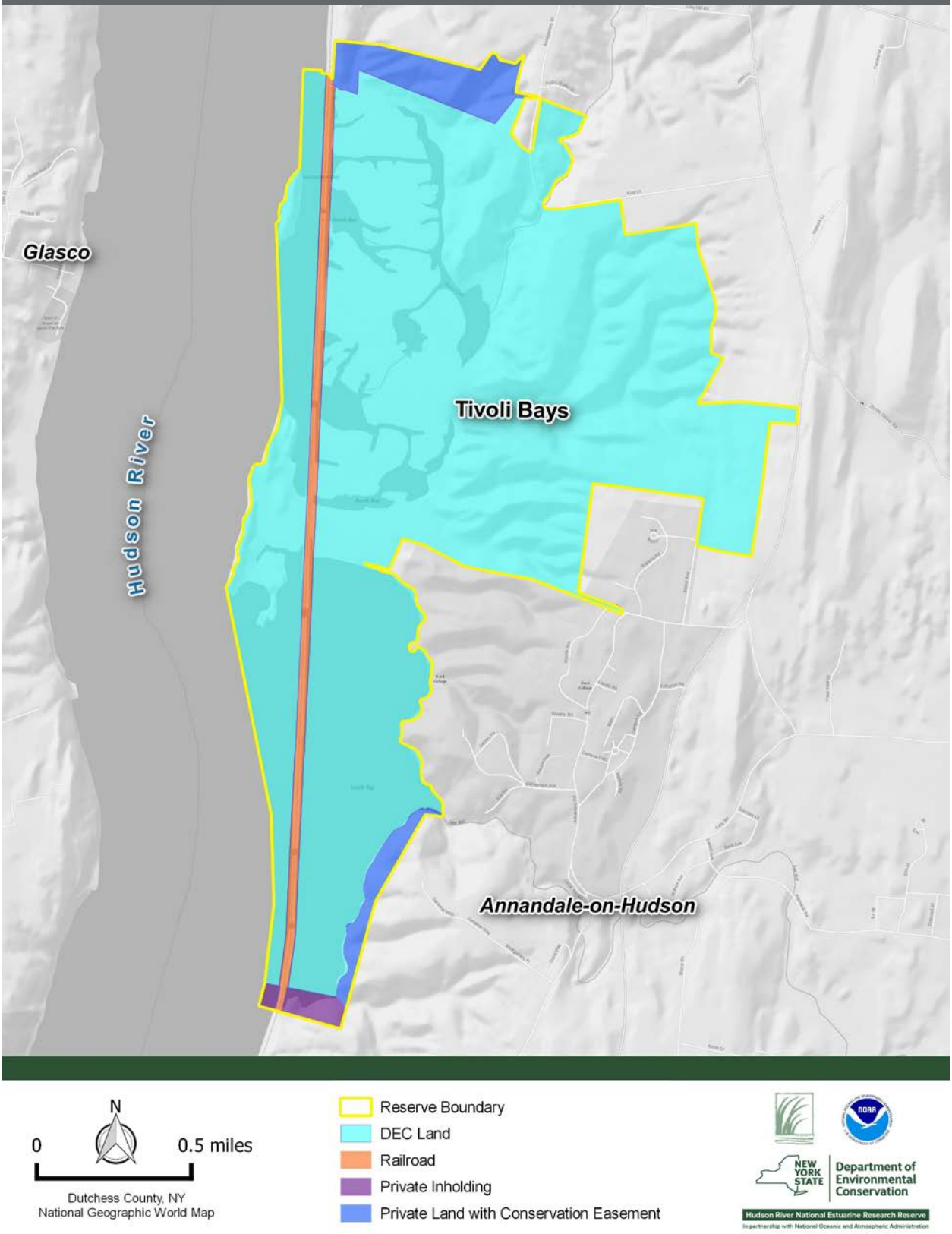
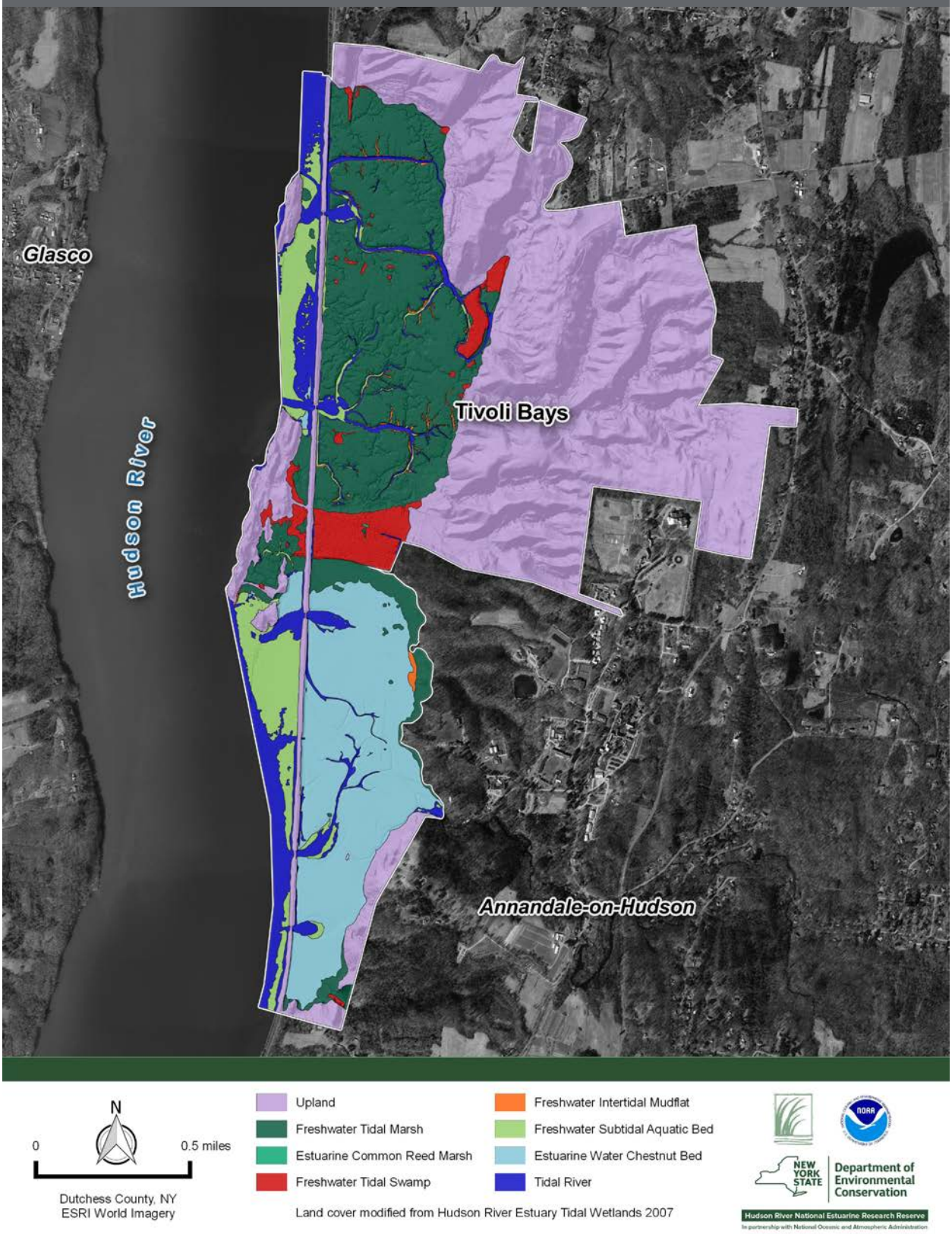


Figure 6: Land Cover at Tivoli Bays



Iona Island

Location, Key Features, and Land Ownership

Iona Island is in the Town of Stony Point in Rockland County, six miles south of West Point. The 556-acre site is in Bear Mountain State Park, part of the Palisades Interstate Park System under the jurisdiction of PIPC (Figure 7). Iona Island is a bedrock island in the Hudson Highlands bordered to the west by:

- Salisbury and Ring Meadows – 270 acres of tidal marshes;
- The mouth of Doodletown Brook – a high-gradient freshwater stream that drains a small, forested watershed; and
- Doodletown Bight – an expanse of shallows and mudflats.

Round Island was attached to the south end of Iona Island with fill in the early twentieth 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: 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.

Natural Resources

Iona Island's tidal wetlands are predominantly freshwater, but they experience slightly brackish conditions, especially in dry summer months. This site has significant and rare ecological communities, including freshwater tidal marsh, freshwater intertidal mudflat, freshwater intertidal shore, and freshwater subtidal aquatic bed. Over the last decade, a phased, carefully executed habitat restoration program reduced the coverage of *Phragmites australis*, an invasive plant. Since then, there has been a remarkable resurgence of native species of both plants (especially cattail, Typha spp.) and animals. The site is well used by diverse nesting, wintering, and migratory birds, and several species of turtles, among many other species of wildlife. Figure 8 depicts land cover at Iona Island.

Special Designations

Iona Island has several 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 the Iona Island Bird Sanctuary in 1947 by the PIPC 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 NYS Parks as the Iona Island/Doodletown Bird Conservation Area in 1998 for its habitat for eagles and migratory birds. See https://www.audubon.org/important-bird-areas/doodletown-and-iona-island and https://www.dec.ny.gov/animals/30779.html.
- The marshes included in the Iona Island Reserve site are part of the Iona Island Marsh Significant Coastal Fish and Wildlife Habitat, designated by 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 birds and other birds. It is a highly diverse habitat of excellent quality that has experienced modest disturbance. See https://www.dos.ny.gov/opd/programs/consistency/Habitats/HudsonRiver/Iona_Island_Marsh_FINAL.pdf.
- Iona Island is a National Natural Landmark designated by the National Park Service. See https://www.nps.gov/subjects/nnlandmarks/state.htm?State=NY.

- Iona Island is part of the Hudson Highlands Scenic Area of Statewide Significance, designated by 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 designated a scenic road under Article 49 of the Environmental Conservation Law (ECL 49-0205). See https://www.dos.ny.gov/opd/programs/consistency/scenicass.html.

Other Issues

For the first half of the twentieth century, the Iona Island Naval Ammunition Depot assembled and shipped arms for both world wars in over a hundred buildings. Because of the risk of residual contamination from these operations, the United States Army Corps of Engineers (USACE) investigated the site under the Defense Environmental Restoration Program in 2007–2008, focusing on 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 contaminant of potential concern (COPC). Antimony, copper, and lead exceeded background surface soil concentrations and ecological screening criteria and were labeled contaminants of potential ecological concern (COPEC). A contaminant of potential ecological concern is generally a contaminant which may cause adverse effects to the plants and animals at a site. The sediment samples showed that antimony and lead were COPCs 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 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 7: Land Ownership at Iona Island

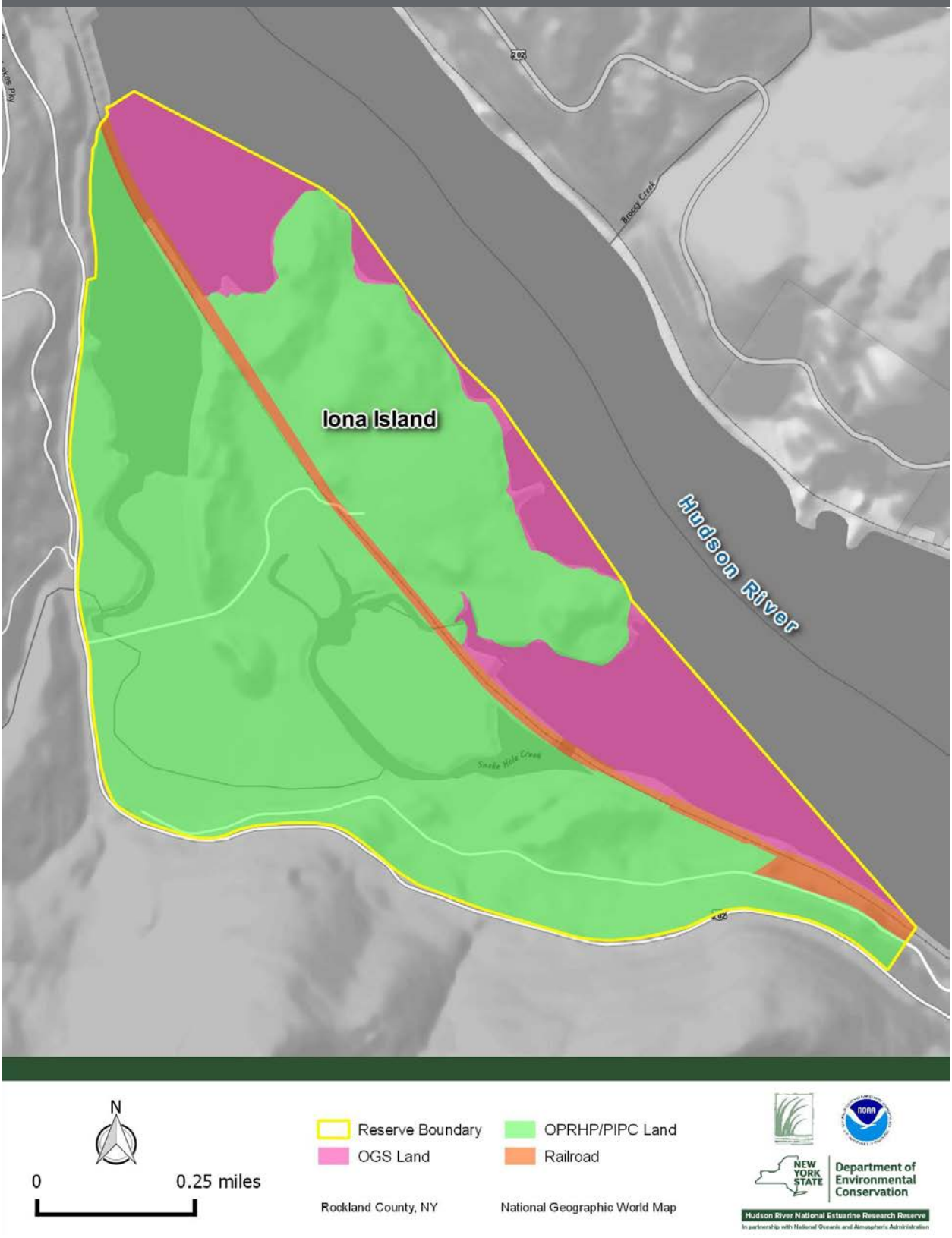
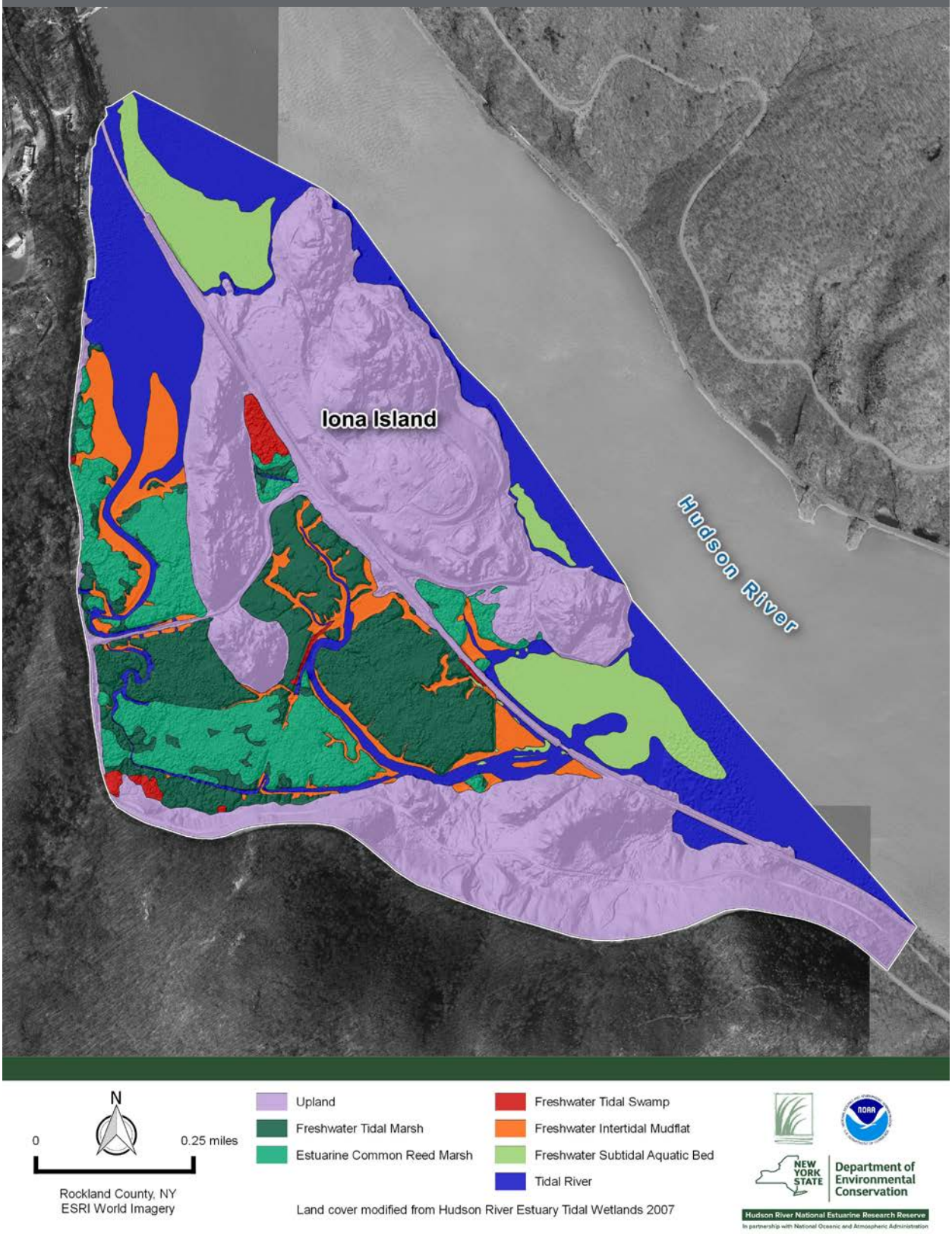


Figure 8: Land Cover at Iona Island



Piermont Marsh

A detailed draft site management plan prepared for Piermont Marsh (DEC 2017) provides considerably more detail than what appears below.

Location, Key Features, and Land Ownership

The Piermont Marsh Reserve hugs the base of Tallman Mountain along the west shore of the Tappan Zee, one of the widest sections of the tidal Hudson River. The marsh extends more than 1.5 miles below Piermont Pier in Rockland County. The salinity ranges from freshwater to brackish (0–12 ppt), and the average tide range is 3.2 feet. Piermont Marsh is bordered on the north by Piermont Pier and on the west by the cliffs, talus, and forested slopes of the Palisades Ridge. Sparkill Creek drains 11.1 square miles of a predominantly urban watershed and discharges into the north end of the marsh. A few well-defined but relatively shallow tidal creeks traverse the marsh. Extensive shallows border the east side of the marsh. This Reserve site is under state jurisdiction, most of it within the boundaries of Tallman Mountain State Park. Figure 9 depicts land ownership at Piermont Marsh.

Natural Resources and Community Setting

The site's 1,030 acres include the estuary's largest brackish tidal marsh, a broad swath of adjacent shallows, and small areas of upland in the Village of Piermont. Given its proximity, the marsh provides a range of vital services to the village, including protection of nearby homes and businesses from waves and storm debris (Village of Piermont 2014). The marsh and shallow-water habitats are regionally rare, ecologically significant, and were historically home to a host of specially adapted plants and animals. Figure 10 depicts land cover at Piermont Marsh.

Special Designations

Piermont Marsh is designated the Piermont Marsh Significant Coastal Fish and Wildlife Habitat by DOS. The designation recognizes its extensive brackish tidal marsh bordered by shallows and mudflats, which are important for resident, breeding, and migratory birds and a host of other vertebrates and invertebrates. See https://www.dos.ny.gov/opd/programs/consistency/Habitats/HudsonRiver/Piermont_Marsh_FINAL.pdf.

Other Issues

The largest wooded area within the Reserve occurs on the east side of Rittenberg Field along Ferry Road. It was formerly brackish tidal marsh before being used as a municipal waste landfill in the mid-twentieth century. The landfill has since revegetated and supports an open canopy of eastern cottonwood and other tree species adept at colonizing disturbed soils and high-light environments. Given the shallow substrate, many of the canopy trees have been uprooted during wind storms and remain on the ground. The understory is a dense tangle of non-native and ruderal (growing in waste places or on disturbed land) species, including Japanese knotweed, Asiatic bittersweet, poison ivy, and grape. In addition to providing limited habitat value for wildlife, the presence of inorganic refuse, including discarded automobiles, large appliances, and mechanical parts, creates a potential hazard for public access and recreation.

Figure 9: Land Ownership at Piermont Marsh

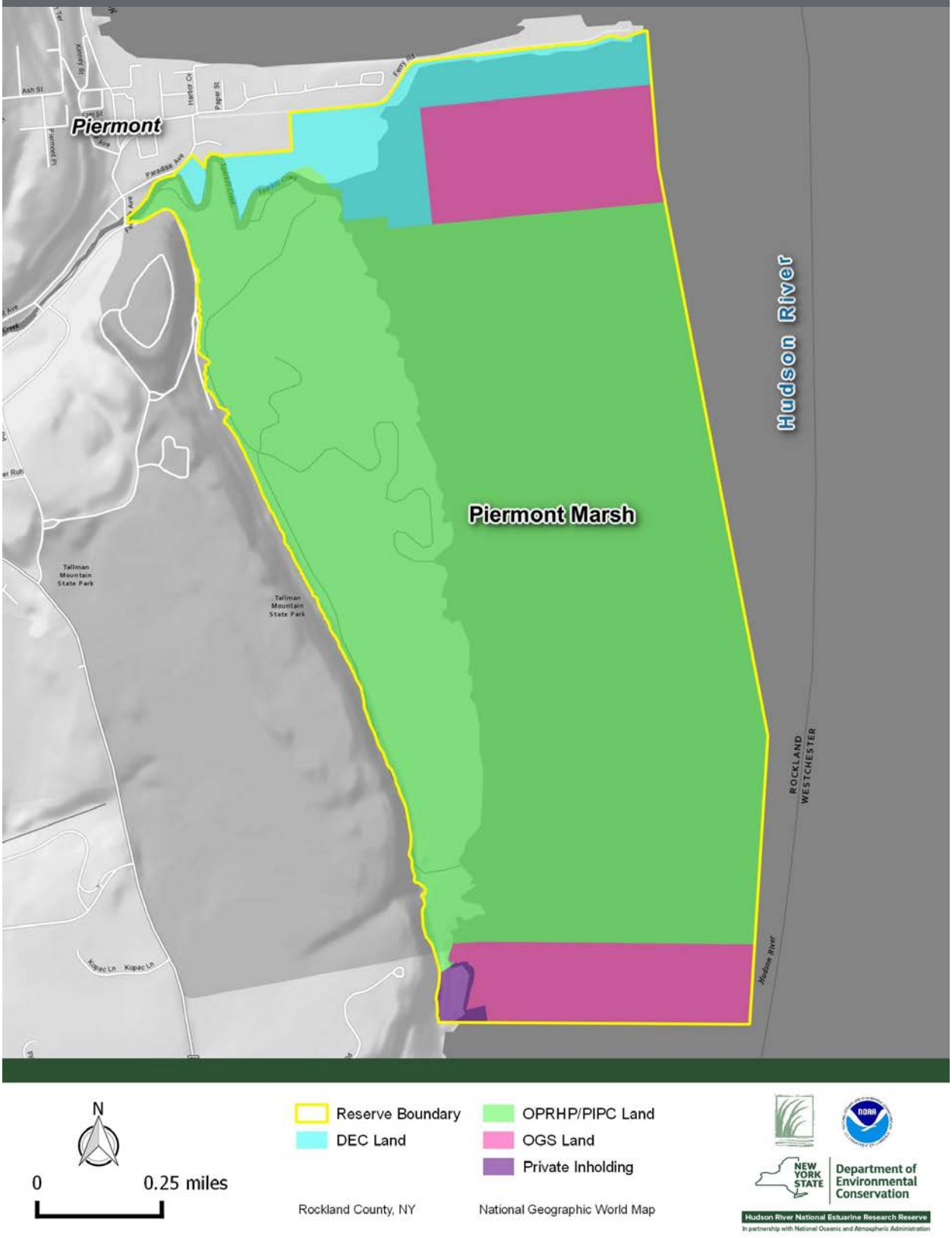
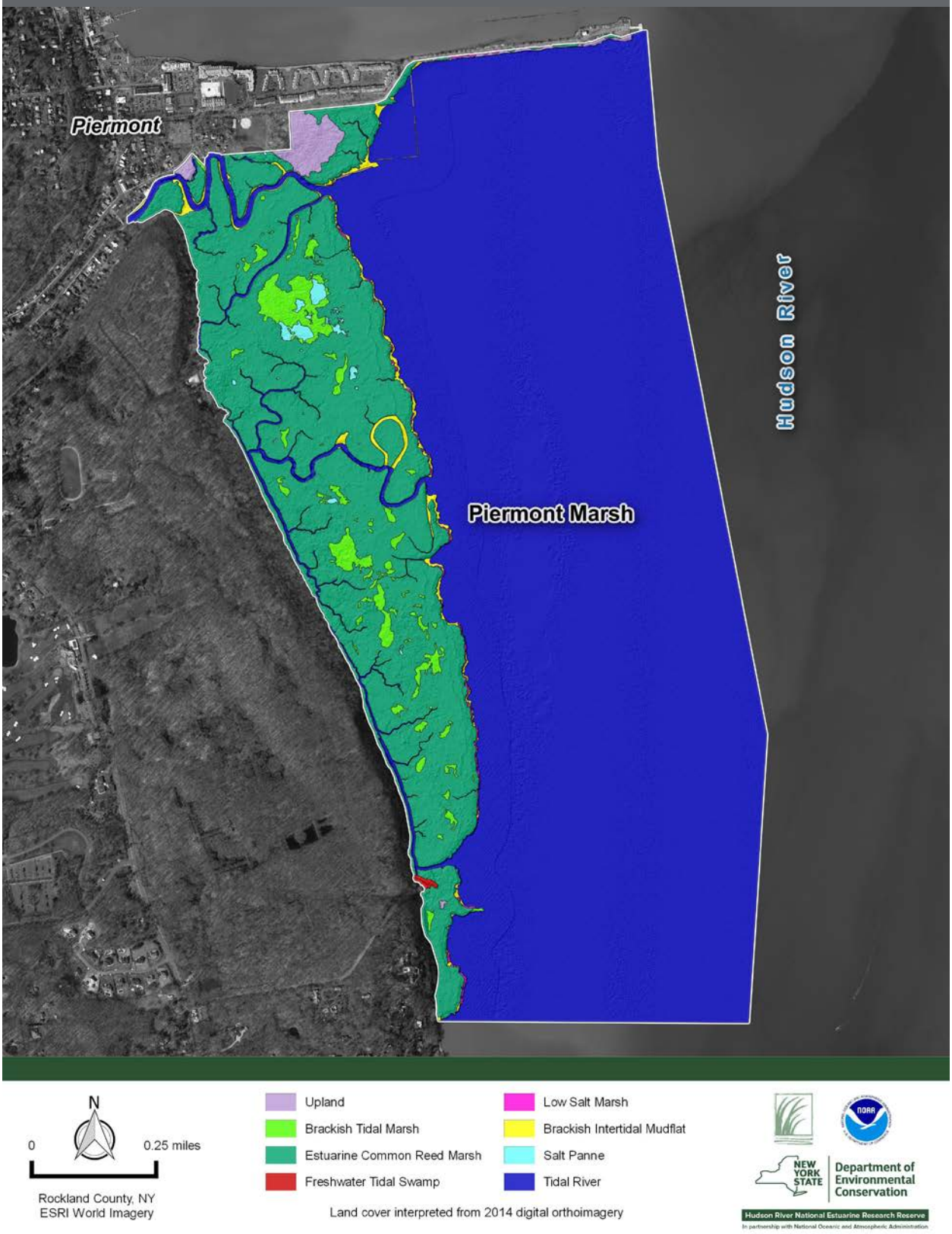


Figure 10: Land Cover at Piermont Marsh



Strategic Plan

Vision

Reserve sites are used as platforms for high-quality research and education, as well as recreational and inspirational experiences. Networked Reserve programs contribute to resilient and sustainable Hudson River habitats, a vital estuary ecosystem, and informed decision makers.

Mission

Improve the health and resilience of the Hudson River estuary by conserving estuarine habitats through integrated education, training, stewardship, restoration, monitoring, and research programs.

Programmatic Goals

1. Reserve science enhances understanding of the Hudson River estuary ecosystem, and the results of research are conveyed to decision makers to meet management needs and support resilient habitats and communities.
2. Resource managers have enhanced capacity to protect, manage, and restore floodplain, shoreline, and river habitats.
3. People of the Hudson Valley appreciate the estuary and the multitude of benefits it provides, understand how to responsibly enjoy and use the river, and engage in multiple levels of stewardship to sustain these resources.
4. Hudson River Reserve sites are models for restoration and stewardship that foster understanding of ecological connections among land, water, and people.

Operational Goals

The Hudson River Reserve maintains a collaborative and collegial work environment, and values and recognizes personal contributions of staff and volunteers that enrich both the individual and the organization.

The organization has sufficient operational capacity, a strong financial foundation, and sufficient facilities to support programmatic goals.

People who live along the Hudson River and within its watersheds know and appreciate the Reserve's role in advancing stewardship through science, education, and conservation.

Core Practices

The Reserve is committed to the following core practices in its work:

- Engaging local communities and citizens to improve stewardship of estuary resources;
- Understanding stakeholder needs and seeking meaningful partnerships to guide program planning and implementation;
- Using collaborative approaches to address complex estuary issues;
- Integrating staff activities to maximize the transfer of research and monitoring to inform decision making and community-based stewardship;
- Aligning with the Hudson River Estuary Program and other programs to promote stewardship of the Hudson River estuary;
- Informing decision-making in the Mid-Atlantic and North Atlantic where appropriate through collaborations with other NERRs; and
- Leading by example through innovating, testing, and applying best management practices.

Reserve Objectives

Administrative Objectives

Objective 1

The Reserve staff and financial resources are sufficient to administer and effectively deliver 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.

Objective 3

Reserve staff have the tools, training, and resources to safely complete their job requirements while working at the Norrie Point Environmental Center and in the field.

Facilities and Construction Objectives

Objective 1

Maintain a safe, welcoming, accessible, functional, and green campus at the Norrie Point Environmental Center.

Objective 2

Maintain and work with partners to manage Reserve site facilities, including car-top boat launches, floating docks, visitor amenities, marsh overlooks, picnic pavilions, boardwalks, and kiosks.

Objective 3

Improve the sustainability of Reserve sites and facilities.

Public Access Objectives

Objective 1

Provide access for scientific research, environmental education, outdoor recreation, and public events while ensuring the protection of the Reserve's natural resources.

Objective 2

Visitor impacts are managed on Reserve lands.

Education Program Objectives

Objective 1

Teachers and educators in kindergarten through college settings will expand their own estuary literacy and curriculum applications through a wide range of professional development, place-based lesson plans, and online multimedia resources.

Objective 2

Students gain environmental literacy through active participation in a wide range of educational offerings based on the foundation principles of the NERRS K–12 Estuary Education Program (KEEP).

Objective 3

Community members, families, and informal visitors learn about their estuary through a range of Reserve-sponsored field programs, presentations, facilities, and online resources.

Estuary Training Program Objectives

Objective 1

Decision makers understand science, regulations, and policy to better protect, manage, and restore shoreline and river habitats under present and future conditions.

Objective 2

Collaborative efforts within New York State and NERRS are supported by the Estuary Training Program (ETP) to foster ecosystem resilience in a changing climate.

Research and Monitoring Program Objectives

Objective 1

Hudson River Reserve and regional estuarine habitat management needs are identified and met through partner collaborations and the dissemination of scientific research and data products.

Objective 2

Hudson River researchers and resource managers better understand long-term trends and short-term variability through the Reserve's continuous monitoring of abiotic parameters and analysis of time-series data.

Objective 3

Hudson River researchers and resource managers better understand the impacts of climate change on Reserve estuarine habitats.

Objective 4

Tidal wetland and submerged aquatic vegetation habitat location, distribution, and change over time are documented by remote sensing and field observations.

Objective 5

Hudson River research by students and visiting scientists is well supported.

Stewardship and Restoration Objectives

Objective 1

Reserve lands are adaptively managed to conserve rare species and sustain biodiversity and critical ecosystem functions while providing opportunities for research, education, and recreation.

Objective 2

Regional stewardship and restoration initiatives and plans are supported to encourage a watershed approach to environmental management.

Objective 3

Reserve tidal wetlands are resilient, and, where feasible and appropriate, migration pathways are conserved or created by improving tidal connectivity.

Objective 4

The Reserve's restoration science, demonstration, and pilot projects; adaptive management; and stewardship inform regional restoration and natural resource management and resilience planning.

Land Acquisition Objectives

Objective 1

New York State acquires remaining private inholdings in the Reserve and transfers OGS lands within the current Reserve boundary to DEC or Parks.

Objective 2

DEC staff develop a plan to expand Reserve boundaries to ensure effective conservation of representative ecological areas, especially given sea level rise and other climate change impacts.

Administrative Plan

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.

Organizational Framework

Interagency and partner collaboration is an essential underpinning of effective Reserve operations, beginning with New York's partnership with NOAA to operate the Reserve. Administration of the Reserve is both enriched and complicated by the fact that it consists of four component sites and a fifth headquarters site, the Norrie Point Environmental Center. These five sites are administered by combinations of three different public state agencies with several regional and park offices playing a role. The Reserve also relies on strategic partners who support staff and programs, administer NOAA grants, or co-manage facilities.

NOAA – New York State Partnership

The mutual commitment of DEC and NOAA to long-term operation of the Reserve is described in a Memorandum of Understanding (Appendix 1), which sets state and federal agency roles and mutual expectations regarding management and operation of the Reserve. This appendix is updated every decade and will next be updated in 2029.

New York State Five Agency Partnership

The management structure for the Reserve was established in a 1982 Memorandum of Understanding among the five involved state agencies (Appendix 2). It established multilateral intent to support and implement the Reserve program and common policies for management of lands in the Reserve. In addition to DEC, the state partners include Parks, DOS, OGS, and PIPC.

New York State Department of Environmental Conservation – Lead Agency

DEC's mission is to conserve, improve, and protect New York's natural resources and environment and to prevent, abate, and control water, land, and air pollution to enhance the health, safety, and welfare of the people of the state and their overall economic and social well-being. DEC is the lead state agency for the Reserve, the principal state contact with NOAA for the Reserve program, and the recipient agency for NOAA capital, land acquisition, and operations financial assistance awards.

DEC:

- Hires and directs Reserve staff
- Carries out Reserve programs in education, research and monitoring, resource protection, stewardship, restoration, 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
- Reviews management plan policies

DEC staff from the Divisions of Marine Resources, Fish and Wildlife, and Lands and Forests co-manage the DEC-owned component sites within the Research Reserve. DEC participates in the development and implementation of management plans and manages land under its jurisdiction in conformance with these plans. DEC 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.

DEC actions undertaken within New York's coastal zone area must be consistent with state coastal management policies.

New York State Office of Parks, Recreation and Historic Preservation

The mission of Parks is to provide safe and enjoyable recreational and interpretive opportunities for all New York State residents and visitors and to be responsible stewards of our valuable natural, historic, and cultural resources. Stockport Flats contains the Hudson River Islands State Park, which is operated out of Parks' Saratoga-Capital District Region. The New York State portions of the Palisades Interstate Park are recognized as a region of Parks, and includes all of Iona Island, within the Bear Mountain State Park, and 90 percent of Piermont Marsh, within Tallman Mountain State Park. In addition, the Reserve headquarters is the Norrie Point Environmental Center, a Parks building within the Margaret Lewis Norrie State Park in Parks' Taconic Region. It is operated under the terms of an agreement that appears in Appendix 3.

Palisades Interstate Park Commission

PIPC oversees management of more than 100,000 acres of park lands in New York and New Jersey under the terms of an interstate compact approved by the two states and Congress in the early twentieth century. PIPC lands within New York State function as a region of Parks. All of Iona Island within the Bear Mountain State Park and 90% of Piermont Marsh, within Tallman Mountain State Park, are under the jurisdiction of Parks and PIPC.

New York State Office of General Services

The OGS Bureau of Land Management is responsible for the disposition of state surplus real property and underwater lands. Some areas of underwater and formerly underwater lands within the Reserve are under the jurisdiction of OGS, although others have been transferred to DEC and Parks for administration.

New York State Department of State

As the administrator of the state coastal management program, DOS was a signatory to the original 1982 Memorandum of Understanding. Although DOS does not own land in the Reserve, its Office of Planning and Development supports the Reserve through its consistency and local planning programs. DOS also administers the NOAA Coastal and Estuarine Land Conservation Program, which previously funded acquisition of ecologically important lands within the Reserve.

Key Administrative Partners

DEC Hudson River Estuary Program

A key feature of the Reserve's organizational landscape is the DEC Hudson River Estuary Program (Estuary Program), a unique regional partnership leading the restoration of the Hudson River through implementation of the *Hudson River Estuary Action Agenda 2015–2020*. Through its Action Agenda, grants to communities, and partnerships, the Estuary Program seeks to address the priorities of:

- Clean Water
- Resilient Communities
- Vital Estuary Ecosystem
- Estuary Fish, Wildlife and Habitats
- Natural Scenery
- Education, River Access, Recreation and Inspiration

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 Estuary Action Agenda 2015–2020*, 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
- Waterfront revitalization

The Estuary Program funds 3.5 full-time contractual positions and 3 interns, and the Reserve supervises the work of these staff. These and other federally funded Reserve contract staff positions are administered under Estuary Program and Reserve contracts with either the Cornell University Water Resources Institute or the New England Interstate Water Pollution Control Commission (NEIWPCC).

Greenway Conservancy for the Hudson River Valley

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 two decades, 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.

New England Interstate Water Pollution Control Commission

NEIWPCC has been an important administrative partner to the Reserve. NEIWPCC 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 NEIWPCC employees through contracts with DEC, administered by either the Estuary Program or the Reserve.

Natural Heritage Trust

The Natural Heritage Trust (NHT) was established statutorily in 1968 as a public benefit corporation of the State of New York. Its mission is to receive and administer gifts, grants, and contributions to further public programs for parks, recreation, cultural, land and water conservation, and historic preservation purposes of the State of New York. NHT supports the Reserve by administering funds that support a habitat restoration biologist at the Reserve.

Operation Funding

Civil service and contractual staff are funded by annual NOAA operations grants, the New York State General Fund, and the New York State Environmental Protection Fund (EPF) (contractors only). Norrie Point Environmental Center operations are funded by NOAA operations and EPF funds. The Reserve relies on state funding (e.g., general fund, environmental protection fund, invasive species management funds) and state resources (e.g., staff of DEC's Division of Operations and Division of Marine Resources) to operate DEC-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, Parks' Saratoga-Capital District Region); Iona Island (Bear Mountain State Park, Parks' Palisades Region); and Piermont Marsh (Tallman Mountain State Park, Parks' Palisades Region). Reserve research and monitoring is funded by a mixture of NOAA, EPF, and competitively awarded research funds.

Staff and Volunteers

Staff

The Reserve is staffed by talented individuals with diverse training and experience that equip them to plan, operate, and deliver effective education, training, stewardship, restoration, research, and monitoring programs. Staff positions, status, and funding are listed in Table 1.

Staff Needs

An adequate Reserve staff is essential to implement the management plan and to achieve the Reserve's program objectives. In April 2018, the Reserve staff included 13 permanent positions. Funding for Reserve staff is secured through annual federal and state funding sources. The Reserve will continue to seek NOAA operations funding and state funds to support several professional staff. The Reserve will also continue its relationship with the Estuary Program for support of selected technical staff and Student Conservation Association (SCA) interns. The Reserve will also seek to convert federally funded core Reserve positions into state-funded positions as opportunities arise.

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 or participate in all safety trainings offered.

Table 1: Hudson River NERR Staff	
Title	**Status, funding source, and duties**
Manager	Full-time state civil service employee funded by NYS General Fund; manages all Reserve staff and programming, Norrie Point Environmental Center, and marine habitat programs in DEC Regions 3 and 4.
Reserve Program Coordinator	Full-time NEIWPCC contract employee funded by EPF; administers Reserve grants and contracts, coordinates management of Reserve sites and Norrie Point operations.
Education Coordinator	Full-time Cornell University contract employee funded by EPF and Coastal Zone Management Act (CZMA) funds; jointly appointed to the Reserve and Hudson River Estuary Program to manage education staff, programs, and facilities.
Research Coordinator	Full-time NEIWPCC contract employee funded by CZMA; manages research and monitoring staff, programs, and facilities.
Estuary Training Coordinator	Full-time NEIWPCC contract employee funded by CZMA; manages ETP staff and programming, supports NERRS Science Collaborative projects, and provides technical assistance on habitat and resilience topics.
Habitat Restoration Coordinator	Full-time NEIWPCC contract employee funded by EPF; implements Hudson River habitat restoration programs and projects for Hudson River Estuary Program, in partnership with the Reserve.
Stewardship Coordinator/ Restoration Biologist	Full-time Natural Heritage Trust contract employee funded by NYS Thruway Authority; manages and implements habitat restoration mitigation projects in and near the Reserve.
Marine Biologist	Full-time state civil service employee funded by NYS General Fund; reviews projects for impacts on marine habitats and provides technical assistance.
Benthic Mapping Coordinator	Part-time NEIWPCC contract employee funded by EPF; coordinates benthic mapping projects, provides technical assistance on mapping; and manages data requests.
Science Educator	Full-time NEIWPCC contract employee funded by CZMA; implements Reserve citizen science and education programs.
Education Specialist	Part-time NEIWPCC contract employee funded by CZMA; conducts public education programs.
Research Assistant	Full-time NEIWPCC contract employee funded by CZMA; implements System-Wide Monitoring Program (SWMP).
SWMP Technician	Full-time NEIWPCC contract employee funded by CZMA; supports all SWMP monitoring activities.
SCA Interns (3)	Full-time, 10-month SCA interns funded by EPF; assist with education and estuary training programs.

Administrative Structure and Organizational Charts

DEC operates as a matrix of natural resource and environmental programs with staff who are either part of the central office or in one of the nine geographic regions. A chart of executive staff (central office) is viewable at https://www.dec.ny.gov/docs/administration_pdf/execorgchart.pdf.

For an overview of the DEC Statewide offices please see https://www.dec.ny.gov/about/558.html.

The Reserve is managed as a regional program under the Office of Natural Resources. Within the Office of Natural Resources, the Reserve is housed in and receives broad programmatic guidance, support for two positions, and modest additional funding from the Division of Marine Resources. Within the Division, the Reserve is in the Bureau of Marine Habitat. The mission of the Division of Marine Resources is to manage and maintain the state's living marine, estuarine, and

anadromous resources, and to protect and enhance the habitat upon which these resources depend, in order to ensure that diverse and self-sustaining populations of these resources are available for future generations.

The Reserve manager reports to DEC's Regional Natural Resources Supervisor in Region 3, based in New Paltz, NY, who reports to the Region 3 Director. Three Reserve sites are within DEC Region 3 (Piermont Marsh, Iona Island and Tivoli Bays). The fourth Reserve site is in Region 4 (Stockport Flats).

The administrative structure and oversight for the Reserve are depicted in the DEC Region 3 Natural Resources program organizational chart in Appendix 4.

Volunteers

Volunteers play an important role in selected Reserve programs. The Reserve principally works with volunteers on citizen science programs, especially the glass eel monitoring project. The Reserve will evaluate the existing and potential role of volunteers in supporting Reserve operations and assess whether a more formalized volunteer program is feasible or desirable.

Advisory Committees

Advisory committees and interagency partner meetings enable the Reserve to coordinate with key partners, ensure good inter- and intra-agency communication, and enhance collaboration on site management and program delivery.

Reserve Site Management Partnership Meetings

The Reserve will convene separate telephone or in-person meetings of management partners for the four Reserve sites and Norrie Point Environmental Center at least once a year, and more frequently as needed. Reserve staff will participate in site management planning activities at each Reserve site and involve appropriate partner agency staff in DEC site management activities. Reserve staff will meet regularly with the Parks Taconic Region and/or Mills Norrie State Park staff regarding Norrie Point management.

Estuary Training Program Advisory Committee

The committee's roles and responsibilities include providing program guidance and vision, reviewing of program-scale strategic Estuary Training Program (ETP) documents, and providing internal policy and program recommendations. Members help with communication and coordination between partners and help guide the program. Meetings are held at least once a year. The committee is made up of the Reserve Manager and representatives from Sea Grant, the coastal zone agency (DOS Office of Planning and Development), DEC's Hudson River Estuary Program, and DEC's Division of Fish and Wildlife.

Education Program Advisory Committee

Reserve education staff will form an advisory committee composed of formal and informal educators to meet semi-annually to review, evaluate, and adapt objectives and strategies for making regional progress in elevating estuary literacy.

Research Advisory Committee

Reserve research staff will periodically assemble ad hoc research advisory committees composed of scientists and resource managers to meet specific needs as they arise, for instance, to advise on baseline monitoring needs for a restoration project or to develop a collaborative research project.

Vessels and Vehicles

The Reserve maintains a fleet of:

- 16 canoes stored on two trailers,
- A 21-foot Boston whaler (2001) and trailer,
- A 16-foot skiff (2001) and trailer,
- A 21-foot electro-fishing boat (2002),
- An amphibious all-terrain vehicle (2015) and trailer, and
- 3 trucks (2002, 2005, 2008).

These are carefully maintained; however, several are nearing the end of their safe and reliable lifespans and will need to be replaced during the next five years. This is especially true of the whaler, which is essential for research, monitoring, and restoration work. The need for a secure, weatherproof vessel storage structure is discussed in the facilities chapter.

Objectives and Strategies

Objective 1

The Reserve staff and financial resources are sufficient to administer and effectively deliver its mandated and assigned programs.

Strategies

- Administer and manage NOAA operations grants to support Reserve staff and programs.
- Develop new staffing contract by 2020 to enable federal funds to support Reserve staff.
- Partner with the Greenway to administer and manage NOAA monitoring grants to deliver Reserve research and monitoring programs.
- Partner with Hudson River Estuary Program to deliver River Habitats targets and actions in support of *Hudson River Estuary Action Agenda* Benefit 3, Vital Estuary Ecosystem.
- Work with Parks and other state agency partners to deliver Reserve stewardship, research, and education programs.
- Evaluate the existing and potential role of volunteers in the Reserve's operation.

Objective 2

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

Strategies

- Convene Reserve Site Management Partnership Meetings 1–2 times per year.
- Coordinate with DEC programs and other land managers of Reserve sites on annual work plan development and implementation.

Objective 3

Reserve staff have the tools, training, and resources to safely complete their job requirements while working at the Norrie Point Environmental Center and in the field.

Strategies

- Implement safety protocols for all Reserve programs.
- Provide safety training annually for all Reserve staff.
- Maintain and, as needed, replace vehicles and vessels.

Facilities and Construction

Introduction

Reserve facilities and operational capacity enable the Reserve to support its staff, partners, and programs.

This chapter describes the Reserve's current facilities and challenges, identifies facility needs to further enhance staff and program capacity, and lists our facility objectives and strategies.

Current Facilities

Norrie Point Environmental Center

The Norrie Point Environmental Center was renovated with substantial financial and logistical support from NOAA, DEC, and Parks from 2005 to 2017. Phase 1 of the renovation was completed 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.

Phase 3 of the renovation made modifications to enhance the building's energy efficiency and install alternative energy sources to reduce Norrie's carbon footprint and decrease operating costs. In 2009, a 29.7-kilowatt photovoltaic system was installed on three separate roofs, and an exhibit panel was added in the Norrie exhibit area to display the system's environmental benefits in real time. Thermal insulation was installed in the building's walls and ceilings, where it was insufficient, reducing heat loss. Exterior siding was replaced on the entire building, selected windows were replaced, and new gutters installed. Old lighting fixtures were replaced with new energy-efficient alternatives, and light sensors were installed, where feasible, to enable automatic shut-off of lights in unoccupied rooms.

Last, Parks renovated and repaired the Norrie Point roof from 2016 to 2017 in the final construction project up to this point. Electrical, plumbing, and HVAC improvements repaired damage resulting from roof leaks. Some services were updated, including the fire alarm system. The roof structure was reconfigured, damaged substructures were replaced, new shingles were applied, and a liquid membrane surface was added to the flat sections of the roof system. The research laboratory and kitchen were substantially renovated to remediate water damage and mold.

Bard College Field Station

The Reserve continues to maintain office and lab space at the Bard College Field Station at a reduced level. This space is used for Reserve-related activities, especially research and monitoring, including work by Reserve staff and research fellows and interns. On the deck of the field station, research and monitoring staff maintain a meteorological and telemetry station, which transmits real-time data and is serviced monthly.

Scott Ice House and Barn at Nutten Hook

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 the most intact and interpretable examples of this once-dominant, water-based Hudson River industry. The Scott Ice House is on the National Register of Historic Places, as well as its New York State counterpart, and is encumbered by a conservation easement held by the nonprofit environmental organization Scenic Hudson, Inc.

Since 1991, substantial state, federal, and volunteer resources have been dedicated to stabilizing the ice powerhouse, shoreline, ice house perimeter, and 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-foot perimeter of the ice house 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 DEC operational funding.

Nutten Hook Ferry Landing

The Nutten Hook to Coxsackie ferry operated in the nineteenth century from the south end of Nutten Hook. Today, the site is a wooded parcel underlain by fill contained by deteriorated timber cribbing. The Reserve is currently working with DEC operations staff to construct an accessible fishing pier with shoreline stabilization at the Ferry Landing. This project is funded by EPF funds, and this site will become part of the Reserve's sustainable shorelines demonstration site network.

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. The structure has been formally documented and has met state and federal requirements for mitigation of loss of a historic structure. 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. The 2018 state budget includes funding for demolition, abatement, and removal, and the project will likely be completed in 2019.

Facility Challenges

The Norrie Point Environmental Center is a large, stone Civilian Conservation Corps-built building located on the eastern shore at the midpoint of the tidal Hudson River. The structure was expanded in the 1970s to its current 11,000 square feet. The age and complexity of the expansion limit further structural renovation of the building.

Norrie Point, the Scott Ice House, and some of the Reserve access facilities are located on the Hudson River in flood zones and face increasing risks associated with sea level rise and more frequent large storms. The Reserve is aware of these issues and will explore options to reduce these risks through facility elevation, relocation, or modification.

The Reserve has achieved Americans with Disabilities Act (ADA) compliance for current facilities at the four Reserve sites, where it is feasible, and will continue to evaluate compliance when new projects are undertaken.

The Reserve also has challenges securing state funding for facility improvements and enhancements with competition from other programs for similar funding sources. In addition, DEC has limited capacity to undertake facility projects due to state workforce shortages and high project costs from outside contractors.

Facility Needs

Norrie Point Environmental Center Needs

Accessibility

In 2013, Cornell University conducted an accessibility review of selected sites that have public access along the Hudson River. Norrie Point was evaluated and found to be out of compliance with the 2010 ADA standards. The accessibility review report included recommendations for actions to achieve compliance. Reserve staff will continue working with Parks to remedy the items that can be corrected using Parks staff. Any larger and more complex problems will need to be evaluated for possible construction/renovation projects, which would be bid out by Parks. As mentioned in the access chapter, accessibility enhancements for education programs at Norrie are needed to provide access to all users.

Parking Lot

Additional state and federal funding is needed and will be sought by DEC and Parks to renovate the parking area and other auxiliary facilities at the Norrie Point Environmental Center to ensure staff safety, efficient operations, continued public access, and sufficient storage space for Reserve equipment. The deteriorated Norrie Point parking lot needs to be renovated to remedy parking, accessibility, and aesthetic issues. Parking spaces need to be defined for the public, staff, and marina users, and an accessible path needs to be created from these new parking spaces to the entrance of the building. Given its proximity to the Hudson River and the frequent flooding the area experiences, one suggestion is to remove the southeast corner of pavement to create a path for the marsh to migrate inland. This would be valuable for both the marsh habitat as well as for public education and interpretation.

Boats, Boat Storage, and Docks

The Reserve maintains three boats (whaler, skiff, and electro-shocker), two canoe fleets with trailers, and an Argo with a trailer. A pole barn or other secure, covered shelter is needed to provide storage for these items. Some of the boats will need to be replaced in the next 5–10 years. Upgraded docking facilities are also needed at Norrie Point to allow Reserve staff and partners deep water access to the Hudson River for research and education. (i.e., the Hudson River Sloop Clearwater).

Norrie Point Stone Foundation

The original stone foundation of the deck, pathway, and patio at Norrie Point needs to be repointed. Parks previously completed a repointing of the corners of the patio, but twice-daily tide changes, wave and ice action, and boat wakes have compromised the integrity of the foundation's existing stonework. The Reserve will work with Parks to secure funding for this improvement project.

Dormitory

The Reserve seeks to develop housing capacity for several Reserve programs to enable support of interns, multiday teacher trainings, and visiting scientists. A fully equipped dormitory facility located at Norrie Point, in partnership with Parks, would greatly enhance Reserve programs.

Exhibits

The education program is implementing a phased update and expansion of the interpretive exhibits at Norrie Point, including new outdoor exhibit panels on the building, walkway, and patio.

Reserve Sites Facility Needs

The Reserve anticipates the need to update and augment both education and research infrastructure at the four Reserve sites. In the education realm, new or updated trail signs, outdoor interpretive exhibits and kiosks, and boardwalks are needed. In the research realm, needs include updated or new sentinel site access pathways, as well as catwalks in high-traffic research areas to avoid long-term damage to the marsh surface. Last, the Reserve envisions the need to rebuild or extend portions of the trail system, install new overlooks, and add composting toilets or portable toilet enclosures.

Objectives and Strategies

Objective 1

Maintain a safe, welcoming, accessible, functional, and green campus at the Norrie Point Environmental Center.

Strategies

- Enhance vehicle and pedestrian entry to the campus by redesigning the traffic pattern, accessible parking, directional signs, parking area surface, surrounding landscape, and other visitor amenities.
- Provide secure, weatherproof storage and housing for vehicles, boats, and field gear.
- Develop dormitory and/or lodging options for interns, scientists, educators, and students at or near Norrie.
- Develop an ADA-accessible pathway for students and people of all abilities to participate in Norrie waterfront educational programs.
- Develop and implement a plan for outdoor interpretive exhibits to meet student, adult learner, and recreational visitor information needs.
- Work with Parks' Taconic Region to achieve modern electrical and communication systems to improve safety and facility operations.
- Work with Parks' Taconic Region to enhance safety and accessibility of riverfront patio, including better lighting, stair repairs, stone foundation repointing, and railings.
- Work with Parks' Taconic Region to complete interior renovations and upgrades, including accessibility improvements, and window and flooring replacements.
- Enhance the Norrie visitor experience by designing and installing accessible indoor interpretive exhibits.
- Work with Parks to research, design, and install an ADA-compliant entrance to the Captain's Room.

Objective 2

Maintain and work with partners to manage Reserve site facilities, including car-top boat launches, floating docks, visitor amenities, marsh overlooks, picnic pavilion, boardwalks, and kiosks.

Strategies

- Evaluate the need for and impact of a research catwalk at Piermont Marsh.
- Remove deteriorated Hammersley Barn at Tivoli Bays, including remediation of the asbestos roof.
- Complete an ADA-accessible fishing platform at the Nutten Hook ferry landing, including interpretive information and road and parking improvements.
- Complete a canoe launch at the Stony Creek in Tivoli Bays, including improved steps and a new gangway and floating dock.
- Complete an ADA-accessible marsh overlook at the Cruger Lane parking area in Tivoli Bays.
- Work with Parks' PIPC staff to complete an accessible trail at Iona Island.

Objective 3

Improve the sustainability of Reserve sites and facilities.

Strategies

- Complete sustainable shoreline enhancements to the ferry landing at Nutten Hook at the Reserve's Stockport Flats site.
- Collaborate with the Village of Piermont to assess opportunities to improve the sustainability and function of the shoreline on the south side of the Piermont Pier.
- Assess patterns of erosion and marsh edge loss on the east side of Piermont Marsh.
- Evaluate the need to increase Reserve facility resilience to projected sea level rise, storm patterns, and flooding, and consider options to reduce these risks through elevation, relocation, or modification of facilities in harm's way.

Public Access and Visitor Use

Introduction

There are many ways to access and enjoy Reserve sites. Public use and enjoyment of the Reserve is encouraged where and when it is compatible with the primary use of the sites as natural field laboratories for research and education and with the protection of each site's resources and ecological integrity. This chapter describes existing access and permitted uses, management authorities, surveillance and enforcement at Reserve sites, and public access and visitor-use objectives. It also describes strategies to accomplish these objectives.

Access and Permitted Uses

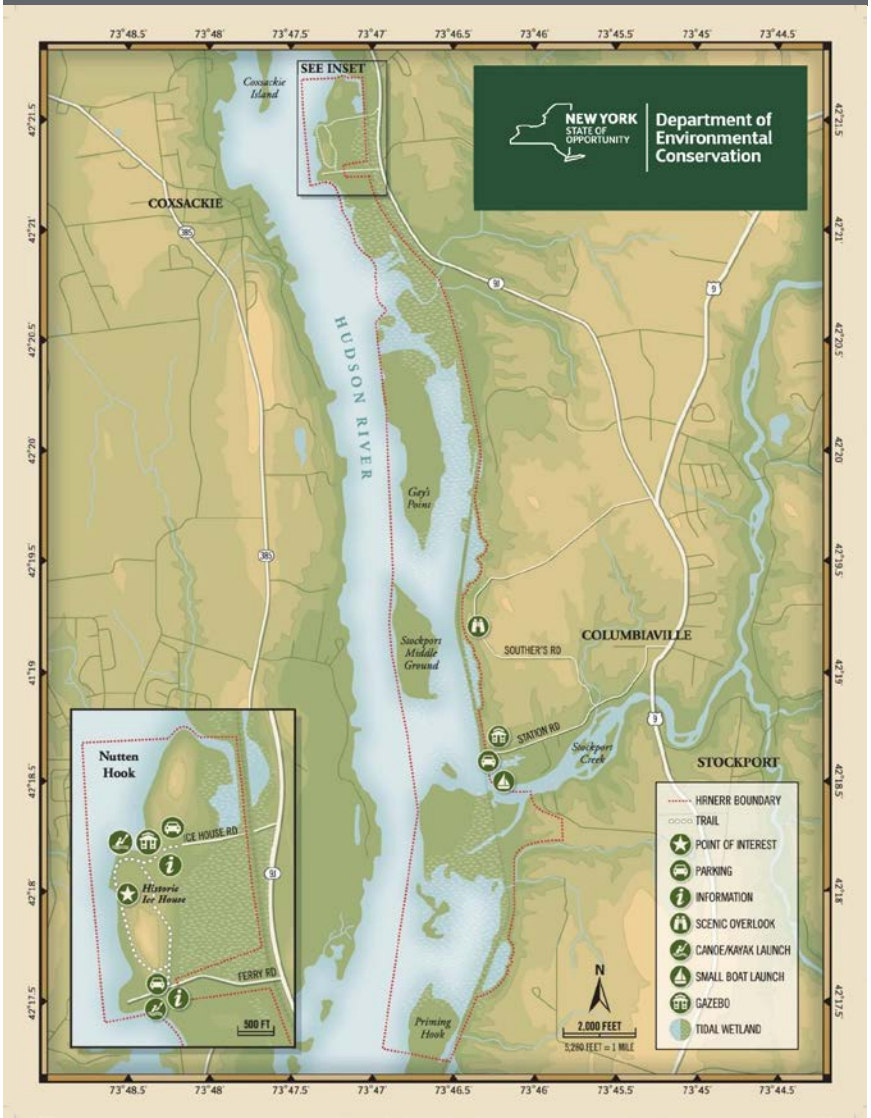
Stockport Flats

Lands that comprise the Stockport Flats/Nutten Hook component of the Reserve include nearly five miles of shoreline, marshes, islands, and peninsulas primarily accessible by boat, as shown in Figure 11. The Stockport Flats/Nutten Hook component includes three broad land-ownership/public-use groupings. These are treated separately below and include Nutten Hook, the Hudson River Islands State Park, and the Stockport Marshes and upland buffer.

Nutten Hook

Nutten Hook is accessible from land via two roads with signaled at-grade railroad crossings. Ferry Road, at the south end of the site, is equipped with an electronic gate and signal as well as a newly installed stoplight at its intersection with Route 9J. Ice House Road to the north is also a signaled at-grade crossing after recent improvements by NYS

Figure 11: Access and Points of Interest at Stockport Flats



Department of Transportation (DOT) to bring this crossing into compliance with at-grade access. These improvements now allow public access to the property, and a new parking lot at the end of Ice House Road was created for cars and buses. Visitors may also access Nutten Hook via foot trails from Ferry Road. Ferry Road is a historic and popular access site to the Hudson River for the surrounding community. Popular activities include sightseeing, ship watching, fishing, and picnicking. However, the shoreline at the site is rapidly eroding as aging timber bulkheads fail and shoreline is lost due to ice scour, boat wakes, and foot traffic. A sustainable shoreline and fishing pier will be installed in the near future.

Permitted uses at Nutten Hook include nature study, hiking, canoeing, boating, and picnicking. Hunting, trapping, and fishing also are permitted with a valid state license. A state fishing license is required on tributaries to the Hudson River. Prohibited activities are those identified as threats to the site's sensitive natural and cultural resources and include camping, swimming, mountain biking, building fires, and operating all-terrain vehicles and personal watercraft. Collection of plants, animals, artifacts, or any other materials is strictly controlled and requires one or more state and/or Reserve permits.

Hudson River Islands State Park

The Hudson River Islands State Park includes Stockport Middle Ground and Gay's Point, both of which can only be reached by boat. Several off-site boat launches exist near the site, including public launches at:

- Hudson (four miles south of Stockport Creek on the east shore, open dawn to 10 PM)
- Catskill (eight miles south on the west shore, open dawn to dusk)
- Coxsackie (directly across from Nutten Hook, open dawn to dusk)
- Athens (seven miles south of Coxsackie)

Permitted uses at the Hudson River Islands State Park include nature study, hiking, canoeing, boating, picnicking, camping, and fires in picnic grills only. Hunting and fishing also are permitted with a valid state license and a Parks hunting permit issued at Schodack Island State Park. A state fishing license is required on tributaries to the Hudson River. Prohibited activities include trapping, swimming, mountain biking, and operating all-terrain vehicles and personal watercraft. Collection of plants, animals, artifacts or any other materials is strictly controlled and requires one or more state and/or Reserve permits. All Parks statewide rules and regulations on public use of park lands apply.

Stockport Marshes and Upland Buffer

Areas comprising the Stockport Marshes and upland buffer include:

- The mouth of Stockport Creek
- The deltaic island west of the railroad bridge
- The dredge spoil island and its associated tidal swamp south of the creek mouth
- The large tidal freshwater marsh that lies between Priming Hook and the dredge spoil island

Most of the area is owned by DEC, with a sizeable amount of acreage under the jurisdiction of OGS.

The principal road and boat access point for the site is just north of the mouth of the Stockport Creek, one mile west of Route 9 at the end of Station Road. Parking space exists for 15 cars east of the railroad line, adjacent to a DEC-maintained ramp for launching small, trailered and car-top boats into Stockport Creek. Access from this ramp to the river channel is limited at low tide, with average water depths of less than six inches. It is not advisable to launch large boats due to limited water depths and low clearance under the railroad bridge.

Souther's Road, which runs between Route 9 and Station Road, also provides visual access to the site at an overlook maintained by the Town of Stockport. From the 130-foot-tall bluff, there are excellent southern and western views of Stockport Middle Ground and the mouth of Stockport Creek. The parking area associated with the boat ramp at the creek's mouth also provides birdwatchers and other visitors with a view of a broad sweep of the river.

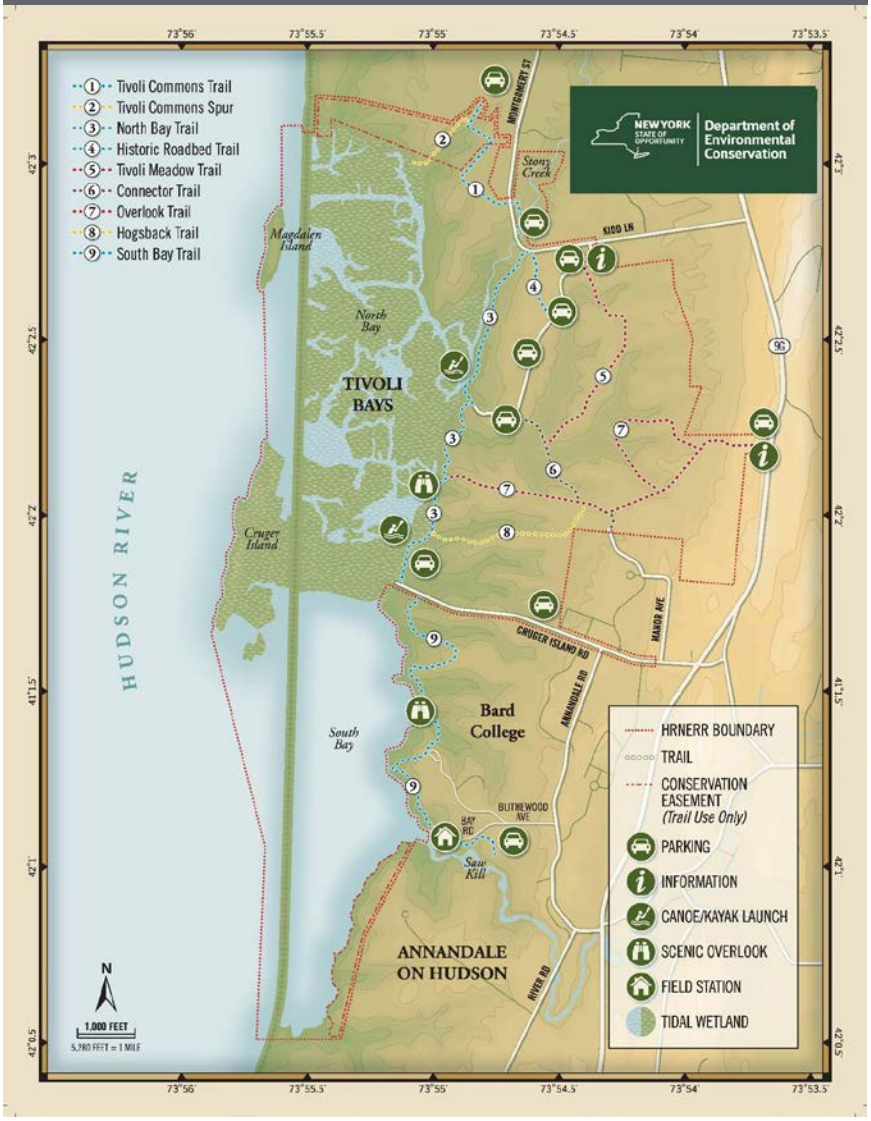
The Stockport Marshes and upland buffer are open to the public year-round, dawn to dusk, for public activities that do not affect the integrity of the ecosystem and natural resources. These include nature observation, education, and research. Pedestrian access across the railroad bridge spanning Stockport Creek is prohibited and extremely dangerous. The boat launch at the creek mouth is open 24 hours a day, although its use is tidally restricted. Permitted uses include nature study, hiking, canoeing, boating, and picnicking. Hunting, trapping, and fishing also are permitted with a valid state license. A state fishing license is required on tributaries to the Hudson River. Prohibited activities include camping, swimming, mountain biking, building fires, and operating all-terrain vehicles and personal watercraft. Collection of plants, animals, artifacts, or any other materials is strictly controlled and requires one or more state and/or Reserve permits.

Tivoli Bays

The Tivoli Bays are accessible by car via three public roads, as depicted in Figure 12. A DEC parking area on Route 9G provides parking for up to 10 cars and access to a trailhead. A second entrance on Kidd Lane, about a half-mile west of Route 9G, permits vehicle access to a trailhead, the site's network of internal roads, and the Stony Creek car-top boat launch. Cruger Island Road provides access to three small parking areas and an unimproved trail to Cruger Island via Cruger Neck.

Canoe access to the site is via the Stony Creek canoe launch or the Cruger canoe launch. Small boats and canoes may be launched from the

Figure 12: Access and Points of Interest at Tivoli Bays



Village of Tivoli's public launch, the Glasco canoe launch at the sewage treatment plant, or launches in Saugerties. Small boats (hand-powered only) and canoes entering from the river must travel under any of five small bridges in the railroad berm to gain access to Tivoli North and South Bays. Clearance under these bridges is limited at high tides.

The Tivoli Bays Reserve site is contiguous with the Tivoli Bays Wildlife Management Area, and public use of the site is governed by state Wildlife Management Area (WMA) regulations, pursuant to New York State Environmental Conservation Law, Article 11. Permitted uses at Tivoli Bays include nature study, hiking, canoeing, picnicking, and mountain biking. Hunting, trapping, and fishing are permitted during legal seasons, except as restricted by posted notice. Prohibited activities include:

- Camping (except under permit by the natural resources supervisor)
- Swimming
- Building fires
- Operating mechanically powered vessels (except as specifically permitted by posted notice), all-terrain vehicles, and personal watercraft

Collection of plants, animals, artifacts or any other materials is strictly controlled and requires one or more state and/or Reserve permits.

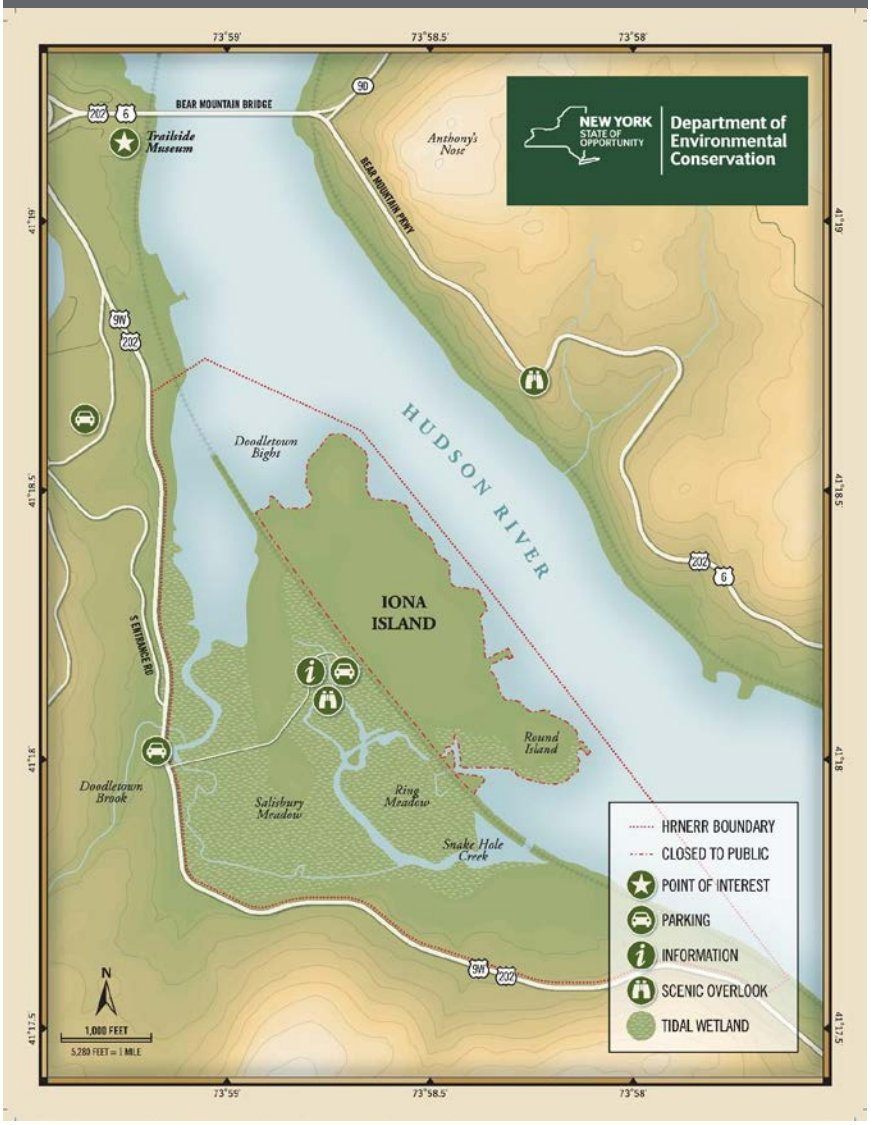
Also prohibited is vehicular use of roads posted against such use. Internal roads are closed to vehicle access during winter and early spring.

Public access is generally prohibited on private lands within the Reserve boundary, which are encumbered by conservation easements, including lands at the northern end of Tivoli Bays and the shorelands of Montgomery Place on Tivoli South Bay. The latter are accessible only with advance permission.

Iona Island

Iona Island can be reached by car via a two-lane causeway from Route 9W across Salisbury Meadow, as shown in Figure 13. Parking for 15 cars is available west of the railroad on either side of the access road. An at-grade railroad crossing without signals provides access to the remainder of Iona Island and to Round Island.

Figure 13: Access and Points of Interest at Iona Island



Access to the Salisbury Meadow marshes is by canoe launched from the east end of the causeway. Access to Doodletown Bight and adjoining marshes, north of the causeway, is by canoe portaged over the causeway from the wetlands to the south, or by small boat from the main stem of the river.

Iona Island can be viewed from an elevated overlook and parking area across the river on Route 6/202, which provides sweeping views of Iona and Round Islands and enables observing of the resting and feeding behaviors of wintering bald eagles. Several overlooks within Bear Mountain State Park also offer splendid views of Iona Island.

Iona Island lands east of the railroad crossing are not accessible to the public under regulations by the PIPC. Lands west of the railroad crossing are accessible and offer views of the marsh. In 2011, PIPC installed a marsh viewing platform looking west from the railroad tracks that offers expansive views of the marsh restoration project area and the Hudson Highlands' backdrop. Canoe access to the marsh is limited to Reserve-guided field trips, which are approved and permitted in advance by the manager of the Bear Mountain State Park. To avoid conflict with breeding bird season, these field trips are conducted only from July to September.

Piermont Marsh

Access to the interior of Piermont Marsh is inherently limited by soft soils, tides, intermittently flooded conditions, a network of tidal creeks, and dense vegetation. The tidal creeks and marsh edges are best viewed by canoe or kayak. However, residents and visitors can enjoy close views of Piermont Marsh and its adjacent shallows from several land locations in the Village of Piermont and Tallman Mountain State Park.

Both DEC and NYS Parks/PIPC lands are closed during hours of darkness. All regulations on public use of state-owned tidal wetlands apply. Permitted uses at and near the Piermont Marsh Reserve include nature study, hiking, canoeing, boating,

Figure 14: Access and Points of Interest at Piermont Marsh

and picnicking at day-use facilities located in adjacent Tallman Mountain State Park, and mountain biking along the Tallman Mountain bike trail. Fires are permitted only in picnic grills. A valid state fishing license is required to fish on tributaries to the Hudson River. Prohibited activities include camping, swimming, trapping, and operating all-terrain vehicles and personal watercraft. Hunting at Piermont Marsh is currently limited to waterfowl in the shallow water areas under DEC and OGS jurisdiction at the northern and southern ends of the Reserve. Hunting is not allowed in any portion of the Reserve owned by NYS Parks/PIPC. Collection of plants, animals, artifacts, or any other materials is strictly controlled and requires one or more state and/or Reserve permits. A permit is required to conduct research in the marsh. The Reserve research guidelines and the Parks/PIPC research permit application can be found in Appendices 5 and 6, respectively.

Management Authorities

Public access provisions for the Reserve are established on a site-by-site basis, as the Reserve is a multi-component site. The existing 1982 Memorandum of Understanding among the five involved New York State agencies stipulates,

> Multiple uses of Reserve lands are encouraged to the extent such uses are compatible with the program and its purposes as expressed in the Reserve 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.

Public access to Reserve sites is controlled to protect each site's ecological integrity and provide a stable environment for research and public education. Traditional uses that do not conflict with Reserve goals are 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. DEC access experts will evaluate the site's accessibility and compliance with the federal and state legislation (e.g., ADA) and assess opportunities to enhance access for everyone, including people with disabilities. For properties that are not adequately protected, the Reserve will work with the property owner to document needs and develop modified access rules and schedules on a temporary, seasonal, or permanent basis to curtail activities that threaten to disturb natural conditions or ongoing research and education activities.

Natural Resource Protection

NERRS regulations allow for multiple uses of reserves that are compatible with each reserve's management plan and consistent with NERRS' mission and goals, which focus on maintaining Reserve sites as field laboratories for research and education.

Resource Protection Authorities

The Reserve's boundaries include areas that fall under several different jurisdictions of local, state, and federal agencies. Coordination, cooperation, and where possible, collaboration among all authorities is needed. Some of the state and federal authorities and policies directly affecting the Reserve are listed in Appendix 7.

Allowable Uses

The uses allowed at the Reserve vary by site and management authority. Tables 3 and 4 list public uses and whether they are allowable, require a permit, and/or have further restrictions. Signs, kiosks, written documents, and web materials are examples of ways the public can learn about existing area regulations and allowable uses.

Table 2: 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 licenses 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 3: 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	A[5]
Trapping	A, SL	NP	NP
Fishing[6]	A, SL	NP	A, SL
Collecting[7]	P	P	P
All-terrain vehicles	NP	NP	NP
Personal watercraft	NP	NP	NP
Off-road biking	A	NP	A[8]

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 in Tallman Mountain State Park
4 Fires allowed only in picnic grills
5 Hunting at Piermont Marsh is currently limited to waterfowl in shallow areas under DEC and OGS jurisdiction at the northern and southern ends of the Reserve. Hunting is not allowed in any portion of the Reserve owned by NYS Parks/PIPC.
6 State fishing licenses required on tributaries to the Hudson River
7 Collection of plants, animals, artifacts, or other materials is strictly controlled and requires one or more New York State permits.
8 Along Tallman Mountain bike trail

Surveillance and Enforcement

State agencies with jurisdiction over lands and waters within Reserve sites coordinate enforcement of state regulations for those lands. For enforcement purposes, DEC will explore the potential for enacting area use regulations on all OGS lands within the Reserve, except those within the Hudson River Islands State Park, which will be overseen by Parks. Reserve and other agency staff will assist in surveillance by notifying the enforcement authorities about any public use problems or criminal actions at the Reserve sites observed during their field work.

State agencies with jurisdiction over lands and waters within the 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 Procedure Law, forest rangers are sworn police officers who have the authority to enforce all laws of the state, but are principally involved in natural resources enforcement on DEC lands. NYS Park Police are sworn police officers who also have the authority under the Criminal Procedure Law to enforce all laws of the state. Park Police are principally involved in parks and recreation enforcement on Parks lands with the Reserve. DEC Environmental Conservation Officers are principally involved in enforcement of the state's Environmental Conservation Law on all lands of the state. Similarly, State Police and county sheriffs enforce general criminal laws statewide.

Objectives and Strategies

Objective 1

Provide access for scientific research, environmental education, outdoor recreation, and public events while ensuring the protection of the Reserve's natural resources.

Strategies

- Maintain a system of trails within the Reserve to safely accommodate low-impact recreation and provide access for scientific and educational programs.
- Evaluate the Reserve sites' accessibility and compliance with federal and state legislation (e.g., ADA) and assess opportunities to enhance access for people of all abilities.
- Make parking, trail, and launch site improvements to foster safe and enjoyable visits and to provide visitors on-site orientation and information.
- Update rules as needed to ensure they meet the needs of the sites' natural resources and visitors.
- Expand the public information about accessing the Reserve through online and on-site information.

Objective 2

Visitor impacts are managed on Reserve lands.

Strategies

- Maintain adequate surveillance and law enforcement to ensure appropriate use of Reserve lands.
- Use research and temporary permits to manage and reduce visitor impacts at Reserve sites.
- Install elevated marsh walkways to reduce research and education impacts on tidal wetlands.
- Maintain bridges and boardwalks to span ravines, unstable ground, and wet areas to reduce foot and bike traffic impacts on trails.

Education

Introduction

The Reserve's education programs combine the best of science-based curriculum with hands-on, place-based experiential education. The programs engage thousands of participants each year at the Norrie Point Environmental Center headquarters, in regional classrooms (both in-person and remotely), and at estuary field sites from urban waterfronts to expansive tidal wetlands. Audiences include kindergarten through college students, formal and informal educators, families, and anyone willing to come down to the river or log on to the digital resources. Programs are accomplished through a broad network of organizations, including dozens of schools, colleges, and non-profit groups. The education program is united with that of DEC's Hudson River Estuary Program and supported by two other key partners: the Cornell University Water Resource Institute and the NEIWPCC.

Since the last management plan, the education department, programs, and facilities have grown significantly. Programs at the Norrie Point headquarters include public, formal, and informal education groups. Growth has been particularly notable among college and high school audiences. The programs now have a bigger component of marsh ecology, resiliency, and ecosystem services, taking advantage of adjacent and accessible wetlands and shallow water habitats. Programs are continuing to expand beyond the Reserve's boundaries and into the entire watershed. This includes classroom programs, online resources like lesson plans and videos, student exploration of local waterfronts, and a range of citizen science opportunities for all ages.

The Reserve continues to integrate its programs with fellow sectors as well as outside partnerships. It has developed better use of the System-wide Monitoring Program (SWMP) data through lesson plans and field work that ties back to the river-wide Hudson River Environmental Conditions Observing System (HRECOS). The tidal marsh canoe programs focus on the range of climate change science the Research team studies, from sediment elevation tables to vegetation surveys. Programs are continually assessed and adapted to meet emerging needs. After Hurricanes Irene and Sandy, the education program developed a component that demonstrates sea level rise, emphasizes the resiliency role of tidal marshes in protecting shoreline communities, and involves students in active stewardship programs that restore habitats. Recently, it has developed a range of marine debris programs, ranging from interpretive signage to active programming elements to mentoring student researchers.

Geographic Focus

The Reserve's education programs take place throughout the New York State counties that border the Hudson River Estuary, including New York Harbor, from New York City (New York County) to Troy (Rensselaer County). The emphasis is on the four component Reserve sites and the Norrie Point Environmental Center. School programs at Norrie draw many classes from Dutchess, Ulster, and Columbia counties, primarily focusing on middle school to college audiences from a wide range of socio-economic and academic backgrounds. The public canoe programs engage audiences from near (Columbia, Dutchess, Orange, and Rockland counties) and far (throughout the state and neighboring states). Two programs, Day in the Life of the Hudson and Harbor and the Hudson River Eel Project, engage thousands of participants from school districts and communities.

Program Descriptions

Teachers on the Estuary and Professional Development

The Reserve offers one three-day training each summer under the NERRS-wide "Teachers on the Estuary" (TOTE) initiative. For several years, the Reserve has partnered closely with the DEC's Five Rivers Environmental Center. DEC handles administration, fees, and credit-granting, while the Reserve staff handle much of the programming and lesson plans, including field work and stewardship projects at the Reserve sites. Teachers are recruited from all over the region, sometimes attending from other states. Each TOTE, approximately 20 hours over three days, follows a theme, such as wetlands, migration, or contaminants. Field work, stewardship projects, presentations, and lesson planning are built around that theme. Teachers explore existing lesson plans and activities from NERRS or DEC and work on their own lesson plans for their classrooms. Field work is always scaffolded with background information and relevant methods to tailor activities for various ages and abilities. Teachers are asked to fill out evaluations at the end of the program, and another follow-up evaluation six to twelve months later.

The Reserve offers a range of other teacher trainings and professional development offerings throughout the year. The Day in the Life of the Hudson and Harbor is supported with up to four trainings that focus on in-class lesson plans and the range of methods for doing river monitoring with students. Each training is six hours long, though in recent years, additional two-hour refreshers are held after school. The Reserve also conducts an annual educator's conference each December and frequently presents at academic courses for institutions like Marist College, New York University, and Math for America. These courses often cover specialized topics such as incorporating river monitoring data in the classroom or building both natural and artistic history into river curriculums.

School Field Programs at Norrie Point

Field-based programs are available at Norrie Point Environmental Center for students in the 6th grade and higher, with a maximum group size of 45. The educational programs draw on past and current Hudson River research and field studies. The Reserve's education programs provide first-hand experience with the estuary. Students explore the Reserve's lands and waters by engaging with educators at various stations. Current stations that are led by Reserve educators include:

- Hudson River Estuary Puzzle: introduction with a 25-foot jigsaw puzzle of nautical charts
- Macroinvertebrates & More: using biological indicators to assess local stream conditions and explore biodiversity
- Fish ID & Biology: usually paired with seining programs (but large tanks allow for independence).
- Fish Seining in Norrie Cove: popular and literally immersive education
- Water & Weather Monitoring: students measure various water quality and weather parameters, then compare findings with the SWMP and HRECOS systems.
- Canoeing & Marsh Ecology (high school only): this involves a short canoe program in the Enderkill Marsh, with a focus on ecology, ecosystem services, and marsh resiliency.
- Microplastics/Marine Debris: a new station, developed with Clearwater and the NOAA Marine Debris Program.

Tidal Wetland Canoe Program

Reserve staff run canoe programs at all four component sites. These programs allow motor-less marsh exploration and access into out-of-the-way parts of the wetland. A typical program involves up to 24 people, including two educators, in eight canoes. Canoe programs for organized groups are scheduled through the office, while participants can sign up for public (open enrollment) programs online. All participants receive information on what to bring and wear, while paddles and life-jackets are provided by Reserve staff. Participants receive a brief training covering safety, canoe protocols, and basic paddling. On the water, Reserve staff assist paddlers, and at points, gather the fleet together to discuss main features of wetland ecology and functions. Safety is paramount, so there are always at least two Reserve staff on the water. Occasionally special groups such as an association of town planners will be invited to cover specific topics.

Each Reserve site has its own unique features. Stockport Flats and Tivoli Bays are freshwater wetlands, while Iona Marsh and Piermont Marsh are in more brackish water. Reserve staff have talking points for each marsh. One of the challenges facing this program is the time it takes to travel to the more distant sites like Piermont, especially with a large trailer of canoes. Another challenge is last-minute weather changes, like sudden thunderstorms or increased winds. This program requires a three-hour commitment by participants, and a fair number of participants return. Evaluation is done with surveys at the end of each program.

Hudson River Eel Project

American eels (*Anguilla rostrata*), a migratory fish, are born in the Atlantic Ocean and enter North American estuaries, including the Hudson River, as tiny, see-through “glass eels” each spring. After arrival, they gain pigment and become part of the ecosystem. The species is in decline over much of its range, and baseline studies of populations are crucial to inform management decisions. The Hudson River Eel Project supports and coordinates teams of scientists, students, and community members. They collect glass eels using fyke nets, eel trap-and-pass devices on eel ladders, and other specialized traps on 13 Hudson River tributaries each spring. The juvenile fish are counted, weighed, and released. Other environmental data are also recorded. At the end of each season, the data are compiled and sent to state fisheries biologists, who share the information with Atlantic coast resource managers through the Atlantic States Marine Fisheries Commission. The project gets students and volunteers directly involved with scientific design and field methodology. Participants experience the local ecosystem first hand and collect important information and relevant data about migrating fish. There are 13 sites where these various devices are employed, ranging from Staten Island in the south to the border of Albany and Greene counties further upstream. The project is evaluated at the end of every season with a brief survey.

Day in the Life of the Hudson and Harbor

Each autumn, about 5,000 students and teachers from New York City to Troy participate in the annual Day in the Life of the Hudson and Harbor event at 85 waterfront sites. Students collect scientific information to create snapshots of the river at dozens of locations, then share their data via the web so they can better understand how their piece of the river fits into the larger Hudson estuary ecosystem.

A Day in the Life is produced with assistance from the Lamont-Doherty Earth Observatory of Columbia University. Participants' findings contribute to an ongoing research project at the observatory studying the presence of various metals in river sediments.

At each location, teams of students and environmental educators use seine nets, water testing kits, and measuring tools to investigate aquatic life, water chemistry, tides, and weather. Many groups also collect core samples of river bottom mud for analysis.

Data from the event are incorporated into lesson plans developed by Reserve staff and state partners and are available to all teachers in the Hudson Valley. Where possible, Reserve staff facilitate partnerships between participating classes and local environmental education organizations. Training workshops, online lesson plans, specialized equipment, fifteen years of results, and other resources are provided.

The project is difficult to evaluate, since this is truly a "bottom-up" planning situation. Teachers design and schedule their own programs based on their students' needs, while Reserve educators facilitate coordination and site selection and implement non-mandatory (but strongly suggested) trainings on equipment, lesson plans, and logistics.

Classroom Programs and Distance Learning

Reserve educators interact with students in school classrooms in three ways:

- Pre- or post-event trips connected to programs such as Day in the Life, the Eel Project, or Submerged Aquatic Vegetation (SAV) planting (most frequently);
- One-time visits to classrooms (occasionally); or
- Distance-learning programs to connect the Norrie Point classroom with students remotely through videoconferencing and live internet programs (increasingly).

In all cases, educators work closely with teachers to plan which topics will be covered.

Reserve educators have been steadily expanding and refining distance-learning offerings, skills, and technology over the last decade. Educators and students can see and talk to each other, ask questions, and explore a wide range of topics via Skype and Zoom. Some cameras on the river allow students to track tide changes and look at boat traffic, while other cameras give a close-up view of live animals.

Programs geared toward middle and high school students can cover topics including estuary basics of tides and watersheds, river ecology and biology, and current Reserve research initiatives. These programs are excellent supportive elements before or after field investigations. They are also considerably easier for both the Reserve and the teachers in terms of scheduling, logistics, travel, and use of other resources. Currently these programs are evaluated qualitatively through communication with teachers.

Public Programs

This includes a range of different programs beyond the canoe programs. Traditionally the Science on the River open house is held in September. This event focuses on translating river research to local families, with guest speakers and hands-on presentations by Reserve scientists and regional partners. For example, Reserve researchers give a hands-on exhibition of the sondes, weather station, and equipment it takes to run a SWMP program. The Estuary Training Program (ETP) coordinator leads participants on a survey of waterfront resiliency and sustainable shorelines. Visiting scientists involve the public in fish tagging, tributary restoration, and invasive species management activities.

The Science on the River event also includes canoe programs, on-site fishing, and periodic guest presentations by people like bird-of-prey rehabilitators or artistic performers. Currently, the event takes place every other year.

Smaller programs at Norrie Point are scheduled throughout the year, focused on seasonal themes like fishing, winter tracking, eagle observations, and vernal pools. Other events are held at festivals throughout the Hudson Valley. The Reserve receives many requests, but, as each event is resource intensive, only three or four are scheduled per year.

Educators also help coordinate two annual events focused on seining and fish monitoring: the World Science Festival in New York City each spring, and the estuary-wide Great Hudson River Fish Count each summer. These public programs are advertised through the local library, postings on online calendars, and social media.

Education Facilities

Norrie Point Environmental Center

The Norrie Point Environmental Center enables the Reserve to conduct a wide variety of education programs. Located directly on the Hudson River with a spacious patio for fishing and river observations, it has access to a beach that can be seined, adjacent trails into forested uplands, and a tributary stream and small marsh for short, introductory canoe programs. The "wet" classroom is used as an education lab, a small lecture hall, a distance-learning platform, and a staging area for equipment, depending on season and need. It has direct access to outside the building and storage in hallways and sheds. The exhibit hall contains several aquariums and interpretive exhibits, which the Reserve refreshes periodically. In 2018, with funds from the NOAA Marine Debris Program, the Reserve added two new displays, including a large striped bass model constructed entirely from marine debris. This grant also supported the development of hands-on activities that have already been incorporated into Norrie-based field programs with student groups, as well as customized public programs for festivals. In addition, the education coordinator has mentored several students studying microplastics in Polgar Fellowships, a Hudson-based research program coordinated in part by the Reserve's Research Coordinator. The Reserve maintains a bulletin board outside the front door listing upcoming programs, and plans to add outdoor exhibits on the waterfront Norrie patio.

Reserve Site Exhibits and Kiosks

Information and exhibits are available at all Reserve sites. Wayside signs orient visitors to the site's natural and cultural history, and kiosks provide site maps, trail routes, and natural history information.

Education Program Evaluation and Assessment

Market Analysis and Needs Assessment

In 2011–2012, the Reserve conducted a market analysis and needs assessment. The market analysis summarized the community of organizations providing river education to a variety of audiences. The needs assessment surveyed teachers and informal educators about their needs and wants. It showed that teachers feel a strong desire to include more data and critical thinking in their curriculum, but need greater facilitation and instruction aids for that curriculum. As a result, the Reserve has refined how river monitoring and trends are taught in professional development workshops. The assessment also noted a strong interest and desire for training in climate change topics. As a result, climate topics have been incorporated into programs at multiple levels.

Program Evaluation

All education programs are regularly assessed by participants. Canoe and Norrie programs use a short post-program survey. Some Norrie and school programs get a short pre- and post-program questionnaire as requested by the Student Conservation Association (SCA). Participants in the TOTE program receive a longer post-course survey and are sent an additional survey after 6 to12 months. Teachers consistently report a preference for more hands-on teacher training and less time spent in structured curriculum development.

Teachers also say their biggest challenge beyond budgets, access, and transportation is getting students involved in field visits. Several outside organizations studied participant motivations and gains in knowledge and skills related to the Reserve's education programs. The Cornell Lab of Ornithology conducted a National Science Foundation-funded study of the participants in the adult eel project, and the

Cary Institute looked at high school and college students in the Poughkeepsie-based eel project. These studies revealed that internal motivations like being with friends, having fun, or just liking to be outside are more important than external motivators like extra credit, peer acceptance, or eel conservation. As a result, the Reserve has been able to tailor recruitment efforts to emphasize the personal and social aspects of citizen science, while still including messages about the importance of environmental conservation. The former study also pointed out the risks of a project that relies on a strong link with an individual leader, prompting a shift toward diversifying leadership and empowering more local partners to interface directly with volunteers.

Objectives and Strategies

Objective 1

Teachers and educators in kindergarten through college settings will expand their own estuary literacy and curriculum applications through a wide range of professional development, place-based lesson plans, and online multimedia resources.

Strategies

- Implement a minimum of 1 professional development training of 15 hours or more per year using TOTE protocols, in collaboration with partners.
- Expand both the audience and the content offerings of the online distance learning program to include teacher trainings.
- Refine existing online lesson plans to adjust to new NYS learning standards.
- Deliver three to five Day in the Life trainings each year throughout the Hudson Valley.
- Continue to update data results and teacher resources on project web pages including Day in the Life and the Eel Project.
- Deliver two to four presentations or workshops for academic and professional teaching organizations such as New York University and Math for America.
- Seek credit-granting authority from the NYS Department of Education.
- Form a more active advisory board of formal and informal educators to meet semi-annually and frame out objectives and strategies for regional progress in estuary literacy.
- Continue to evaluate programs using a range of assessment tools.

Objective 2

Students gain environmental literacy through active participation in a wide range of educational offerings based on the foundational principles of the NERRS K–12 Estuary Education Program (KEEP).

Strategies

- Continue to engage students in exploring the river through a wide range of place-based programs at the Norrie Point Environmental Center.
- As appropriate, host canoe programs for student groups at Norrie Point and component Reserve sites.
- Augment field programs with classroom visits, both in-person and through distance learning, to better prepare students for their experiences.
- Continue classroom programs as recruitment and orientation elements of the Hudson River Eel Project.
- Recruit, train, and coordinate student and school-group participation in the Eel Project.
- Work with teachers and students to grow submerged aquatic vegetation (SAV) in the classroom, with later out-planting at Reserve sites.

- Coordinate the annual student monitoring event, Day in the Life of the Hudson and Harbor (Day in the Life). The emphasis is on maintaining the quality of the experience, not on expanding to additional sites.
- Create short videos that introduce students to the basic content and structure of regular offerings like Norrie Point trips, canoe programs, and Day in the Life.
- Create new online learning tools and lesson plans based on Reserve and partner science, including fish tagging, marsh research, and the use of the Hudson River Environmental Conditions Observing System (HRECOS).
- Develop and implement new learning stations on topics including marine debris/microplastics, climate change science, and estuary monitoring and restoration.
- Keep all materials, gear, and equipment organized and in good working order.
- Create a short self-guided or educator-led walking nature trail on the forest and wetland habitats adjacent to Norrie Point.
- Reserve education programs will continue to be available to as many schools and groups as resources allow, and Reserve educators will reach out particularly to environmental justice communities, schools with high free/reduced lunch indices, and communities not traditionally served by our programs.
- Engage college audiences in field programs, internships, and Polgar fellowships as appropriate based on timing and opportunity.
- Develop Norrie Point interpretive displays that can be used in conjunction with student and teacher programs, e.g., a more interactive use of the HRECOS console.
- Continue to develop new programming and interpretation based on emerging issues, including climate change, community resiliency, marine debris/microplastics, and drinking water contaminants.
- Increase accessibility to the Reserve sites and programs.
- Continue to evaluate programs through a range of assessment tools.

Objective 3

Community members, families, and informal visitors learn about their estuary through a range of Reserve-sponsored field programs, presentations, facilities, and online resources.

Strategies

- Continue to develop and offer public programs at Reserve sites, including fishing clinics, nature walks, and other presentations.
- Pursue conducting our “Science on the River” open house on a biennial basis, with alternate years offering a smaller public program.
- Present or table at several popular festivals each year, including the Clearwater Revival, the Beacon Sloop Club Strawberry Festival, and others.
- Implement public presentations and lectures at other non-Reserve venues as timing and staffing needs dictate.
- Improve the Reserve’s online presence by updating the website with features like videos and success stories.
- Implement a strategic redesign of exhibits and interpretive materials at the Norrie Point Environmental Center and select Reserve sites.
- Develop Norrie Point interpretive displays that can be used in conjunction with public programs, for example, a more interactive use of the patio features and space.
- Increase physical and logistic accessibility to our sites and programs.
- Continue to evaluate programs through a range of assessment tools.

Continue to develop new programming and interpretation based on emerging issues, including climate change, community resiliency, marine debris/microplastics, and drinking water contaminants.

Estuary Training Program

Introduction

The Estuary Training Program (ETP) 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.[1]

ETP includes training about:

- Hudson River habitats, especially shoreline habitats
- Scientific research, in partnership with the Hudson River Environmental Society
- Communication and facilitation skills, emphasizing science-based information on the conservation and restoration of Hudson River habitats in a changing climate.

In addition, the ETP provides technical assistance to decision makers on topics related to nature-based shorelines and on NERRS Science Collaborative (NSC) research projects.

The ETP concentrates its efforts in the ten counties from Albany and Rensselaer south to Rockland and Westchester, with their 2.8 million people and 79 municipalities bordering the estuary.

Training Needs

Several needs assessments were conducted in 2017. They have been used to inform the ETP Strategy and this management plan. These needs assessments were conducted by consulting a focus group of organizations working on waterfront resilience, conducting interviews with shoreline designers across the state, and interviewing users of abiotic water quality data collected by the Reserve. In addition, an online survey was sent to 1,000 past training program participants. Training needs and opportunities will continue to be identified through needs assessments and consultation with the ETP Steering Committee.

Since the last management plan, there is more interest in restoration both because of the development of system-wide restoration plans and because of the potential for an influx of restoration funding due to mitigation projects. There is an increase in knowledge on the effects of sea level rise on tidal wetlands and consequent efforts to consider management options and protect adjacent lands. There is more interest and capacity building in New York State to use nature and natural systems to reduce risk and enhance resiliency. This includes using nature-based shoreline erosion protection through the well-established Hudson River Sustainable Shorelines Project (HRSSP). More projects requiring state permits are including sustainable shoreline techniques. The ETP has developed a niche to work primarily on ecosystem resilience versus community resilience.

[1] The program coincides with the main goals of the Reserve alongside the work of the Reserve's management, education, research, stewardship, and restoration sectors.

Priorities and Opportunities

A complete list of specific issues and topics relevant to the Hudson River estuary region, identified through these needs assessments, can be found in Appendix 3 of the *Strategy for Hudson River NERR Estuary Training Program 2018–2022*. To prioritize the topics and subjects, the ETP coordinator relied on her own local knowledge and experience as well as the knowledge and opinions of the steering committee and other Reserve staff. The ETP will focus on the following topics and sub-topics:

- Hudson River aquatic/shoreline habitats
  - Ecosystem services of aquatic habitats
  - Status and trends of the Hudson River aquatic and shoreline habitats, including vulnerability to climate change and options for adaptation
  - Restoration of aquatic habitats, including remediated sites
  - Scientific information from the Reserve and others relevant to habitat management
- Hudson River Sustainable Shorelines Project (HRSSP)
  - Monitoring protocol, demonstration sites, and scientific research
- Natural and nature-based shoreline protection and use of resiliency measures to reduce risk and promote resiliency in New York State
  - Transferrable outreach tools and/or programming that foster consistent nature/nature-based shoreline messages across the state's coasts (Hudson River, NYS Great Lakes, and NYS Marine and Coastal District).
  - Understanding the permit process and regulations
- Community Risk and Resiliency Act (CRRA)
  - Natural resilience measures in relationship to Hudson River shoreline habitats and community resilience
- Process and technical skills
  - Use of Reserve research (e.g., abiotic dataset)
  - Training on facilitation, project management, and communication skills
  - Use of online mapping tools, such as Hudson River Flood Mapper and Digital Coast

The ETP coordinator's involvement in several regional organizations and committees will enable the program to identify new training partners and needs and gaps in programming.

Audiences

The highest priority training audiences are the professionals and volunteers who make decisions that affect the Hudson River estuary habitats. This audience includes regulators, shoreline stakeholders, natural resource managers, land stewards/managers, scientists, and municipal officials (elected and appointed officials, volunteer boards, and staff). Some members of the ETP's target audience overlap roles, responsibilities, and expertise. For example, regulators include staff biologists and ecologists involved in permit decisions within governmental agencies. Shoreline stakeholders are people who are concerned with shoreline erosion and shoreline habitat. This latter group may include private and public property owners, engineers, landscape architects, state and federal permit staff, land and natural resource managers, municipal officials, policy makers, and advocates.

Training Delivery

Training is delivered both in-person and remotely. In-person trainings are offered at Norrie Point and in other venues that are free or low-cost, often in partnership with other organizations. For remote programming, the ETP uses web-conferencing services for all audiences, and uses the DEC video conference system for DEC staff at their work places. The Reserve has strong working relationships with several governmental agencies (municipal, state, and federal) and stakeholder groups; these important partners collaborate on programming and provide expertise and other support. NEIWPCC helps with the management of funds when registration fees are charged.

The Hudson River Environmental Society is a consistent partner for day-long research forums. Training event expenses are funded by grants, funds from the DEC Hudson River Estuary Program, and by attendee registration fees.

The program routinely issues continuing education credits through the American Institute of Certified Planners and the Practicing Institute of Engineering, Inc., and has recently started providing Society of Ecological Restoration certification credit. Providing continuing education credits through the Association for State Floodplain Managers may be considered.

Partners

The ETP works with partners in many ways. The table below shows how various organizations partner with the ETP by providing expertise in specific topics, assisting with financial management, providing networking opportunities, and working collectively to provide mutually beneficial projects and training events.

Table 4: Partners working with the Estuary Training Program										
	SHAD (collective)	HRSSP	CRRA	Training Expertise	Staff	Venue	Financial Agent or Other Support	Networking & Collective Impact	Professional Credits	ETP Steering Committee
American Institute of Certified Planners									X	
Cary Institute of Ecosystem Studies	X	X		X				X	X	
Hudson River Environmental Society				X		X	X	X		
Hudson River Valley Greenway		X					X	X		
Metropolitan Waterfront Alliance (Waterfront Edge Design Guidelines Program)		X		X					X	
NEIWPCC							X	X		
NERRA and other Reserves				X			X	X		
NERRS Science Collaborative-funded research institutions				X						
New York Sea Grant				X				X		X
NOAA's Office for Coastal Management				X			X			
NYS DOS Office of Planning and Development		X	X	X						X
NYS Parks		X	X					X		
DEC: Estuary Program, Bureau of Ecosystem Health, Office of Climate Change, Division of Marine Resources, Division of Environmental Permits, Division of Environmental Remediation, and Great Lakes Program	X	X	X	X		X		X		X
Practicing Institute of Engineering, Inc									X	
Scenic Hudson	X	X		X				X		
Shoreline design professionals				X					X	
Shoreline Habitat Adaptation Dialogue (SHAD)	X	X		X				X		
Society for Ecological Restoration				X					X	
Stevens Institute of Technology		X		X						
Student Conservation Association (SCA)					X					
The Nature Conservancy	X	X		X				X		
The Practicing Institute of Engineering, Inc									X	
Waterfront Resilience Coordination Collective								X		

Integration with Other Sectors

Reserve staff are involved with ETP program planning and implementation in a variety of ways:

- Habitat restoration staff are expert speakers on invasive species control and management and shoreline and habitat restoration projects.
- Education staff interpret science related to ETP issues for Reserve visitors and K–12 audiences and help design/lead canoe trips for field activities of ETP.
- Research staff are expert speakers on:
  - Hudson River habitat status and trends that are documented in Hudson River Geographic Information System (GIS) mapping products;
  - aspects of Sentinel Site Application Module 1 (SSAM-1: Coastal Habitat Response to Changing Water Levels);
  - application and interpretation of water quality data;
  - findings of SWMP; and
  - research on marsh buffers and Piermont Marsh restoration project. ETP provides outreach through webinars and trainings for NSC products, abiotic data, and sentinel sites.
- With expertise on habitat vulnerability to climate change, including pathways for wetland migration, the Reserve manager has been the lead on most of the NSC grants for the HRSSP.
- The Reserve's ETP coordinator, manager, and restoration staff have worked together on the HRSSP for over a decade. Education staff interpret the findings for their audiences.

In addition, all Reserve staff benefit from ETP training events for professional development. For example, Reserve staff participate in SHAD and will collaborate on transferring findings on habitat protection, restoration, and climate change vulnerability and resilience projects. Further, Reserve staff with expertise in habitat restoration as well as knowledge of DEC's regulatory processes are mutually beneficial to the ETP's programming—as both collaborators/experts and audience members. Finally, the ETP coordinator and other Reserve staff have been principal investigators or otherwise involved in multiple NSC projects over the last decade. The Reserve will actively seek new opportunities through the NSC.

Evaluation

ETP is evaluated by both post-event surveys and input from the Steering Committee members on the efficacy of programming as per their organization's observations and objectives. In addition, indicators of the effectiveness and performance of the training program include audience members requesting related programming, attending multiple events, and recommending the program to their colleagues. Another measure is the number of ETP partners that continue to be interested in collaborating on training events.

A long-term outcome of the training program is that decision makers understand science, regulations, and policy to better protect, manage, and restore shoreline and river habitats under present and future conditions. Training activities are an essential part of achieving this outcome, coupled with technical assistance. Shorter-term outcomes from training include:

- Decision makers network with experts and peers.

- Decision makers share the information they learned with their colleagues and their own audiences.
- Decision makers know where to find more information about the specific topics covered in trainings.
- End users are included in collaborative science projects, and research scientists adaptively manage their projects with end users' needs in mind.
- Decision makers apply what they learned in their work or volunteer capacities.

Objectives and Strategies

The following content is primarily taken from *Strategy for Hudson River NERR Estuary Training Program 2018–2022* accepted by NOAA's Office of Coastal Management on October 18, 2018. For more detail, please consult the Strategy in Appendix 8.

Objective 1

Annually, 90% of participants state that they intend to apply the science-based knowledge and skills relevant to shoreline and river habitats and coastal management gained through the ETP.

Strategies

- Assess the audience's most pressing science information and training needs.
- Develop and implement relevant curricula and trainings covering science, regulation and policy by using steering committee input, findings of needs assessments and literature research.
- Collaborate with external partners and Reserve staff to develop and provide training and technical assistance, and work closely with SHAD, HRSSP, and Hudson River Habitats team colleagues, Hudson River Estuary Program, and DEC's Bureau of Ecosystem Health.
- Use Reserve sites for training and case studies.
- Develop case studies of innovative projects, develop other information resources and use websites and other communication media to reach decision makers.
- Provide networking opportunities to help decisionmakers increase their effectiveness and ability to conserve, restore, and manage coastal habitat and to enhance ecosystem resilience.
- Fulfill the requirements of NERRS' *Coastal Training Program Performance Monitoring Manual* (NERRS 2014) and any updates.

Objective 2

Annually, at least two collective and collaborative efforts will receive technical assistance from the ETP to address ecosystem health and resilience or other mutual priorities relevant to coastal management and Hudson River habitats.

Strategies

- Collaborate on and lead statewide natural and nature-based shoreline work group.
- Support implementation of outreach and training for CRRA and other climate and resiliency efforts.
- Participate in relevant national, Mid-Atlantic regional, and New York State initiatives via involvement in meetings and committees within New York and NERRS.
- Support Reserve efforts to expand observations of vegetation trends, sediment dynamics, and water levels in Reserve tidal marshes and other estuary tidal marshes.
- Seek out, apply for, and participate in NERRS Science Collaborative (NSC) research projects relevant to the Hudson River.

Research and Monitoring

Introduction

The Reserve's component sites are living laboratories, ideal sites for research and long-term monitoring. Research and monitoring contribute to the growing understanding of how estuaries function and change over time and inform predictions of how coastal ecosystems will respond to climate change and natural and human-induced disturbances. Reserve research is focused on how environmental factors, such as water quality and water level, impact coastal ecosystems, particularly benthic, submerged aquatic vegetation, and tidal wetland and adjacent upland habitats. Reserve research and monitoring data provide a strong, science-based foundation for addressing coastal management challenges and decision making. The NSC fosters data relevance by requiring grantees to bring end users of scientific information and data products into the research process. The Reserve also operates two NOAA sentinel sites at the Tivoli Bays and Piermont Marsh to assess the impacts of changing water levels on coastal ecosystems.

The Reserve's research and monitoring program delivers the Applying Science goal of the NERRS 2017–2022 Strategic Plan: "Improve the scientific understanding of estuaries and their watersheds through the development and application of reserve research, data, and tools." The Reserve partners with the DEC Hudson River Estuary Program to deliver the habitat goals of the Estuary Program's *Action Agenda 2015–2020*. Specifically, the Reserve's habitat work addresses Action Agenda Benefit 3: Vital Estuary Ecosystem, under Long-Range Target 1: "Increase the quantity and quality of tidal wetlands, submerged aquatic vegetation beds, [and] natural or nature-based shorelines through conservation and restoration to foster a healthy ecosystem that is resilient to change."

NERRS Research and Monitoring Program

NERRS 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 national plans that identify goals, priorities, and implementation strategies for these programs. The NERRS Standard Operating Procedures are implemented by the research program, with data products developed and disseminated in collaboration with the education, training, and outreach programs. The goal of this approach is to ensure the availability of scientific information that has long-term, system-wide consistency and utility for stakeholders to use in protecting or improving natural processes in their estuaries.

In recent decades, NERRS has supported three major system-wide research and monitoring programs: NSC, the Graduate Research Fellowship (GRF) program, and the System-Wide Monitoring Program.

NERRS Science Collaborative

Research is funded through NSC, which currently is jointly administered by NOAA and the University of Michigan. NSC projects promote end-user involvement, where stakeholders who need scientific information help design and carry out each project. NSC offers grants for several types of activities, including collaborative research, integrated assessments, and science transfer efforts. All NSC projects must address a need identified by one or several reserves, and project teams must work closely with intended users of project

results. The Reserve works with partner organizations to identify and prioritize research needs and has participated in several NSC research projects since 2008. Research topics have included sustainable shorelines, tidal wetland capacity to buffer storm surges, storm surge barriers, and dam removal impacts to sediment transport. More details and future directions for these projects can be found below in the Reserve research focus areas section of the management plan.

Graduate Research Fellowships

In 1997, the NOAA/Estuarine Reserves Division began funding a competitive graduate research fellowship program in NERRS. The NERRS GRF program is intended to produce high-quality research focused on improving coastal zone management while providing graduate students with hands-on experience in reserve research and monitoring. Past Hudson River National Estuarine Research Reserve GRF research topics have included critical fish habitat, sedimentation and contaminant deposition, and carbon and nitrogen cycling in tidal wetlands. The Reserve's last GRF fellow completed his project in 2014, and since then, there has been a gap in GRF funding. However, a new iteration of the GRF program is being developed by NOAA and NERRS.

NERRS System-Wide Monitoring Program

The goal of SWMP is to provide long-term data on water quality, weather, biological communities, habitat, and land use and land cover characteristics. The NERRS Centralized Data Management Office (CDMO) provides data quality control and access to real-time and historic data through their publicly accessible website.

The SWMP Plan (NERRS 2011) documents the monitoring approach that is applied across the national system, including a suite of standard approaches that are applied as tools to address monitoring needs specific to each Reserve site. SWMP elements have been grouped into "toolkits" according to the nature of the parameters they measure and the products they generate. The toolkits include abiotic and biotic, mapping, data analysis and interpretation, translation, and education. SWMP elements from various toolkits may be packaged together into application modules to address specific management issues or answer specific research questions. Because they employ standardized protocols, SWMP Application Modules provide a mechanism for comparing SWMP information and products across NERRS. The *2016 Sentinel Sites Guidance Document* (NOAA, 2016) details the standard operating procedures for Sentinel Site Application Module 1 (SSAM-1): Coastal Habitat Response to Changing Water Levels. This first application module developed for NERRS' SWMP data is focused on understanding changes in sea levels; inundation; and the associated responses of marsh, mangrove, and submerged aquatic vegetation.

Hudson River Reserve Monitoring

The Reserve engages in the following SWMP and related monitoring activities.

SWMP Abiotic Monitoring

The Reserve's primary SWMP sites include Tivoli North Bay and Tivoli South Bay and their respective main tributaries, Stony Creek and Saw Kill (Table 2). Since 1991, the Reserve has collected monthly samples at these sites and measured water temperature, specific conductivity, salinity, dissolved oxygen (% and mg/L), total suspended solids, chlorophyll a, nitrate, ammonium, phosphate, chloride, and sulfate. Since 1995, the Reserve has also collected continuous (15-minute) water quality SWMP data using Yellow Springs Instrument (YSI) sondes, including water temperature, specific conductivity, salinity, dissolved oxygen (% and mg/L), depth, pH, and turbidity.

Since 1999, the Reserve has collected continuous (15-minute) meteorological SWMP data at the Bard College Field Station (adjacent to the mouth of the Saw Kill where it meets Tivoli South Bay), including air temperature, barometric pressure, photosynthetically active radiation (PAR), rainfall, relative humidity, wind direction, wind gusts, and wind speed. The Reserve's SWMP implementation strategy will be re-evaluated using a needs assessment process in anticipation of the possible loss of the Saw Kill station due to removal of the dam to which it is attached. The NERRS SWMP Oversight Committee and Data Management Committee will be consulted to determine the best strategy.

Related Abiotic Monitoring at the Reserve

Since 1991, the Reserve has collected monthly water samples beyond the SWMP program at three tidal wetland-tributary stream paired locations: Stockport Flats and Stockport Creek, Iona Island and Doodletown Brook, and Piermont Marsh and Sparkill Creek (Table 2). Monthly nutrient data collected here since 1991 include the same parameters as the SWMP nutrient data (see above). In 2007, additional non-SWMP stations also were established outside the Reserve boundaries at the Norrie Point Environmental Center and the adjacent tributary, Indian Kill. Since 2007, monthly nutrient data, including the same parameters as the SWMP nutrient data, have been collected. In addition, at Norrie Point Environmental Center only, continuous (15-minute) water quality non-SWMP data have been collected using YSI sondes since 2007, including the same parameters as the SWMP water quality data. Continuous (15-minute) meteorological SWMP data collected at Norrie Point since 2007 include the same parameters as the SWMP meteorological data. Norrie Point water quality and meteorological data are publicly available on the Hudson River Environmental Conditions Observing System website. As the Reserve re-evaluates the SWMP implementation strategy, it will consider adding new Reserve component sites as SWMP sites.

Abiotic Monitoring Data Needs Assessment

In 2017, Reserve staff commissioned a needs assessment to identify the needs of end-users for SWMP and non-SWMP monitoring data, and the degree to which they were aware of and used these data. The overarching findings from this needs assessment were that Reserve data are under-used, primarily because educators, natural resources managers, and researchers do not know about them. Participants agreed that the Reserve data are vital for exploring environmental questions such as how climate change is affecting wetlands and the relationship between land uses and ecological changes over time. Immediate next steps resulting from the needs assessment process are to conduct a full analysis of the historic Reserve SWMP and non-SWMP data, and to produce an outreach product that will be accessible on a public website. Funding has been identified to contract with LimnoTech to conduct these analyses. Going forward, the Reserve will explore the use of nutrient probes on YSI dataloggers to meet the identified need for publicly available real-time nutrient data. SWMP nutrient monitoring will continue as a method for field verification of the nutrient probes.

Table 5: Reserve Abiotic Monitoring						
Station	**River Mile**	**Continuous Water Quality Data ***	**Monthly Nutrient Data ^**	**Continuous Meteorological Data ~**	**HRECOS Data Access****	**CDMO Data Access^^**
Stockport Flats	120	1995	1991	N	N	Y
Stockport Creek	120	1995	1991	N	N	Y
Tivoli North	100	1995	1991	N	Y	Y
Stony Creek	100	1995	1991	N	N	Y
Tivoli South	100	1995	1991	N	Y	Y
Saw Kill	100	1995	1991	N	N	Y
Tivoli Field Station	100	N	N	1999	Y	Y
Indian Kill Creek	85	N	2007	N	N	N
Norrie Point	85	2007	2007	2007	Y	N
Iona Island	45	N	1991	N	N	N
Doodletown Brook	45	N	1991	N	N	N
Piermont Marsh	25	N	1991	N	N	N
Sparkill Creek	25	N	1991	N	N	N

* Water quality parameters: depth, dissolved oxygen, temperature, conductivity, salinity, pH, turbidity, and chlorophyll

^ Nutrient parameters: ammonium, nitrate, phosphate, sulfate, chloride, suspended sediment, and chlorophyll

~ Meteorological parameters: air temperature; relative humidity; barometric pressure; precipitation; photosynthetically active radiation; and wind gust, speed, and direction

** Hudson River Environmental Conditions Observing System http://www.hrecos.org/

^^ NERRS Centralized Data Management https://cdmo.baruch.sc.edu/

Turkey Point Tide Station

Until recently, the Reserve's Tivoli Bays sentinel site was more than 100 miles from the closest National Water Level Observing Network (NWLON) station. Local tidal datums had to be extrapolated from the Battery station in New York City for the Marsh Resilience to Sea-Level Rise (MARS) data analysis and other local tidal datum needs. In 2014, the Reserve constructed the Turkey Point tide station, located on the western shore of the Hudson River approximately one mile from the study site, through a partnership with the DEC Hudson River Estuary Program and the NOAA Center for Operational Oceanographic Products and Services (CO-OPS). Provisional Turkey Point tide data were made publicly available on NOAA's Tides and Currents website on September 18, 2017, and CO-OPS station validation was finalized in the spring of 2018.

The Turkey Point data increase the accuracy of NOAA tide predictions for the Hudson River, improving navigational safety and informing sea level rise and climate change research.

Tivoli Bays Marsh Resilience Monitoring

Reserve staff have implemented NERRS biological monitoring and sentinel sites protocols at four Tivoli Bays sites since 2011. Sentinel site monitoring includes vegetation transects, surface elevation tables, a water quality station, and groundwater wells. Real-time kinetic surveying is used in conjunction with the regular monitoring to measure the elevation of all components and establish vertical control. At all sites, vegetation transect monitoring and marsh elevation surveys were conducted annually from 2011 through 2015. After five years, the emergent marsh data were analyzed, and it was

determined that there were no significant shifts in vegetation at the annual time scale. Starting in 2016, the Reserve shifted to monitoring each of the three sites on a three-year rotation, with the submerged aquatic vegetation site still monitored annually due to its more dynamic nature. At each emergent marsh site, three Surface Elevation Tables (SETs) are measured spring, summer and fall. Reserve sentinel site data were included in the MARS indices published in "Assessing tidal marsh resilience to sea-level rise at broad geographic scales with multi-metric indices" (Raposa et al. 2016). The MARS index will be recalculated periodically to assess changes in marsh resilience.

Piermont Marsh Resilience Monitoring

In 2018, sentinel site infrastructure was installed in Piermont Marsh. By implementing SSAM-1 protocols, data collected at Piermont Marsh can be compared to similar studies within the Hudson River (Tivoli Bays) and compared to similar marshes at other NERRS sites at both a regional and national scale. Piermont Marsh shows some visual evidence of edge erosion and expansion of interior pannes—depressions within the wetland—that could indicate degradation. Piermont Marsh is also dominated by invasive *Phragmites australis*, which has expanded in a monoculture and limited the biodiversity of the native vegetation. SSAM-1 infrastructure will be installed strategically to address marsh management questions, particularly to assess the impacts of potential *Phragmites* management, and the potential need to perform thin layer placement of sediment if the panne expansion is causing degradation due to a diminished sediment supply to the marsh interior.

Reserve Research Focus Areas

The Reserve conducts independent research, works on collaborative research projects with a variety of partners, and provides logistical support to partners on research projects. This work is conducted in the Reserve's four component sites as well as in the entire Hudson River watershed south of the Troy Federal Dam.

Habitat Inventory and Assessment

Reserve Site Tidal Wetland Inventories

The tidal wetlands in the Reserve component sites span a salinity gradient that includes globally rare freshwater tidal wetlands. To characterize and monitor change in the Reserve's tidal wetlands, inventories were conducted in 1991, 1997, and 2005 using aerial photography obtained for all four Reserve component sites. Twenty categories of vegetation were delineated in accordance with the Tier 1 mapping protocols of SWMP. Multiple inventories were conducted so that habitat change over time can be analyzed. The Reserve's vegetation maps were accepted as a final NERRS Habitat Mapping and Change product on July 13, 2012.

Estuary-Wide Tidal Wetland Inventories

In 2007, a tidal wetlands inventory of the Hudson River estuary from Hastings to Troy was mapped using 13 vegetation categories. Since Hudson River tidal wetland maps were produced in 2007, a full tidal wetland mapping inventory has not been repeated, but a tidal wetland habitat map was interpreted from the 2014 photos for just Piermont Marsh as part of a restoration planning effort. Future funding will be sought in order to repeat the tidal wetland mapping inventory of the entire Hudson River estuary, including a change analysis with the 2007 maps to assess areas of tidal wetland loss or expansion, including horizontal migration.

Estuary-Wide Submerged Aquatic Vegetation Inventories

Submerged aquatic vegetation (SAV) has vital ecosystem functions, including elevating dissolved oxygen in the water column and providing habitat for many life stages and species of fish, birds, turtles, and invertebrates. In 1995 and 1997, the first comprehensive inventory of SAV from Troy to Hastings was completed by Cary Institute of Ecosystem Services (IES), Cornell University, and the Reserve. Vegetation mapping categories included SAV, which is dominated by native *Vallisneria americana*; the invasive water chestnut *Trapa natans*, which competes with SAV; unvegetated open water; and upland. Subsequent inventories were completed in 2002, 2007, 2014, and 2016. The team developed the Hudson River Estuary Documented SAV dataset that illustrates areas of mapped SAV in all inventories combined for use in regulatory decision making. Future SAV inventories will use higher-resolution digital photography, and the possibility of accurately identifying and mapping specific species of SAV will be explored.

Citizen Science SAV Monitoring

Since 2013, SAV has been monitored annually by citizen scientist volunteers through a program co-managed by the Reserve and the Cary IES and funded by the Estuary Program. This program provides data for years when SAV is not mapped, and informs key SAV management decisions, such as determining whether SAV restoration or planting efforts are needed following major storms.

Estuary-Wide Benthic Habitats

Over the last 20 years, the Reserve has overseen the collection of detailed bathymetry and other sonar data for most of the estuary (91,000 acres) working with the Hudson River Estuary Program, NOAA, Columbia University, The State University of New York (SUNY) Stony Brook, and other partners. Independently, NOAA has recently surveyed much of the deeper part of the estuary and the data has been released. Feedback indicates that the public (engineering firms and local municipalities, in particular) are most comfortable using bathymetric data in the form of contour maps. In the next few years, Reserve staff will create contour maps of bathymetry for the estuary with water depths relative to mean lower low water (MLLW), the same vertical datum as NOAA charts. Temporal change in areas with survey data from different years will be examined. This will add to the current information on how areas of the estuary are gaining or losing sediment. This research has also been coupled with fish tracking to better understand how species of concern utilize specific types of benthic habitats.

Hudson River Sustainable Shorelines Project

The Reserve and several partners launched the HRSSP in 2008 to enhance knowledge of and confidence in the suitability of natural and nature-based shoreline stabilization techniques in the Hudson River estuary. It has continued through four NSC-funded research and information transfer phases and resulted in a significant body of engineering, ecological, and other shorelines information and tools (available at www.hrnerr.org). The Reserve's training staff supported the development of statewide guidance under the 2014 New York State CRRA related to natural measures to promote resiliency. The Reserve will continue to promote the use of Sustainable Shorelines guidance in the regulatory process. Other shoreline scientific and management topics will be explored as need and opportunity arise, including establishing monitoring methodologies to assess shoreline function and the effects of intense storms on shoreline performance.

Tidal Marsh Services and Management

Piermont Marsh Role as a Buffer

The Reserve participates in another NSC project, Understanding the Role Coastal Marshes Play in Protecting Communities from Storm Surge and Flooding, funded from 2016 to 2019 and led by Dr. Y. Peter Sheng of the University of Florida (UF). The project team (UF, University of Miami, and USGS) is using state-of-the-art predictive models and local vegetation measurements to evaluate different approaches to managing the marsh. As a result, marsh managers will better understand the role of coastal wetlands in enhancing community resilience to storm events and will have the tools and knowledge to make sound decisions about management of coastal marshes.

Thin Layer Placement for Wetland Restoration

Reserve staff participated in a Mid-Atlantic regional NERR project connecting SSAM-1 data to support thin layer placement (TLP) of sediment for wetland restoration. Findings from a needs assessment informed planning for an April 2018 regional workshop that engaged NERRS staff and stakeholders. A data and tools inventory and a roadmap were also developed to assist reserves from other regions to apply NERRS and partner data to broader decision making. The Reserve is supporting the development of a potential collaborative research project that will connect historical marsh data, assessed through sediment cores and aerial photography change analyses, to a predictive sediment cohort model that would inform TLP decisions by evaluating marsh degradation.

Watershed-Estuary Linkages

Dams and Sediment on the Hudson (DaSH)

Another NSC project, funded 2016 to 2019, is led by Dr. David Ralston of Woods Hole Oceanographic Institution to address needs identified by managers and regulators. The research is assessing the potential impacts that dam removals have on sediment transport in the estuary and deposition in downstream tidal wetlands, including how these dam-derived sediments might help offset future sea level rise impacts. The approach combines field observations with analysis of sediment transport using a proven hydrodynamic model. The project will develop watershed assessment tools for permitting dam removals and establish an improved scientific basis for considering the potential downstream benefits in regulatory decision making.

Climate Adaptation Impacts

NY Harbor Surge Barriers

The Reserve is a partner in a one-year NSC project funded in 2018–2019, led by Dr. Philip Orton of the Stevens Institute of Technology to inform decision making related to the storm surge barriers for the New York metropolitan area. The project will engage a broad array of scientists to supplement a study by USACE and to address complex and pressing information needs. This is being achieved through a stakeholder-guided approach with an advisory panel comprising decision-maker end users, collaborator end users, and science advisers. Outputs will include a scope of work to augment the USACE project scope of work, modeling and scientific analyses of estuary physical processes, and written plans for expanding the research and the scientific community involvement in decision making for storm surges.

Key Research Partnerships

The Reserve benefits from work with a host of partners who are integral to the success of the research and monitoring programs. These partners have helped direct the research focus, attract research scientists and funding, implement research and monitoring programs, and extend research and monitoring results to decision makers and managers. Although this is not a complete list of important partners, it includes partners with whom the Reserve currently have a formal work agreement. Research institutions that the Reserve partners with on grant-funded research projects are mentioned in the research focus areas section of the management plan.

Hudson River Estuary Program

NYSDEC's Hudson River Estuary Program has provided financial and other project support to many Reserve research and monitoring priorities, enabling substantial work on the identification, mapping, change analysis, functional assessment, and restoration of key aquatic habitat types, such as submerged aquatic vegetation, tidal wetlands, shoreline, and river bottom.

Hudson River Foundation

The Hudson River Foundation has co-sponsored and underwritten the Polgar Fellowship Program since 1985, which has generated a wide-ranging body of Hudson River research, much of it at Reserve sites.

U.S. Coast Guard

The Coast Guard granted permission for the installation of a water level monitoring station at Turkey Point funded by the Hudson River Estuary Program. The Turkey Point Tide Station was installed in November of 2014.

National Ocean Service Center for Operational Oceanographic Products and Services

Through an agreement with NOAA Office for Coastal Management, a CO-OPS work plan was established to partner with the Reserve for the NWLON validation and dissemination of the Turkey Point tide station data.

Cary Institute of Ecosystem Studies

Cary IES scientists have served in leadership roles on Reserve research advisory committees, restoration plan review, and sustainable shorelines projects; provided access to the analytical laboratory's services and equipment for water monitoring; monitoring of submerged aquatic vegetation; and functional assessment of shoreline habitats.

Cornell University

Tidal wetland and SAV maps were produced in partnership with the Cornell Institute for Information Sciences (IRIS). The Reserve continues to contract with IRIS to develop future mapping products.

Bard College

The Reserve coordinated with Bard College's Environmental and Urban Studies Program to support their advancement of a watershed conservation plan and continue to collect data and maintain the weather station at the Bard College Field Station.

Palisades Interstate Parks Commission

At Iona Island, the Reserve collaborated with PIPC to install and monitor surface elevation tables to help inform *Phragmites* and marsh management.

Fellowships and Internships

Polgar Fellowship Program

The Tibor T. Polgar Fellowship program was created in 1985 in partnership with the Hudson River Foundation, with initial NOAA research funding. This competitive program has supported summer research projects undertaken by eight graduate and undergraduate students each year, and produced a large body of research about the Hudson River estuary and its watershed.

NOAA Fellowship Programs

Students may apply through NOAA to become a Hollings Scholar for estuarine studies. NOAA has also partnered with selected colleges, including Holy Cross, to provide undergraduate students with college-funded summer internship opportunities. The Reserve hosted several Holy Cross interns from 2011–2016.

New York State Internships

The Reserve also actively recruits student interns through the "*New* New York Leaders Initiative," a statewide student intern program, to give several students each college semester the opportunity to assist with SWMP and sentinel sites monitoring. Many of these students are from Marist College and the SUNY New Paltz.

Information Dissemination

The Reserve's research program ensures that Reserve data and data products are publicly accessible through several avenues. The Reserve's website (www.hrnerr.org) provides easy public access to project findings, documents, and tools. A 2005 site profile summarized knowledge about Reserve sites. The NERRS Centralized Data Management Office provides access to the Reserve's SWMP data and metadata via an online information server (www.nerrsdata.org). Norrie Point non-SWMP water quality and meteorological data are publicly available through the Hudson River Environmental Conditions Observing System (HRECOS) (http://www.hrecos.org/). All GIS mapping products generated by or through the Reserve are publicly available on the New York State GIS Clearinghouse (https://gis.ny.gov/). Turkey Point Tide Station data are validated by CO-OPS according to their QAQC protocols, and are immediately made publicly available on the NOAA Tides and Currents website (https://tidesandcurrents.noaa.gov).

Research Permits

Permits are required to conduct research within the Reserve. The Reserve's research guidelines and the Parks/PIPC research permit application can be found in Appendices 5 and 6, respectively.

Objectives and Strategies

Objective 1: Hudson River National Estuarine Research Reserve and regional estuarine habitat management needs are identified and met through partner collaborations and the dissemination of scientific research and data products.

Strategies

- Participate in national, Mid-Atlantic regional, and New York State initiatives through DEC and NERRS meetings and committees to identify research needs and implement research priorities.
- Seek funding for and support the collaborative development of natural and social science research projects through the NSC and other funding sources.
- Facilitate the dissemination of research results and data to researchers, resource managers, educators, and others through the delivery of data products, reports, and publications in an integrated effort with the Reserve's restoration, education, and estuary training programs.

Objective 2

Hudson River National Estuarine Research Reserve researchers and resource managers better understand long-term trends and short-term variability through the Reserve's continuous monitoring of abiotic parameters and analysis of time-series data.

Strategies

- Fully implement the NERRS SWMP abiotic protocols at the Tivoli Bays component site and deliver data through the NERRS Centralized Data Management Office website.
- Maintain HRECOS water quality and meteorological stations at Norrie Point and Tivoli Bays, and deliver data through the HRECOS website.
- Evaluate need for and utility of monthly non-SWMP nutrient data and, if warranted, continue data collection and analysis using current methods or field-testing nutrient probes while remaining in compliance with SWMP protocols.

Objective 3

Hudson River National Estuarine Research Reserve researchers and resource managers better understand the impacts of climate change on Reserve estuarine habitats.

Strategies

- Collaborate with partners in New York State and in the Mid-Atlantic region to assess data and information needs, and deliver data products that improve the understanding of coastal habitat response to changing water levels.
- Fully implement the NERRS SSAM-1 protocols to monitor SAV and tidal wetland habitat response to changing water levels at the Tivoli Bays and Piermont Marsh.
- Perform annual analyses of all SSAM-1 data with a statistical comparison to historic data and submit annual biological monitoring reports to NERRS.
- Maintain the Turkey Point tide station in compliance with NOAA NWLON protocols to assess long-term changes in water level.

Objective 4

Tidal wetland and SAV habitat location, distribution, and change over time are documented by remote sensing and field observations.

Strategies

- Collect aerial photo inventory of the Hudson River estuary every two years and assist with the production of GIS map interpretations of SAV in partnership with Cornell University IRIS and DEC's Hudson River Estuary Program.
- Oversee the Cary Institute of Ecosystem Studies SAV Volunteer Monitoring Program to annually assess habitat change and function between mapping inventories, in collaboration with the Estuary Program.

Objective 5

Hudson River National Estuarine Research Reserve research by students and visiting scientists is well informed and supported.

Strategies

- Coordinate the Tibor T. Polgar Fellowship Program in partnership with the Hudson River Foundation, fund eight student research projects per year, and produce research reports for public distribution.
- Seek student interns through the "*New* New York Leaders" program, the Hollings Scholars program, and the NOAA College-Supported Internship Program to extend the research program.

Promote and facilitate research by outside partners within the boundaries of the four Reserve component sites and report all Reserve research activities on the NERRS Research Database.

Stewardship and Restoration

Introduction

Stewardship of natural resources is a major programmatic focus of the Reserve, along with research, training, and education. Stewardship of the Reserve's lands and waters rests in the hands of several management agencies and public stewards who undertake actions to promote stewardship of Reserve sites and resources. It also rests in the hands of the many people who visit the Reserve and may directly affect the Reserve's natural resources.

In partnership with other state agencies and conservation partners, the Reserve strives to practice sound natural resource management that exemplifies wise coastal stewardship within its borders, as well as throughout the Hudson River estuary. The Reserve works closely with the Hudson River Estuary Program and other partners to advance knowledge of river habitats, and to implement the Hudson River Habitat Restoration Plan. The Reserve also offers technical assistance to communities and organizations on stewardship and restoration.

This chapter describes management objectives and strategies; the resource protection plan, including the organizational frameworks for management of each site; types of stewardship and restoration; and the Reserve's habitat restoration activities.

Site Management Frameworks

Each Reserve site has a different complement of managers and partners who participate in site stewardship and management. There is no central controlling body that orchestrates management at each site or overall. These managers and stewards vary in the degree to which they engage with the Reserve, with some in contact on a regular and frequent basis and others on an occasional basis.

Stockport Flats has the most complex management structure, as the five-mile site includes three sub-units: Nutten Hook, Hudson River Islands State Park, and the Stockport Marshes. Nutten Hook is managed principally by Reserve staff, with significant support from DEC Region 4 operations staff. The Town of Stuyvesant leaders have long had a keen interest in enhancing public access to this site, and meet periodically with DEC staff. The Scott Ice House and an accessway is protected by a conservation easement held by Scenic Hudson, which conducts an annual easement inspection. The Greenway Conservancy has administered a mitigation account established for access work at Nutten Hook in cooperation with the Reserve and DEC Region 4. The administrative lead for the Hudson River Islands State Park is the NYS Parks' Saratoga-Capital District Region, although scarce resources have limited direct site management in recent years. The Stockport Marshes portion of the site is administered by the Reserve, with input and support from DEC Region 4 Operations and Lands and Forests (for squatter cabin removal), as well as DEC Wildlife staff, who also manage the adjoining Stockport Wildlife Management Area.

The Tivoli Bays component is managed as a collaboration among three DEC Region 3 programs: Wildlife, Marine Habitat/Reserve, and Operations. These managers coordinate regularly on stewardship, maintenance, and access projects to manage the Tivoli Bays as a NERRS site, a Wildlife Management Area, and a Natural Heritage Area. They are supported by members of the Bard College community who help with eel passage and tributary monitoring, and allow continued operation of a weather station at the Bard College Field Station. The Red Hook Trails Committee coordinates with DEC staff on management of the trail network. The Reserve helped launch the Saw Kill Watershed Community, which is actively

engaged in tributary stream water monitoring and watershed stewardship. Other partners, such as the staff of Hudsonia Ltd., serve as additional eyes and ears on the ground and routinely share information about site conditions or issues.

Iona Island is actively managed by PIPC stewardship staff, with support from PIPC law enforcement and operations staff, and Bear Mountain State Park staff. PIPC stewardship staff regularly advise and consult Reserve staff about site restoration, invasive plant control, monitoring, and public access topics. PIPC stewardship and Reserve staff have also collaborated on the installation of surface elevation tables in the tidal wetlands at Iona. The League of Naturalists based at Bear Mountain monitor a variety of species at Iona Island.

Piermont Marsh is mostly within the Tallman Mountain State Park and part of the Palisades Interstate Park. The northern 10% of the marsh is under the jurisdiction of DEC. Underwater lands within the Reserve are under the jurisdiction of NYS OGS, DEC, and PIPC but there has been no active management of these. Parks and Reserve staff work closely on marsh monitoring and management, most recently on developing a draft management plan for the Piermont Marsh Reserve (https://www.dec.ny.gov/docs/remediation_hudson_pdf/hrnerrpiermontplan.pdf), Appendix 9. The Sparkill Creek Watershed Alliance has been active in watershed protection and the promotion of green infrastructure to enhance water quality and diminish flooding.

Resource Management, Habitat Restoration, and Resilience Building

Resource Management

The Reserve sites contain diverse and significant natural resources. All the sites include a variety of ecological communities, many of them uncommon in the state, while others are globally rare. These communities, especially the aquatic ones, provide critical habitat for a host of species, including several rare plants and animals. In addition to providing habitat, the Reserve sites perform many critical ecosystem services, including production and transport of nutrients and organic matter, removal of nutrients and contaminants, reduction of wave energy during storms, storage of flood water, and trapping of sediment. In some cases, sustaining the natural resources itself depends on resource management.

Habitat Restoration

Although the Reserve contains some of the best examples of native Hudson River estuarine natural communities, historically these sites have been affected negatively by invasive plant species, altered hydrology, land use patterns, and dredging and filling activities associated with the construction of the federal navigation channel and railroad dikes. While many of these impacts are irreversible, there are opportunities for enhancing ecosystem function in the Reserve through habitat restoration, in keeping with an estuary-wide restoration plan (Miller 2013).

Building Habitat and Ecosystem Resilience

Many of the Reserve's habitats are vulnerable to the direct and indirect changes associated with rapid climate change, including accelerated sea level rise, more intense storms, more frequent surge, changing patterns of drought and rainfall, and increasing heat. Of major concern is whether the Reserve's tidal wetlands will be able to keep up with or adapt to changing water levels and other factors. The Reserve is committed to exploring these issues and piloting techniques to enhance resilience, and is prepared to act if or when it becomes necessary.

Stewardship and Restoration Projects by Site

Stockport Flats

Gay's Point Side Channel Restoration and Monitoring

Reserve staff began working with the New York State Thruway Authority in 2013 to design and implement the restoration of a tidal side channel at Stockport Flats. The project is the first of its kind in the Hudson River estuary and is intended to restore a mosaic of shallow water, tidal wetland, and shoreline habitats. These valuable habitats, particularly in the upper estuary, were destroyed on a large scale in the early twentieth century because of dredge and fill activities associated with the construction of the federal navigation channel. Preliminary feasibility studies for construction of the side channel included environmental and biological surveys, and hydraulic and sediment transport modeling. Baseline biological surveys in 2015 and 2016 included assessments of water quality, sediments, benthic macroinvertebrates, fish, and intertidal vegetation at both the project and reference sites. Construction of the 1,200-foot-long by 65-foot-wide side channel began in August 2017 and was completed by early November 2017. The project involved the excavation and onsite reuse of approximately 20,000 cubic yards of historical dredge spoils and the installation of more than 5,000 native plant plugs and 600 live stakes. Five years of post-restoration monitoring will began in 2018.

Phragmites Control

Intertidal freshwater marsh is extensive throughout the Stockport Flats component site. In 2012, The Nature Conservancy (TNC) was funded to map and initiate management efforts of several clones of invasive *Phragmites* in Stockport Flats. Since then, Reserve staff have managed bi-annual mapping and control efforts to maintain the progress made by TNC. Monitoring has demonstrated that *Phragmites* coverage was reduced by more than 95%. Staff will continue vegetation-community monitoring. If needed, emerging small stands of *Phragmites* will be spot-sprayed with an approved glyphosate on a bi-annual basis.

Sustainable Shoreline Project at Ferry Landing

In partnership with the Estuary Program and the Hudson River Greenway, a sustainable shorelines demonstration site was designed with the goal of stabilizing the shore and enhancing or improving habitat value and human-use activities. The final design incorporated engineered elements to provide stability augmented by plant materials and shallow sloping intertidal areas to provide habitat for fish and wildlife. A fishing platform was included to give anglers and sightseers access to the water and to direct foot traffic away from intertidal shoreline vegetation. The project will be done in 2019–2020.

Tivoli Bays

Phragmites Control

Invasive *Phragmites* was first mapped in Tivoli North Bay in 2006. Since then, annual, and subsequently, bi-annual spraying of existing treatment sites has contained and reduced the amount of *Phragmites* by over 95%. Recovery of native plant communities has been vigorous in treated areas. Reserve staff map standing dead *Phragmites* in early spring to identify places where small areas of the plant persist, and undertake spot control on a bi-annual basis as needed.

Eel Passage

A small "trap-and-pass" eel ladder was installed at the lowest dam on the Saw Kill on Bard College property in 2004. Since then, eels have successfully passed over the dam with the help of local community volunteers and students from Bard College and Simon's Rock of Bard College. The eel ladder will be used for as long as the dam remains in place. However, the eel ladder has also drawn attention to the dam and raised awareness of its environmental impacts. Bard College has recently decided to seek funding to remove the dam, in which case eel passage will no longer be needed at the site.

Young Forest Initiative

DEC Region 3 Wildlife staff is developing a Habitat Management Plan to guide habitat management decision making on areas within the Tivoli Bays WMA, which is coterminous with the Reserve, to benefit wildlife and facilitate wildlife-dependent recreation. One habitat management goal is to create 30 acres of young forest (or 5% total forested area) to provide food and cover for American woodcock and white-tailed deer and nesting cover for wild turkey. Remaining habitat areas in the WMA will continue to be maintained for their current benefits.

Iona Island

Tidal Marsh Restoration

PIPC has been managing for native tidal marsh communities at Iona Island since fall 2008, when it began to manage a 10-acre trial area under a three-year DEC Invasive Species Eradication Grant. This grant enabled control of *Phragmites australis* through use of a wetland-approved herbicide. By 2010, the management regime had reduced *Phragmites* cover from 70% to less than 5% of the pilot area. The project site recovered passively, with plants emerging from the existing seed bank. It was fully revegetated with a diverse mix of native marsh plants by 2012. Among these were large colonies of state rare species (e.g., annual salt marsh aster, yellow-flat sedge, and New England bulrush), which had been nearly extirpated due to *Phragmites* competition. Annual breeding bird surveys also revealed the return of marsh specialist birds, including Virginia rail, marsh wren, and the state-threatened least bittern. Based on the positive outcome of the pilot area, PIPC extended *Phragmites* management to an additional 32 acres in 2013 and another 20 acres in 2017. Winter mowing of dead *Phragmites* was added to the management sequence to improve conditions for native seed germination. This resulted in a faster response trajectory for the 32-acre area begun in 2013.

In 2014, PIPC installed a tide gate on a culvert to allow inundation of a formerly diverse, 3.5-acre tidal wetland that had become dominated by a *Phragmites* monoculture at the northeast corner of the marsh. Although inundation paired with periodic mowing has curtailed *Phragmites* growth in this area, managers were not able to achieve a sufficient water depth for complete *Phragmites* control. Plans to raise an adjacent road bed which frequently floods may provide greater water depth and more effective control through inundation in the future.

Through these two approaches (herbicide and inundation), a total of 65.5 acres (43% of the marsh) is currently under active management.

Control of Upland Invasive Species

The uplands at Iona support a wide array of invasive species given the island's disturbance history (it was formerly a navy base) and its location in the lower Hudson Valley of New York. While there is no program to eliminate invasive plants from the island, PIPC site managers manage several invasive plant species of local or regional importance. Mile-a-minute vine is a relatively recent invader at Iona and has been the subject of a coordinated control effort among land managers and conservation groups in the Hudson Valley. In 2005, Iona was the first location in New York State to receive biocontrol weevils (*Rhinoncomimus latipes*), approved for release by the U.S. Department of Agriculture (USDA) and previously distributed in Mid-Atlantic states for mile-a-minute control. Additional releases were made annually through 2016. In 2009, PIPC partnered with the Glynwood Center under its innovative agriculture grant program, and conducted a goat grazing experiment on mile-a-minute.

A severe outbreak of gypsy moths in 2017 and 2018 was treated with aerial applications of Gypchek in 2017 and *Bacillus thunbergii* in 2018 to protect the island's chestnut oak forest, a significant natural community type. Results of the spring 2018 treatment look promising. Over a ten-year period beginning in 2006, USDA researchers studied the phenology, insect pests, and pathogens of black swallow-wort, another invasive plant found on the island.

Piermont Marsh

Phragmites Control (Solarization)

Beginning in 2014, the Lamont-Doherty Secondary School Field Research Program undertook a series of pilot projects to control the non-native strain of *Phragmites australis*. Students used black geotextile to cover small areas of previously flattened *Phragmites* in the northeast part of the marsh to deprive the plants of sunlight, and in time, kill the rhizomes and roots. It presented an opportunity to study the impacts of this non-chemical control technique on the seed bank, vegetation recovery patterns, and marsh surface elevation. Reserve staff will work with program leaders to determine how best to advance this project, including duration of the experimental approach, monitoring strategies, and next steps.

Eel Passage

A small, portable eel ladder was constructed and installed on the first dam on the Sparkill Creek in Piermont, NY. The ladder is designed to be lifted by block and tackle to a walkway at the top of the dam, where volunteers can safely remove eels and pass them upstream. The ladder will be re-installed annually, and passage rates of eels will be monitored by local volunteers.

Objectives and Strategies

Objective 1

Reserve lands are adaptively managed to conserve rare species and sustain biodiversity and critical ecosystem functions, while providing opportunities for research, education, and recreation.

Strategies

- Coordinate closely with partner agencies and organizations on Reserve land management and stewardship priorities, activities, and funding needs.
- Periodically inventory and monitor Reserve sites to identify critical natural resources, changing issues and threats, and management needs and opportunities.
- Where priority natural resources are threatened, implement and monitor invasive species control and prevention measures at Reserve sites.
- Foster healthy populations of rare plants and wildlife species of greatest conservation need (e.g., American shad, American eel, least bittern, northern diamond-backed terrapin, eastern grasswort, etc.).
- Support initiatives to keep Reserve upland forests healthy and diverse to provide habitat for early successional species and, where allowed, opportunities for hunting.
- Foster a range of ecosystem services at Reserve sites; for example, maintain an adequate vegetation buffer at Piermont Marsh to maintain or enhance the marsh's capacity to buffer adjoining communities from storm surge.
- Where artificial barriers are present, improve diadromous fish passage, especially eel passage, in tributaries to Reserve sites.

Objective 2

Regional stewardship and restoration initiatives and plans are supported to encourage a watershed approach to environmental management.

Strategies

- Work with partners to restore priority estuarine habitats identified in the *Hudson River Habitat Restoration Plan* (Miller 2013), including intertidal marshes, vegetated shallows, natural and nature-based shorelines, and tributaries.
- Advance tidal wetland and SAV habitat conservation targets identified in the *Hudson River Estuary Action Agenda 2015–2020*.

Objective 3

Reserve tidal wetlands are resilient and, where feasible and appropriate, migration pathways are conserved or created by improving tidal connectivity.

Strategies

- Evaluate methods for enabling marsh surface elevations to keep up with sea level rise; for example, thin layer deposition of sediment.
- Explore methods for preventing marsh edge retreat using sills or other structures.
- Map areas in the 500-year floodplain within and adjacent to Reserve lands where sea level rise will, in time, create conditions for intertidal wetlands to exist, and identify and pursue opportunities to permanently conserve these pathways.
- As sea level rises, facilitate the migration of tidal wetlands by removing tidal restrictions that limit hydrologic connectivity.

Objective 4

The Reserve's restoration science, demonstration and pilot projects, adaptive management, and stewardship inform regional restoration and natural resource management and resilience planning.

Strategies

- Provide technical assistance to communities and partner organizations to advance regional restoration planning and implementation.
- Develop and distribute case studies of innovative projects.
- Provide networking and training opportunities to help municipalities and organizations increase their effectiveness and ability to conserve, restore, and manage coastal habitats, and to enhance natural and community resilience.
- Provide information and technical support to help citizen groups, organizations, and individuals identify and complete coastal restoration projects.
- Provide support for long-term monitoring of abiotic and biotic elements of restored habitats.

Land Acquisition

Introduction

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. The Reserve's plan for land acquisition is consistent with NOAA's regulatory guidelines, which appear in the introduction to this plan, as well as emerging NOAA guidance relative to ensuring long-term resilience of reserves. All completed acquisition projects as well as land acquisitions in progress since the last management plan are within the current Reserve boundaries and do not require a boundary expansion.

Completed Projects

In the last decade, DEC acquired several private in-holdings and accepted a transfer of jurisdiction of state lands from OGS, all within the Reserve boundary. The transfers are completed using a couple of acquisition methods and a variety of funding sources. The acquisition methods are State Land Purchase (SLP) and Transferred Jurisdiction (TJ). The funding sources include Coastal Estuarine Land Conservation Program (CELCP), Environmental Protection Fund (EPF), and Pittman Robertson (PR).

- **SLP Columbia 42.07** – Scenic Hudson (Grantor); 305.834 acres; $1.6 million (CELCP)

  Date of Acquisition: 5/15/2013

  Location: Towns of Stuyvesant and Stockport

  Description: This property is commonly referred to as the "Plotkin Acquisition." Deed parcels #1 and #2, totaling 86.849 acres, are within the Reserve and lie west of Route 9J and the railroad corridor. Deed Parcel #3, totaling 218.985 acres, is comprised of uplands on the east side of state highway 9J.

- **SLP Columbia 42.08** – from Michael Colligan (Grantor); 0.225 acres; $10,000 (EPF)

  Date of Acquisition: 7/8/2016

  Location: Town of Stuyvesant

  Description: This was a small tax foreclosure lot located northwest of the intersection of Ice House Road and Route 9J. This was an addition to the Reserve.

- **TJ Columbia 42.10** – OGS (Transfer of Jurisdiction); 0.7 acres; no cost

  Date of Transfer: 3/20/2017

  Location: Town of Stuyvesant

  Description: This is a small piece of land, now or formerly under the waters of the Hudson River, lying between the Michael Colligan Acquisition (SLP Columbia 42.08) and the east bounds of the railroad; part of the Reserve.

- **SLP Columbia 42.05** – Scenic Hudson (Grantor); 111.756 acres; $1.120 million (PR)

  Date of Acquisition: 2/23/2015

  Location: Towns of Greenport and Stockport

  Description: This is commonly referred to as the “Joslen Heights Acquisition.” This entire parcel is upland buffer for the Reserve but not included within the Reserve. It does adjoin a 43.5-acre parcel of Reserve land, now or formerly under the waters of the Hudson River, which lies on both sides of the railroad corridor and was transferred by OGS to DEC on 10/20/2010.

- **Tivoli Bays Utility Corridor** – Scenic Hudson (Grantor); 62.5 acres; $460,500 (PR)

  Date of Acquisition: 4/6/2018

  Location: Town of Red Hook

  Description: A 200-foot- wide, Y-shaped utility corridor extending west from Route 9G through the uplands to Tivoli North Bay and across Cruger Island to the Hudson River.

Acquisitions in Progress

- **SLP Columbia 42.09** – Scenic Hudson (Owner); 590.231 acres; $4.6 million (PR).

  This property in the Town of Stockport adjoins state-owned Reserve lands (Plotkin acquisition). About 72 acres of this proposed acquisition are in the Reserve, east of Gay’s Point, and are lands now or formerly under the waters. It also includes uplands outside the Reserve boundary for tidal wetland migration. The land transferred to DEC in December of 2018.

Objectives and Strategies

Objective 1

New York acquires remaining private inholdings in the Reserve, and transfers OGS lands within the current Reserve boundary to DEC or Parks.

Strategies

- Acquire remaining private inholdings within the Reserve, including lands and waters east of Gay's Point in the Stockport Flats reserve.
- Transfer OGS lands within the four Reserve sites to DEC or Parks for long-term stewardship and management.

Objective 2

DEC staff develop a plan to expand Reserve boundaries to ensure effective conservation of representative ecological areas, especially given sea level rise and other climate change impacts.

Strategies

- Assess the need to incorporate recently acquired state or private lands that contribute to protection of significant and sensitive natural resource areas, and/or provide pathways for tidal wetland migration as sea level rises.
- Explore the need to acquire and/or incorporate core and/or buffer lands at sites not contiguous with the existing Reserve sites to ensure the Reserve continues to include representative natural areas through the twenty-first century as sea level rises.

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Appendices

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2. Memorandum of Understanding among Five New York State Agencies
3. Memorandum of Understanding between NYSDEC and NYS Office of Parks, Recreation and Historic Preservation Regarding Norrie Point Environmental Center
4. Staff Duties and Organizational Charts for the Hudson River Reserve
5. Hudson River Reserve Research Guidelines
6. Hudson River Reserve Parks/PIPC Research Permit
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Appendix 1

Memorandum of Understanding between NYS DEC and NOAA

Memorandum of Understanding
Between the
National Oceanic and Atmospheric Administration and
The New York Department of Environmental Conservation

Detailing the State-Federal Roles in the Management of the Hudson River National Estuarine Research Reserve

This Memorandum of Understanding (MOU or agreement) establishes the framework for the cooperative management of The Hudson River National Estuarine Research Reserve (NERR) in the State of New York, between the New York Department of Environmental Conservation (NY DEC) and the National Oceanic and Atmospheric Administration, Office for Coastal Management (NOAA). This agreement supersedes the previous agreement (MOA-2008-065) between NOAA and the NY DEC regarding the Hudson River NERR made on April 1, 2009.

I. AUTHORITY

The authority for this agreement is the Coastal Zone Management Act of 1972, as amended (CZMA, 16 U.S.C. §§ 1451 *et seq.*), and its implementing regulations at 15 C.F.R. Parts 921, 923.

II. BACKGROUND

A. The State of New York has determined the waters and related coastal habitats of the Hudson River provide unique opportunities for the study of natural and human processes to contribute to the science of estuarine ecosystem processes, enhance environmental education opportunities and public understanding of estuarine areas, and provide a stable environment for research through the long-term protection of reserve resources.

B. The State of New York has determined that the resources of the Hudson River NERR and the values they represent to the citizens of New York and the United States will benefit from the management of these resources as part of the National Estuarine Research Reserve System.

C. The NY DEC, as the agency designated by the Governor of New York, is responsible for maintaining, operating and managing the Hudson River NERR in accordance with Section 315 of the CZMA, 16 U.S.C. § 1461, and acknowledges the value of state-federal cooperation for the long-term management and protection of the reserve in a manner consistent with the purpose of its designation.

D. NOAA finds that the State of New York has satisfied the legal and procedural requirements for designation and, pursuant to its authority under Section 315 of the CZMA, 16 U.S.C. § 1461, and in accordance with implementing regulations at 15 C.F.R. Part 921, has designated the Hudson River NERR.

E. The Hudson River NERR management plan approved by NOAA describes the goals, objectives, strategies/actions, administrative structure, and institutional arrangements for the reserve, including this agreement and others. In consideration of the mutual agreements herein, NOAA and the NY DEC agree to the following roles indicated in Section III of this agreement.

III. STATE-FEDERAL ROLES IN RESERVE MANAGEMENT

A. State Role in Reserve Management

The NY DEC shall:

1. be responsible for compliance with all federal laws and regulations, and ensure that the Hudson River NERR management plan is consistent with the provisions of the CZMA and implementing regulations;

2. ensure protection of the natural and cultural resources of the reserve, and ensure enforcement of the provisions of state law and regulations aimed at protecting the reserve;

3. ensure adequate, long-term protection and management of lands and waters included within the reserve boundary;

4. cooperate with NOAA to apply for and manage funds to support the reserve in accordance with federal and state laws, the reserve management plan, annual funding guidance from NOAA, and any other NOAA directives pertaining to reserve operations, research and monitoring, education and stewardship, and, as necessary, land acquisition and reserve facility construction;

5. conduct and coordinate research and monitoring programs that encourage scientists from a variety of institutions to work together to understand the ecology of the reserve ecosystem to improve coastal management;

6. conduct and maintain programs that disseminate research results via materials, activities, workshops, and conferences to resource users, state and local agencies, school systems, the general public, and other interested parties;

7. provide staff and endeavor to secure state funding for the manager, education coordinator, and research coordinator;

8. secure facilities and equipment required to implement the provisions within the reserve management plan;

9. ensure adequate support for facilities operation and maintenance;

10. maintain effective liaison with local, regional, state, and federal policy makers, regulators, and the general public;

11. serve as principal contact for issues involving proposed boundary changes and/or amendments to the reserve management plan; and

12. cooperate with NOAA regarding review of performance pursuant to Section 312 of the CZMA, 16 U.S.C. § 1458, 15 C.F.R. § 921.40, and ongoing management plan approvals.

B. Federal Role in Reserve Management

NOAA shall:

1. administer the provisions of the Sections 312 and 315 of the CZMA, 16 U.S.C. §§ 1458 and 1461, respectively, to ensure that the reserve operates in accordance with goals of the reserve system and the Hudson River NERR management plan;

2. review and process applications for financial assistance from the NY DEC, consistent with 15 C.F.R. Part 921, for management and operation of the reserve, and, as appropriate, land acquisition and facility construction;

3. advise the NY DEC of existing and emerging national and regional issues that have bearing on the reserve and reserve system;

4. maintain an information exchange network among reserves, including available research and monitoring data and educational materials developed within the reserve system; and

5. to the extent possible, facilitate the allocation of NOAA resources and capabilities in support of reserve goals and programs.

C. General Provisions

1. Nothing in this agreement shall obligate either party in the expenditure of funds, or for future payments of money. Each party bears its own costs to implement this agreement. NOAA may provide Federal funding in accordance with the CZMA and any requirements of the U.S. Department of Commerce through financial assistance awards that are separate from this agreement.

2. A free exchange of research and assessment data between the parties

is encouraged and is necessary to ensure success of cooperative studies.

D. Other Provisions

1. Nothing in this agreement diminishes the independent authority or coordination responsibility of either party in administering its respective statutory obligations. Nothing in this agreement is intended to conflict with current written directives or policies of either party. If the terms of this agreement are inconsistent with existing written directives or policies of either party entering this agreement, then those portions of this agreement that are determined to be inconsistent with such written directives or policies shall be invalid; but the remaining terms not affected by the inconsistency shall remain in full force and effect. In the event of the discovery of such inconsistency, and at the first opportunity for revision of this agreement, the parties shall seek to amend or terminate this agreement in accordance with the provisions of subsection V of this agreement.

2. Any disagreement on the interpretation of a provision, amendment, or other matter related to this agreement shall be resolved informally at the lowest operating level of each party's respective organization. If such disagreement cannot be resolved, then the area(s) of disagreement shall be stated in writing and presented to the other party for further consideration. If agreement is not reached within thirty (30) days of presentation, then the parties shall forward the written presentation of the disagreement to their respective higher official for appropriate resolution.

IV. PROGRAM EVALUATION

In accordance with section 312 of the CZMA, 16 U.S.C. § 1458, and 15 C.F.R. § 921.40, NOAA will schedule periodic evaluations of the NY DEC performance in meeting the terms of this agreement and the reserve management plan. Where findings of deficiency occur, NOAA may initiate action in accordance with the interim sanctions or withdrawal of designation procedures established by the CZMA and applicable regulations at 15 C.F.R. Part 921, Subpart E.

V. EFFECTIVE DATE, REVIEW, AMENDMENT, AND TERMINATION

A. This agreement will commence on date of the last signature on this agreement and will remain in effect until terminated by either party.

B. This agreement shall be reviewed periodically by both parties at least once every five years to determine whether it should be revised, and may only be amended by the mutual written consent of both parties.

C. This agreement may be terminated by mutual consent of both parties or by unilateral termination by either party. Termination of this agreement may provide grounds for NOAA (at its discretion) to withdraw designation of the reserve from the reserve system, pursuant to applicable provisions of the CZMA and its implementing regulations as described under 15 C.F.R. Parts 921 (Subpart E) and 923 (Subpart L). Section 315 of the CZMA, 16 U.S.C. § 1461, provides that NOAA may withdraw designation of a National Estuarine Research Reserve if: 1) NOAA finds that any of the criteria for establishing the reserve no longer exist; or 2) a substantial portion of the research conducted within the reserve fails to meet reserve system guidelines. In making any decision to withdraw designation, NOAA will take into consideration factors set forth in 15 C.F.R. § 921.40.

D. If any clause, sentence, or other portion of this agreement shall become illegal, null, or void for any reason, the remaining portions of this MOU shall remain in full force and effect.

E. No waiver of right by either party of any provision of this agreement shall be binding unless expressly confirmed in writing by the party giving the waiver.

IN WITNESS THEREOF, the parties have caused this agreement to be executed.

Jeffrey L. Payne, Ph.D
Director
Office for Coastal Management
National Oceanic and Atmospheric Administration
U.S. Department of Commerce

9/20/19
Date

Nancy Lussier
Director of Management and Budget Services
New York State Department of Environmental Conservation

OCT 2 2019
Date

Appendix 2

Memorandum of Understanding among Five New York State Agencies

MEMORANDUM OF UNDERSTANDING

This Memorandum serves as an expression of intent among five parties-in-interest hereinafter called the Signatories: the New York State Department of Environmental Conservation (Lead Agency), the New York State Office of General Services, the Palisades Interstate Park Commission, the New York State Office of Parks, Recreation and Historic Preservation, and the New York State Department of State.

Witnesseth:

WHEREAS, New York State has received a grant from the United States Secretary of Commerce for acquisition, development and operation of certain portions of the Hudson River Estuary (see Appendix **A**) as the Hudson River National Estuarine Sanctuary (the Sanctuary), and

WHEREAS, the purpose of such grant is to create new opportunities for coordinated Hudson River research and public education (the Program), and

WHEREAS, such Program has wide public support, and

WHEREAS, the Signatories have already evidenced support for such Program through the formation in 1981 of a Hudson River Estuarine Sanctuary Steering Committee which has met regularly to coordinate the efforts of the Signatories in establishing the Sanctuary,

NOW THEREFORE, in consideration of the mutual benefits to be derived from implementing this Program, the Signatories agree to the following:

1. The lands described in Appendix **A** are hereby designated as the Hudson River Estuarine Sanctuary.

2. There shall be a Management Plan for the Sanctuary, which Management Plan shall provide a framework for conducting research and educational programs. The Management Plan shall be developed by the Estuarine Sanctuary staff and reviewed by the Steering Committee. Such Management Plan shall set forth compatible and non-compatible uses for each site in the Sanctuary. The Management Plan shall not take effect except upon unanimous approval of the Signatories. The Management Plan shall be reviewed annually and shall be revised as needed, but no revisions shall take place except upon unanimous approval of the Signatories.

3. No land ownership and management prerogatives in the Sanctuary shall be changed except as specified in the Management Plan.

4. The purpose of the Program is the protection of such lands for use as a natural field laboratory in which to gather data and make studies of the natural and human processes occurring within the Hudson River estuary.

5. The Signatories shall adhere to the Management Plan in their land ownership and management activities within the Sanctuary.

6. Multiple uses of such 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 Sanctuary as a natural field laboratory, shall be prohibited or limited to the greatest extent feasible, by the agency having jurisdiction.

7. Management Structure

a. There shall be a Sanctuary Steering Committee, comprised of one member from each of the Signatories, which shall review the recommendations of Sanctuary Advisory Committees and shall submit them to the agencies having jurisdiction over lands in the Sanctuary. The Steering Committee shall review the Management Plan annually and shall advise the Lead Agency regarding its implementation. The chairman of each Sanctuary Advisory Committee and a representative of the National Oceanic and Atmospheric Administration shall serve as non-voting, ex-officio representatives to the Steering Committee.

b. There shall be three Sanctuary Advisory Committees appointed by the Lead Agency, in consultation with the Steering Committee, which shall meet regularly to discuss the progress of the Sanctuary and to make recommendations to the Steering Committee.

c. The Lead Agency shall implement the Program by hiring and directing Estuarine Sanctuary staff, supervise and coordinate implementation of the provisions of the Management Plan, and by receiving and acting upon the recommendations of the Steering Committee.

d. The Estuarine Sanctuary staff, hired by and reporting to the Lead Agency, is immediately responsible for Program coordination with the agencies having jurisdiction over respective Sanctuary sites.

8. No projects shall be carried out on Sanctuary lands without the approval of the agency having jurisdiction over such lands. Such agency shall maintain all facilities built on its lands in furtherance of a project, and shall cooperate with Sanctuary staff in carrying out the Program.

9. The Lead Agency and the Department of State shall confer regularly to ensure coordination between the Estuarine Sanctuary Program and the Coastal Management Program.

10. This Memorandum shall not be construed so as to preclude additional transfers of property among the Signatories, or to preclude additions of appropriate lands to the Estuarine Sanctuary.

11. This Memorandum shall continue in effect in perpetuity; additional Signatories may join by unanimous approval of existing Signatories, and the Memorandum may be amended or terminated by majority vote of the Signatories at any time. Nothing in this Memorandum shall, however, preclude the unilateral withdrawal of any of the Signatories. In such latter eventuality is understood that the lands of such withdrawing Signatory would be dedesignated from the Sanctuary, and it is understood that the federal Office of Management and Budget will take appropriate action with respect to grant funds as may be indicated by its regulations.

Signed,

Department of Environmental Conservation

By _____

Date 8/4/82 Title First Deputy Comm

Office of General Services

By _____

Date 8/5/82 Title Deputy Commissioner

Palisades Interstate Park Commission

By _____

Date _____ Title _____

Office of Parks, Recreation and Historic Preservation

By _____

Date 8/2/82 Title Deputy Commissioner

Department of State

By _____

Date 8-2-82 Title _____

ADDENDUM TO 1982 MEMORANDUM OF UNDERSTANDING

1. By act of Congress in the 1986 Coastal Zone Management Act Reauthorization, the name of the program was changed from Hudson River National Estuarine Sanctuary to Hudson River National Estuarine Research Reserve.

2. By April 15, 1992 vote of the Steering Committee, local advisory committees were removed from the Reserve's administrative structure. Many other opportunities for public input will be provided under the State Environmental Quality Review, especially public scoping sessions and meetings during the development of site management plans.

APPENDIX A

to the Memorandum of Understanding

(The following maps and their symbols are described fully in Part II of this FEIS.)

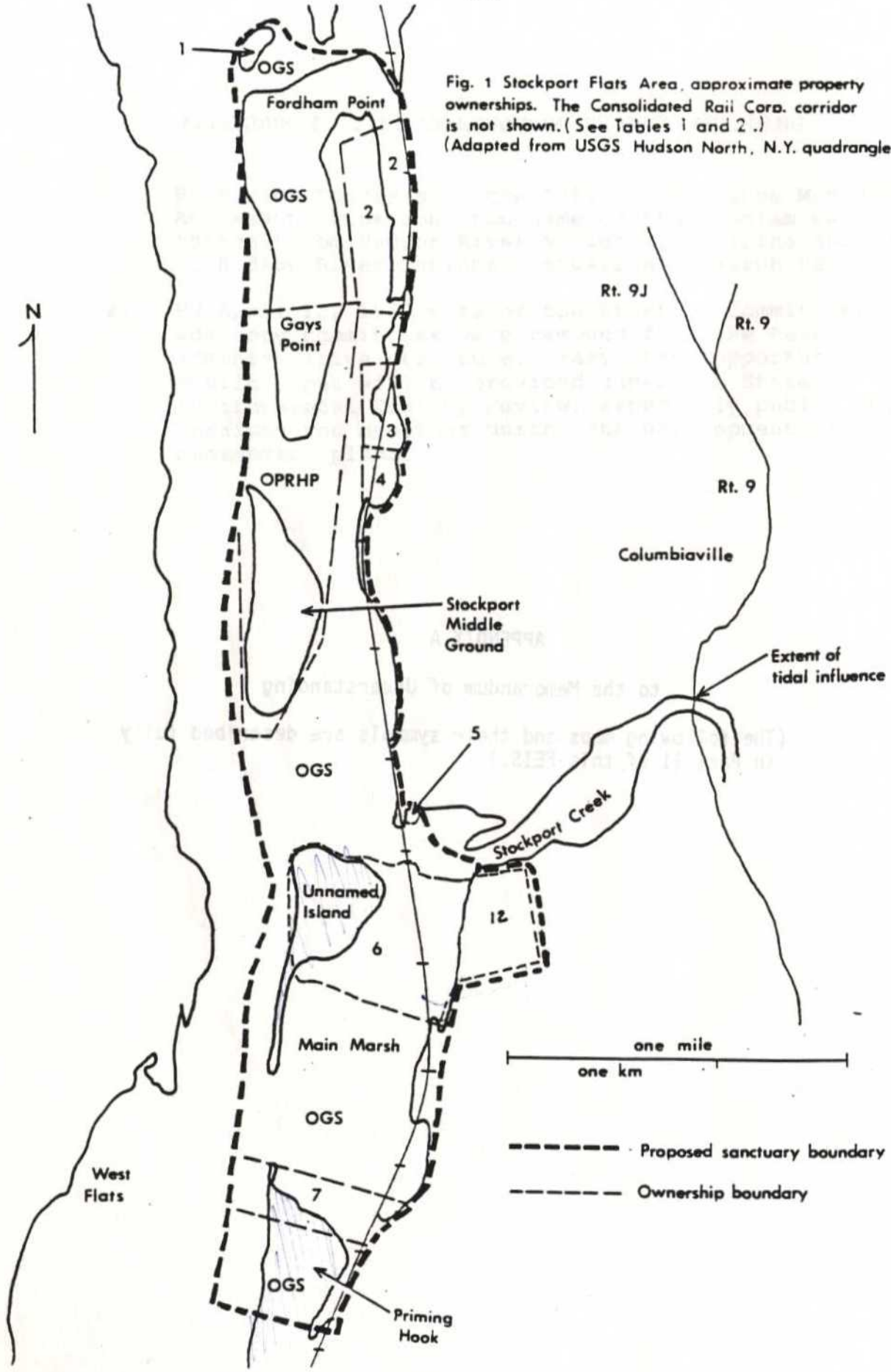


Fig. 1 Stockport Flats Area, approximate property ownerships. The Consolidated Rail Corp. corridor is not shown. (See Tables 1 and 2.) (Adapted from USGS Hudson North, N.Y. quadrangle.)

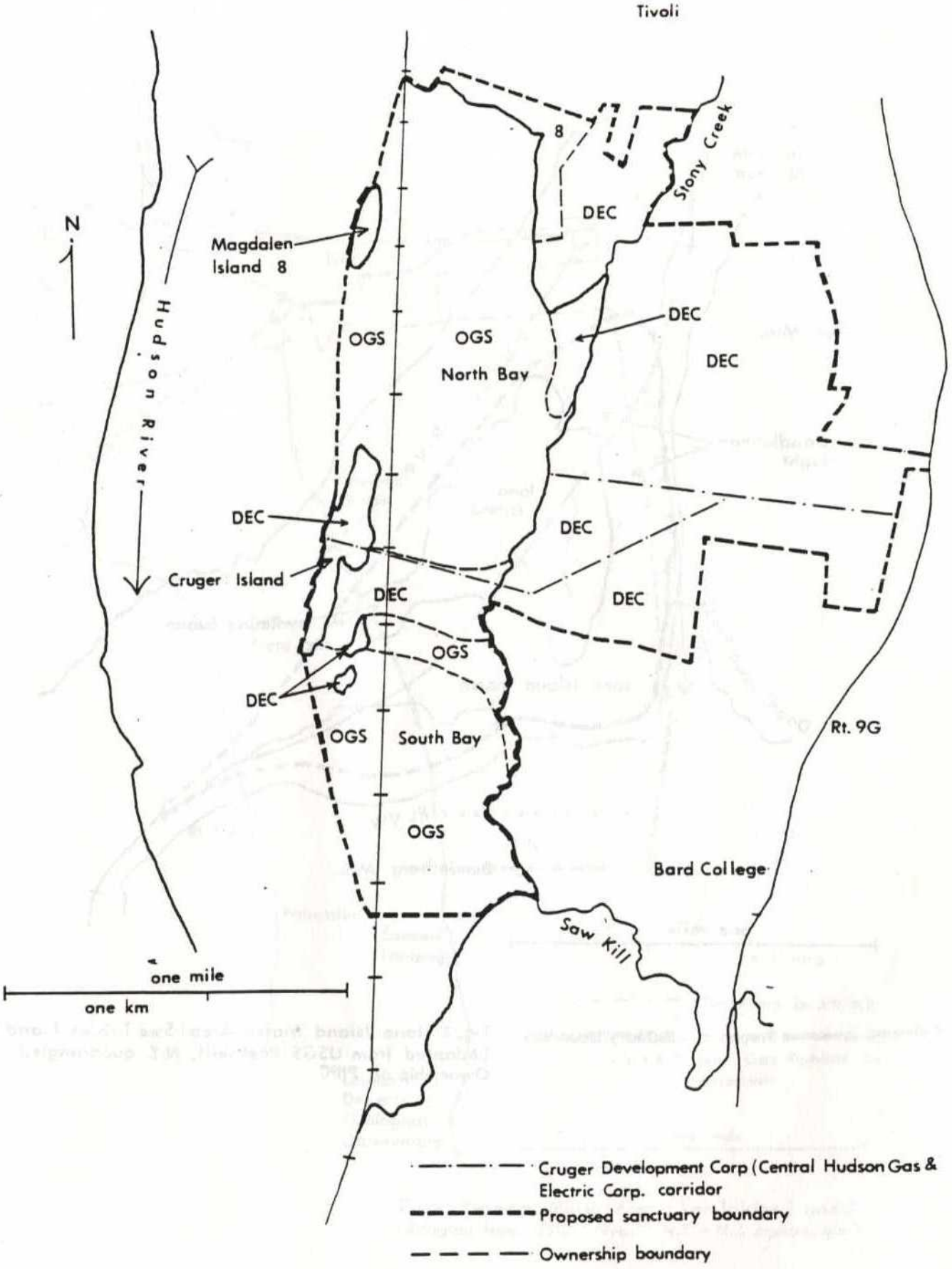


Fig. 2 Tivoli Bays Area. (See Tables 1 and 2.)
(Adapted from USGS Saugerties, N.Y. quadrangle.)

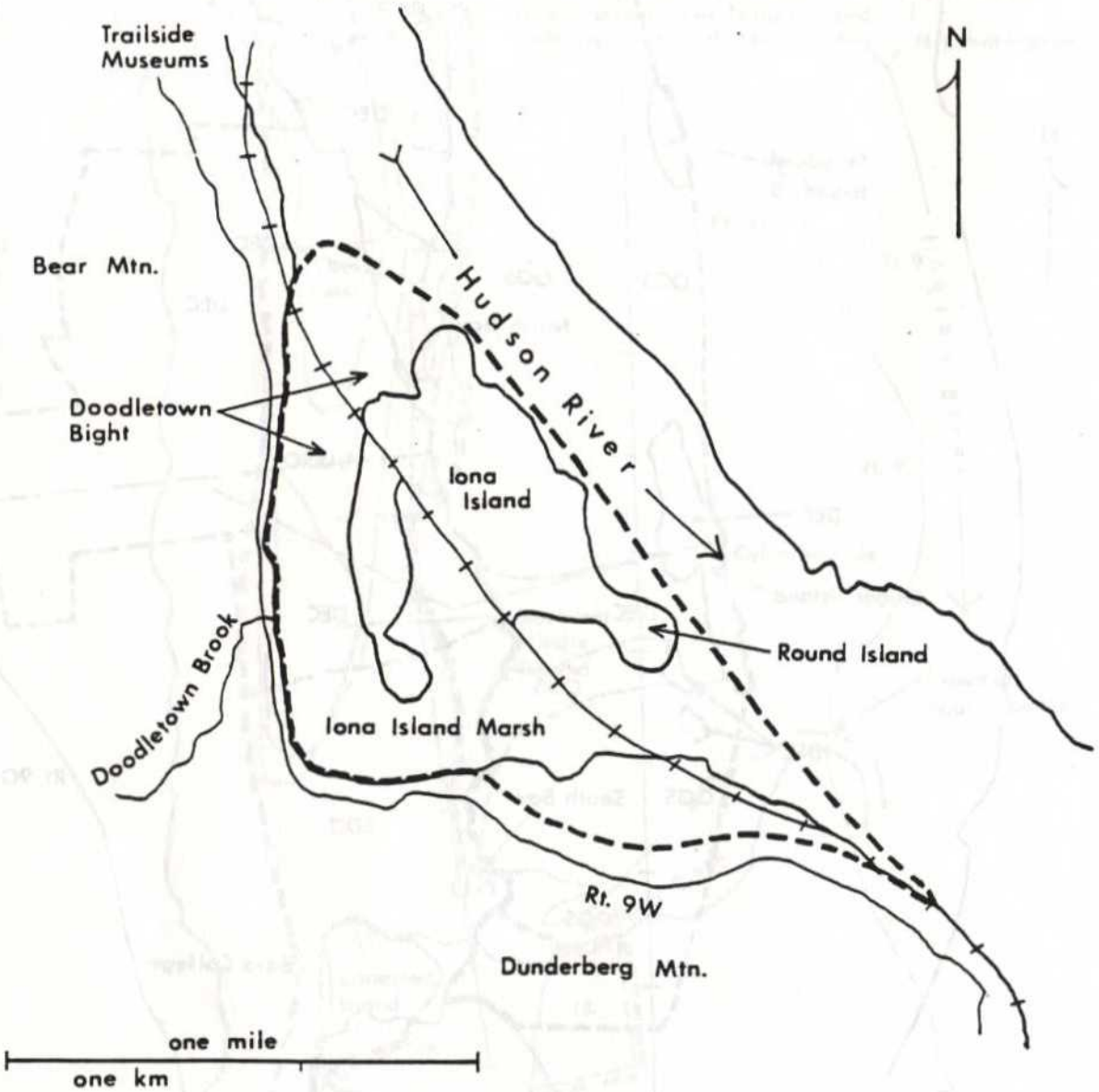


Fig. 3 Iona Island Marsh Area (See Tables 1 and 2.)
(Adapted from USGS Peekskill, N.Y. quadrangle.)
Ownership all PIPC

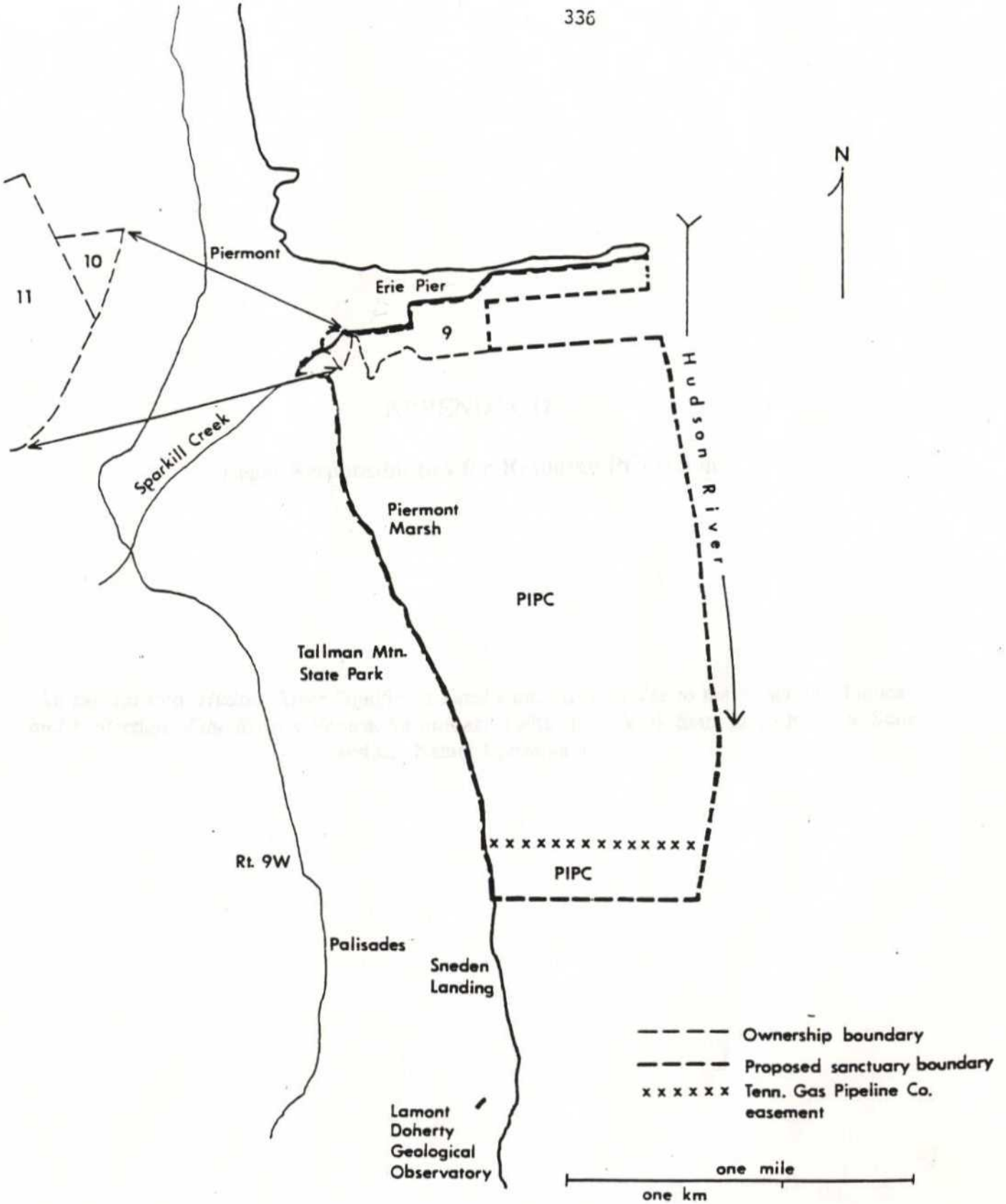


Fig. 4 Piermont Marsh Area. (See Tables 1 and 2.)
(Adapted from USGS Nyack, N.Y.–N.J. quadrangle.)

Appendix 3

Memorandum of Understanding between NYSDEC and NYS Office of Parks, Recreation and Historic Preservation Regarding Norrie Point Environmental Center

AM05902

MEMORANDUM OF UNDERSTANDING

BETWEEN

THE NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION

AND *Office of Parks, Recreation and Historic Preservation*

MEMORANDUM OF UNDERSTANDING

THIS AGREEMENT made by and between the People of the State of New York, acting by and through the Commissioner of the New York State Department of Environmental Conservation, with offices at 625 Broadway, Albany, New York, 12233 (hereinafter "DEC") and the People of the State of New York, acting by and through the Commissioner of Parks, Recreation and Historic Preservation, with offices at Agency Building 1, Empire State Plaza, Albany, New York 12238 (hereinafter "PARKS").

WITNESSETH:

WHEREAS, PARKS has jurisdiction over certain lands in the Town of Hyde Park, County of Dutchess and State of New York, known as the Norrie Point Inn within the Margaret Lewis Norrie State Park as described in Schedule A attached hereto; and,

WHEREAS, pursuant to Section 3.09(2) of the Parks, Recreation and Historic Preservation Law ("PRHPL"), PARKS is authorized to directly or indirectly operate and maintain New York State historic sites, parks, parkways and recreational facilities by contract, lease or license; and,

WHEREAS, pursuant to PRHPL Section 3.09(6), PARKS' mission includes encouraging, promoting, and engaging in cooperative recreational, educational, historic and cultural activities, projects and programs undertaken by any federal, state or local governmental agency or private philanthropic or non-profit interest for the benefit of the public; and,

WHEREAS, PARKS and DEC recognize the need and desirability for public ownership and use of the Norrie Point Inn property as a component of the statewide and regional park system, and as an environmental center for Hudson River Estuary studies; and,

WHEREAS, DEC has formally expressed its desire, ability and intent to fund the renovation of the Norrie Point Inn, and operate and maintain facilities for research, education, stewardship, and recreational purposes, as described in the Concept and Operations Plan ("Plan") in Schedule B, hereinafter attached and hereby made a part of this Agreement; and,

WHEREAS, DEC is willing to convey, and have PARKS expend, $1,700,000 for the renovation, development and improvement of the Norrie Point Inn pursuant to the Plan.

NOW, THEREFORE, in consideration of the mutual covenants and conditions hereinafter set forth, PARKS and the DEC hereby agree as follows:

1. TERM:

a. This instrument shall not take effect until it has been approved by both parties and shall remain in effect for a period of Twenty (20) years, with an option for DEC to renew the agreement for an additional Fifteen (15) years.

b. During the initial 20 years of the Agreement, PARKS shall only exercise its right to terminate this Agreement if DEC is in default of a material term of this Agreement. Before exercising its right to terminate this Agreement, PARKS agrees to give the DEC notice of the default and a reasonable period of time to cure the default.

c. During the initial 20 years of the Agreement, DEC shall only exercise its right to terminate this Agreement if PARKS is in default of a material term of this Agreement. Before exercising its right to terminate this Agreement, DEC agrees to give PARKS notice of the default and a reasonable period of time to cure the default.

2. DEC RIGHTS:

a. The Norrie Point Inn will serve as a joint facility with both a DEC and OPRHP presence. Other than the apartment, classroom, and office space as delineated as PARKS jurisdiction on Schedule A (hereinafter "Parks Property"), the DEC shall have the right to use, occupy and possess the property as shown on Schedule A (hereinafter the "Subject Property"), for the term of this Agreement for research, education, stewardship, and recreational uses in accordance with Schedule B, subject to the terms and conditions of this Agreement. DEC shall occupy the building on or around October 1, 2006, or whenever the building receives a certificate of compliance.

b. This Agreement shall not be assigned, transferred or otherwise disposed of without the prior written approval of PARKS.

c. With the prior consultation and written approval of PARKS, which shall not be unreasonably withheld, DEC may establish fees for access to or for use of the Subject Property.

3. DEC REPRESENTATIONS:

a. The DEC agrees that all future actions involving the change of use, development, improvement or structural alteration of the Subject Property shall require the prior written

approval of PARKS, which shall not be unreasonably withheld. Such prior written approval shall not be required for routine maintenance of the Subject Property by the DEC.

b. The DEC agrees to provide PARKS with $1,700,000 of the cost for renovating the Norrie Point Inn according to Schedule B. Funds will be provided by DEC to PARKS via a sub-allocation. A portion of these funds ($825,000) must be expended by September 30, 2006. The remaining funds ($875,000) must be expended by May 31, 2007. Funding shall be used for roof repairs, demolition of existing exhibits, installation of new interior partition walls, rehabilitation of existing laboratory, refinishing of interior surfaces, reconfiguration of front and rear entrances, installation of accessible restrooms, and upgrading of building mechanical, electrical, and plumbing systems.

c. The DEC shall procure, at the DEC's own cost and expense, any and all permits, licenses and approvals necessary for the legal operation of the Subject Property, and shall be solely liable for any costs or fees associated therewith.

d. The DEC, in its building operation, shall not alter any historic elements of the Subject Property, without prior assessment by and consultation with the PARKS Field Services Bureau and written approval by PARKS.

4. PARKS REPRESENTATIONS:

a. PARKS shall develop in consultation with DEC and submit to DEC for its review and approval, which shall not be unreasonably withheld, all plans for the construction, installation and modification of all facilities and improvements to the Subject Property. PARKS shall be responsible for compliance with applicable Building Code requirements and shall provide copies of all building permits and approvals to DEC.

b. PARKS shall act as lead agency for meeting the requirements of the State Environmental Quality Review Act (SEQR) in connection with the renovation of the Subject Property. The DEC shall not undertake any development of the Subject Property, apart from in-kind replacement and maintenance activities, until PARKS has complied with SEQR.

c. PARKS shall provide DEC with financial reports every six months on the status of construction expenditures. Such reports shall include details on project expenditures by the following federal cost categories: equipment, supplies, contractual and construction. Reports shall be provided August 1, 2006 for January through June, 2006; February 1, 2007 for July through December, 2006; and August 1, 2007 for January through June, 2007.

d. PARKS agrees that it will lease, let, and allow subleasing of the apartment and north classroom only to such tenants who it reasonably expects will not interfere or otherwise negatively impact on the DEC's use of the Subject Property. All agreements with respect to such uses or letting shall include language addressing activities and uses and the requirement to avoid such interference or negative impact.

5. PARKS RIGHTS:

a. PARKS hereby retains all rights, over the Parks Property as described supra in paragraph 2a.

6. OPERATION AND MAINTENANCE:

a. DEC and PARKS shall share the cost of and responsibility for the operation, maintenance, security and administration of the Norrie Point Inn in accordance with Schedule B. PARKS shall maintain the exterior of the Norrie Point Inn in a safe condition suitable for passive recreation or for other uses as may be agreed to by the parties.

b. DEC shall maintain the interior of the Subject Property and any externally located research equipment that supports DEC research or educational programs in a safe condition suitable for research, education, public visitation according to Schedule B.

7. IMPROVEMENTS AND ALTERATIONS:

a. All improvements to the Norrie Point Inn, including the Subject Property, which are structural in nature or attach to the realty, shall become the property of PARKS upon installation. Other improvements, the removal of which will not cause damage or which are not attached to the realty, shall be removed by the DEC upon termination or expiration of this Agreement.

b. It is understood and agreed by and between the parties that during the initial term of this Agreement and any extensions thereof, that, with the prior written approval of PARKS, which shall not be unreasonably withheld, DEC may make minor alterations or installations, including but not limited to carpeting, window treatments, exhibits, telephone or other communications lines.

8. USE OF SUBJECT PROPERTY: The Subject Property shall be used primarily for recreational, educational, research and conservation purposes. Other compatible uses will be considered on a limited basis. Traditional passive recreational uses of the Property by the public shall not be unduly restricted or prohibited.

9. RECORD KEEPING AND ACCOUNTING:

a. The DEC and PARKS shall each maintain separate accounting and fiscal records of all receipts and expenditures of funds in connection with the operation, maintenance and administration of the Norrie Point Inn.

b. If and when user fees are established for use of the Subject Property and the classroom as arranged by the DEC, these shall be deposited in a PARKS special account dedicated to operation of the Norrie Point Environmental Center.

10. ACCESS:

a. Duly authorized officers or employees of PARKS shall have access to the Subject Property at all times for the purpose of making repairs and improvements and to ensure compliance with all terms of this Agreement. PARKS, in exercising its rights under this Clause, shall not unreasonably interfere with DEC's access, use and occupancy of the Subject Property.

b. PARKS will provide DEC with sufficient sets of keys for access to the building and any systems it may need to operate and maintain the Subject Property.

11. UTILITY EASEMENTS: PARKS and the DEC acknowledge that utility easements may need to be granted to utilities in the future to serve the needs of the Subject Property and other purposes. PARKS agrees to cooperate with the DEC to provide the necessary documents, easements and grants as permitted by law. PARKS furthers agrees to require that such installations are constructed in such a way that prevents damage to improvements installed by the DEC, or to mitigate any unavoidable damage to DEC improvements by requiring restoration of such DEC improvements as part of the work.

12. SIGNAGE: The Subject Property shall be known as the Norrie Point Environmental Center within the Margaret Lewis Norrie State Park. All signs, publications and other materials shall identify the Subject Property as owned by PARKS and operated by the DEC under a cooperative agreement with PARKS. The Parties agree that the name of the Subject Property may be changed upon mutual consent of the parties. Exhibit A shall serve as a guide for the production of signs.

13. NOTICES: All notices pertaining to this Agreement shall be in writing delivered to the parties by hand, by commercial express courier service, by United States Express Mail, or by certified United States mail, postage prepaid, addressed to the parties at the addresses set forth below or such other address as the parties may designate by notice. All notices shall be deemed given when received. Notices shall be addressed as follows:

To DEC:

Director of Operations
NYS Department of Environmental Conservation
625 Broadway
Albany, NY 12233
ATT: Michael Turley, and
Reserve Manager
NYS Department of Environmental Conservation

Before fall, 2006: Bard College Field Station, Annandale, NY 12504
After fall, 2006:

Norrie Point Environmental Center, Staatsburg, New York 12580

To PARKS: NYS Office of Parks, Recreation & Historic Preservation
P.O. Box 308
Staatsburg, NY 12580
Attn: Regional Director

14. GENERAL:

a. The parties agree, to the extent permitted by applicable laws and regulations, whenever the consent or approval of a party is required by this Agreement to not unreasonably withhold or delay any consent or approval required by this Agreement.

b. Should the parties deem any provision(s) of Schedule B unacceptable, or should future modifications of Schedule B be warranted, the parties shall cooperate to the utmost to negotiate provisions satisfactory to each. Upon written approval by both parties, the revised Schedule B shall supersede the attached Schedule B.

15. Executory Clause: In accordance with Section 41 of the State Finance law, DEC shall have no liability under this Memorandum of Understanding to Parks or to anyone else beyond funds appropriated and available for this Memorandum of Understanding.

Signature Page Follows

IN WITNESS WHEREOF, the parties have caused these presents to be executed on the day, month and year appearing below their respective signatures.

NYS Department of Environmental Conservation

By _____

Name: Nancy Lussier

Title: Director of Management and Budget Services

Date: DEC 19 2006

New York State Office of Parks, Recreation and Historic Preservation

By _____

Name: Christopher Pushkarsh

Title: Executive Deputy Commissioner

Date: 12-5-06

SCHEDULE A

DESCRIPTION OF THE NORRIE POINT INN

The former Norrie Point Inn exists within the Margaret Lewis Norrie State Park in the Town of Hyde Park, in Dutchess County, New York. The building is a large stone Civilian Conservation Corps-era building that was built on a south- and east-facing promontory on the Hudson River. The structure was expanded in the 1970s, and now includes approximately 11,000 square feet.

Figure 1 depicts the Norrie Point Inn. The north classroom, PARKS office, and apartment shall be the domain of PARKS, and the remainder shall be the domain of DEC. In addition, DEC shall have exclusive use of the garages and outbuildings immediately north of the Norrie Point Inn to use for storage of field equipment, boats, and other research and educational equipment.

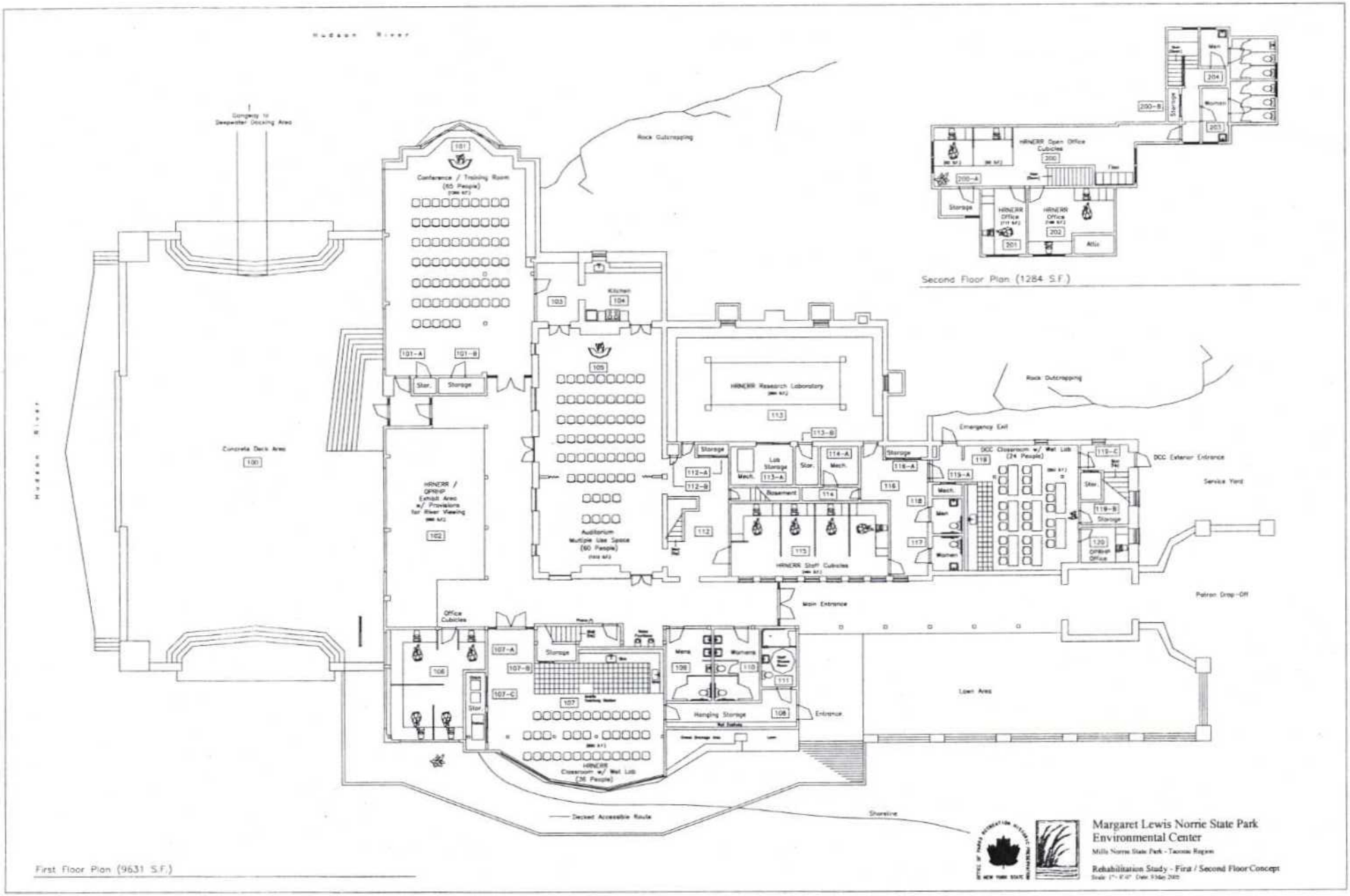


FIGURE 1 - PAGE 9

SCHEDULE B

CONCEPT AND OPERATIONS PLAN FOR THE NORRIE POINT ENVIRONMENTAL CENTER

I. INTRODUCTION

The New York State Department of Environmental Conservation (DEC) will partner with the New York State Office of Parks, Recreation, and Historic Preservation (PARKS) to renovate the Norrie Point Inn and operate the Norrie Point Environmental Center (the ENVIRONMENTAL CENTER) in the Margaret Lewis Norrie State Park, Taconic Region for research, education, stewardship, and recreational purposes.

II. PURPOSE OF NORRIE POINT ENVIRONMENTAL CENTER

The ENVIRONMENTAL CENTER will be operated as a center for research and education activities designed to improve stewardship and science-based management of the Hudson River Estuary. The lead operating program will be DEC's Hudson River National Estuarine Research Reserve program (the Research Reserve), with its associated education, training, stewardship, research and monitoring functions. The ENVIRONMENTAL CENTER will be used to train managers and decision-makers who will better manage resources of the Hudson River Estuary and its watershed, engage teachers who will educate people about the estuary ecosystem and human setting, attract scientists who will perform work that is relevant to management, and provide opportunities to students and the public to learn about their important role in conservation of the estuary.

In addition, the site will remain a small conference center with river-related exhibits. It will also become part of a network of over 27 facilities in the National Estuarine Research Reserve System, one of over 20 Hudson River Estuary Program Learning Centers, and an affiliate of the Beacon Institute for Rivers and Estuaries.

III. RENOVATION

The renovation will include roof repairs, structural repairs necessitated by water and ice damage, demolition of existing exhibits, installation of new interior partition walls, replacement of degraded exterior siding, rehabilitation of existing laboratory, refinishing of interior surfaces, reconfiguration of front and rear entrances, installation of accessible restrooms, installation of a classroom, installation of telephone and other communications lines, and the replacement of building mechanical, electrical, and plumbing systems. Associated renovation and repair work on the sea wall and patio shall be accomplished as funding permits.

The Norrie Point Inn was extensively enlarged in the late 1970s and since that time there has not been a sustained program to fund additional capital improvement. This renovation will address long-standing problems caused by initial design deficiencies and deferred maintenance. Replacing the roof system(s) and modernizing the mechanical systems is the primary focus of the proposed rehabilitation. A secondary component of the project will address interior space improvements with a focus on improving building function and modernizing component systems required to facilitate an improved environmental education program.

Due to the historic classification of the building, the proposed renovations will preserve the remaining architecturally significant Civilian Conservation Corps-era building features. The concept plan for this building received a determination of "no adverse effect" by the New York State Historic Preservation Office (SHPO).

Within the limits of the project budget, the project team will also seek to incorporate green building features and requirements of Executive order No.111 that may be interpreted as part of the Reserve's education and training activities.

After the completion of construction drawings and specifications, the Project will be bid competitively in accordance with requirements of New York State Finance Law. At the conclusion of the bid process, the most qualified low bidder will be selected and a contract for the work will be executed.

After the award of a construction contract, a PARKS Taconic Region staff person will be assigned primary responsibilities for the management of construction phase services. It is anticipated that construction phase services will include shop drawing review/approval, meeting coordination, payment application administration, contract/contractor negotiations, field and change order processing, and on-site inspections. The Construction Service Manager (or Director's Representative) will be responsible for coordinating all aspects of the project through completion and involving the Project Team as needed during the process.

IV. OPERATIONS PLAN

A. ADMINISTRATION

1. DEC Role
- Pay for operational expenses as listed below.
- Develop lease arrangements, except for apartment leasing and rear classroom, subject to the approval of PARKS.
- Oversee lessees' compliance with lease agreements, except for apartment and classroom.
- Handle reservations for conference rooms.
- Deposit revenue generated from the facility into PARKS' special account.

2. PARKS Role
- Establish a special account for receiving payments and fees collected by PARKS, associated with use of Norrie Point Environmental Center.

- Approve leases.
- Administer apartment and classroom lease.
- Deposit revenue generated from the apartment and classroom leases into PARKS' special account.
- Pay operating expenses from the special account.

B. PROGRAM DEVELOPMENT

1. DEC Role
- Develop and operate Research Reserve programs & partnerships.
- Develop and fund Research Reserve exhibits.
- Assist PARKS in identifying an entity to lease the north classroom for educational purposes related to the Hudson River Estuary focus of the Center.

2. PARKS Role
- Identify an entity to lease the north classroom for educational purposes related to the Hudson River Estuary.

C. OPERATIONS & MAINTENANCE

1. DEC Role
- Provide for janitorial services, at DEC expense, in the DEC occupied area.
- Maintain interior of structure as a clean, well-ordered space.

2. PARKS Role
- Handle snow removal.
- Handle landscape and lawn care.
- Maintain potable water source.
- Maintain on-site septic system.
- Maintain sea wall, dock, and other exterior surfaces and walkways.
- Maintain parking lot surface.
- Maintain electrical and water service to the building.
- Maintain garage and outbuildings immediately north of the Norrie Point Inn.
- Maintain exterior of Norrie Point Inn.
- Pay monthly services for trash removal from PARKS' special account.
- Require Lessees of the Classroom and apartment to provide for janitorial services, at Lessees expense, in the Lessees occupied area.

D. SECURITY

1. DEC Role
- Secure and lock windows and doors at end of day, and set intrusion alarm.

2. PARKS Role

- Patrol Norrie Point as part of routine Mills-Norrie Park oversight.
- Maintain the electronic security system and upgrade as necessary.
- Assume full cost of security system operating expenses and pay expenses from PARKS' special account and from another funding source if special account is not sufficient.

E. UTILITIES

1. DEC Role
- Contract with and pay directly to companies for DEC telephone, internet and cable services.
- Assume responsibility for shared costs of oil, propane and electricity as outlined below.

2. PARKS Role
- Contract with and pay directly to companies for PARKS telephone, internet and cable services. These services will not be paid from the PARKS' special account.
- Pay monthly charges for electricity, oil and propane for the facility from the PARKS' special account. PARKS will bill DEC for their share of the operating expenses as outlined below.
- Will not charge DEC or Lessees for potable water use.

F. SHARED OPERATING EXPENSE RESPONSIBILITY

Item	DEC	PARKS
Oil	*	*
Propane	*	*
Electricity	*	*

* Responsibility will be based on the percentage of occupied floor space.

Continued on next page

V. FUTURE RENOVATION PLAN

PARKS and DEC will collaborate on the planning for and fund-raising for any future renovations to the Norrie Point Environmental Center and its environs, to potentially include:

Expansion of Existing Building to Accommodate Program Growth -- The existing structure is not adequate to accommodate additional partnerships or program growth, and it may be advantageous to develop space for these uses. This would most likely be accomplished by expanding the existing second story to cover more of the building.

Creation of Living Quarters for Visiting Researchers, Trainees, and Students – Short-term living quarters will be a substantial asset for attracting teachers and resource managers from throughout the Hudson River Estuary to attend multi-day professional development workshops. The Research Reserve also envisions attracting young professionals, post-secondary students, interns, and fellows to undertake projects at the Reserve, and housing is a key inducement.

Additional Research Laboratories, Based on Demand – Renovations to the main laboratory will be sufficient to enable 4-6 people to work simultaneously. However, in the event of future growth in demand for lab facilities, a location and funding for additional facilities may be sought.

Outdoor Storage and Facilities – Future developments may include repairs or new construction to enable storage for canoes and kayaks, and the associated field equipment; racks for drying wet gear; a shed for boats, such as the Reserve's Boston whaler and Carolina skiff; a covered work area on deck to accommodate 30 people; a fish cleaning station on the deck with water supply to support classroom field trips and public fishing.

EXHIBIT A

Norrie Point Environmental Center

Operated by

New York State Department of Environmental Conservation

Through a Cooperative Agreement with the

New York State Office of Parks, Recreation and Historic Preservation

State of New York
George E. Pataki, Governor

NYSDEC Denise Sheehan, Commissioner	OPRHP Bernadette Castro, Commissioner

AM05902 Amendment #1

MEMORANDUM OF UNDERSTANDING

Between

NEW YORK STATE OFFICE OF PARKS, RECREATION & HISTORIC PRESERVATION

And

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION

THIS AMENDMENT to an existing Memorandum of Understanding is made by and between the NYS Department of Environmental (hereinafter referred to as "DEC") having offices at 625 Broadway, Albany, NY 12233, and the NYS Office of Parks, Recreation and Historic Preservation (hereinafter referred to as "PARKS") with offices at Agency Building #1, Empire State Plaza, Albany, NY 12238.

WITNESSETH:

WHEREAS, DEC and PARKS entered into a Memorandum of Understanding (MOU) designated as AM05902 in December 2006, for the improvement, operation and maintenance of a portion of Margaret Lewis Norrie State Park known as the Norrie Point Inn; and

WHEREAS, the MOU anticipated that additional funds would become available for additional improvements to the property; and

WHEREAS, DEC has secured additional Federal funds for these purposes and wishes to transfer such funds to PARKS for implementation; and

WHEREAS, Article 3 stated that all future actions involving the change of use, development, improvement or structural alteration of the Subject Property shall require written approval;

NOW THEREFORE, the MOU is hereby amended as follows:

Article 1 is hereby amended to add the following sentence:

a. This Agreement may be amended upon written mutual consent of both parties.

Article 3 is hereby amended to add:

b.1. The DEC agrees to sub-allocate to PARKS an additional $300,000 to implement selected recommendations of the NYS Energy Research Development Agency's Energy Audit Report for the Norrie Point Environmental Center, for a contract total of $2,000,000. PARKS will use the funds to insulate the structure, make repairs to the building envelope, install renewable energy features, including solar photovoltaic cells, and install other energy saving devices, including window shades. PARKS agrees to secure reimbursement of the maximum allowable amount from NYSERDA for costs related to installation of the alternative energy components of the improvements.

All other terms and conditions of AM05902, as amended, will remain in full force and effect.

IN WITNESS WHEREOF, this instrument shall not take effect until it has been approved by both parties.

NYS DEC SIGNATURE

Title: [signature]

Dated: 6/16/09

AGENCY SIGNATURE

Title: Andy Beers

Dated: 5/26/09

Appendix 4

Staff Duties and Organizational Charts for the Hudson River Reserve

APPENDIX 4

STAFF DUTIES and ORGANIZATIONAL CHARTS for the HUDSON RIVER RESERVE

RESERVE STAFF ROLES

Management Staff

Reserve Manager (1 FTE, NYS Civil Service position, NYS funding) - Manage Hudson River National Estuarine Research Reserve's (Reserve) education, research and stewardship programs, develop and supervise staff, build and maintain partnerships, oversee facilities development and serve as primary liaison and spokesperson for the program.

Reserve Program Coordinator (1 FTE, contractual, NYS Estuary Program funding) - Coordinate administration of federal, state and private grants related to reserve programs, including preparation of new grant applications and extension/change of budget requests and maintenance of fiscal tracking system. Also coordinate site stewardship, resource protection and maintenance activities at Nutten Hook, Stockport Flats and Piermont Marsh sites.

Research Staff

Research Coordinator (1 FTE, contractual, NOAA funding) - Manage and develop research and monitoring programs, facilities and equipment; supervise research staff and promote partnerships, awareness of the research program and use of the scientific information by scientists, educators and managers.

Research Assistant (1 FTE, contractual, NOAA funding) - Conduct the NERRS Systemwide Monitoring Program, including deployment and maintenance of field equipment, data collection, wet chemistry, weather station operation, annual review and submission of all data to NOAA, creation and maintenance of relational databases, data analysis, laboratory oversight and supervision of the part-time Research Assistant.

SWMP Technician (1 FTE, contractual, NOAA funding) - Assist the Research Assistant with all aspects of the water-quality monitoring program, including deployment and maintenance of field equipment, wet chemistry, weather station operation and data entry.

Education Staff

Education Coordinator (1 FTE, contractual, ½ NOAA funding, ½ NYS Estuary Program funding) - Manage and develop education and interpretive programs, facilities and equipment; supervise education staff, and promote partnerships, awareness of the education program and

translation of scientific information for general public, formal-education and informal-education audiences.

Education Assistant (1 FTE, contractual, NOAA funding) - Support and enrich Reserve education programs; responsible for implementation of Reserve citizen science projects and education programs.

Estuary Educator (part-time, contractual, NOAA funding) - Support and enrich Reserve education programs; responsible for Reserve public education programming, especially canoe programs.

SCA Education Intern (10 months, contractual, NYS Estuary Program funding) - Support Reserve education programs, especially citizen science projects.

SCA Education Intern (10 months, contractual, NYS Estuary Program funding) - Support Reserve education programs, especially the public field programs.

Training Staff

Estuary Training Program Coordinator (1 FTE, contractual, NOAA funding) - Develop and oversee the Coastal Training Program, including organization of a steering committee, market analyses and needs assessments, development of strategic and marketing plans and delivery of estuary training programs and products, including coastal decision-maker workshops, issue forums and guidance documents.

SCA Training Intern (10 months, contractual, NYS Estuary Program funding) - Support Reserve ETP coordinator and training programs

Restoration/Stewardship Staff

Habitat Restoration Coordinator (1 FTE, contractual, NYS Estuary Program funding) - Assess habitat restoration opportunities in tidal wetlands, modified shorelines, tributary streams and submerged habitats; prepare restoration program guidelines and a plan for habitat restoration in the Hudson River estuary; provide technical assistance to agencies and municipalities and evaluate the feasibility of restoring priority sites on the Hudson River Estuary.

Habitat Restoration Biologist (1 FTE, contractual, NYS Thruway Authority funding) - Responsible for management and implementation of habitat restoration mitigation projects for Tappan Zee bridge replacement.

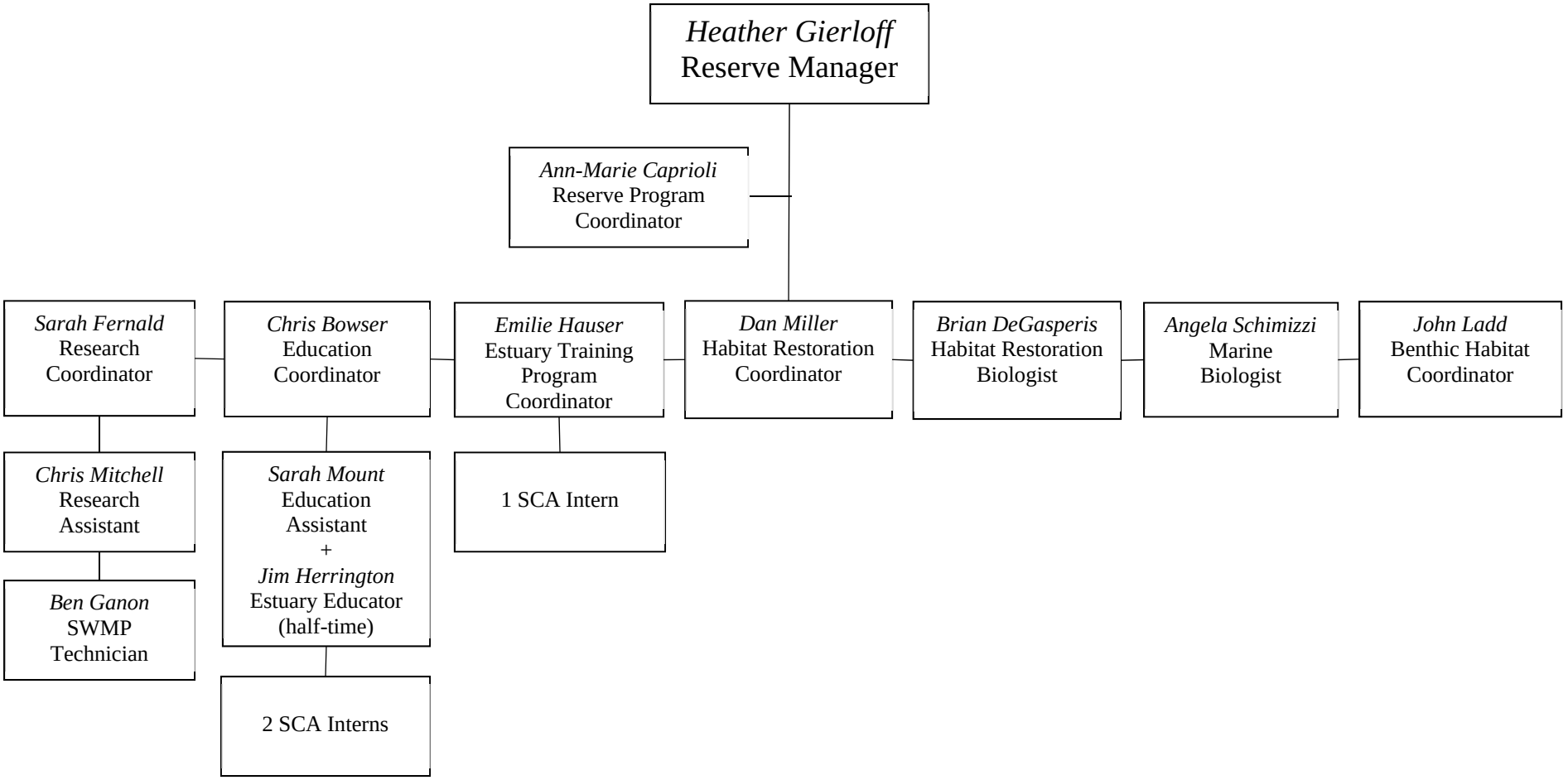
Marine Biologist (1 FTE, NYS Civil Service position, NYS funding) - Responsible for regulatory review of marine habitat projects, provision of technical assistance, and collaboration on management guidance.

Benthic Habitat Coordinator (part-time, contractual, NYS Estuary Program funding) - Coordinate the benthic mapping program, including determination of appropriate technologies to map benthic substrates and to define and characterize key estuarine habitats and their flora and fauna, coordination of the design of web-based access to benthic data, response to benthic data and information requests and oversight of contracts related to mapping project.

ORGANIZATIONAL CHARTS

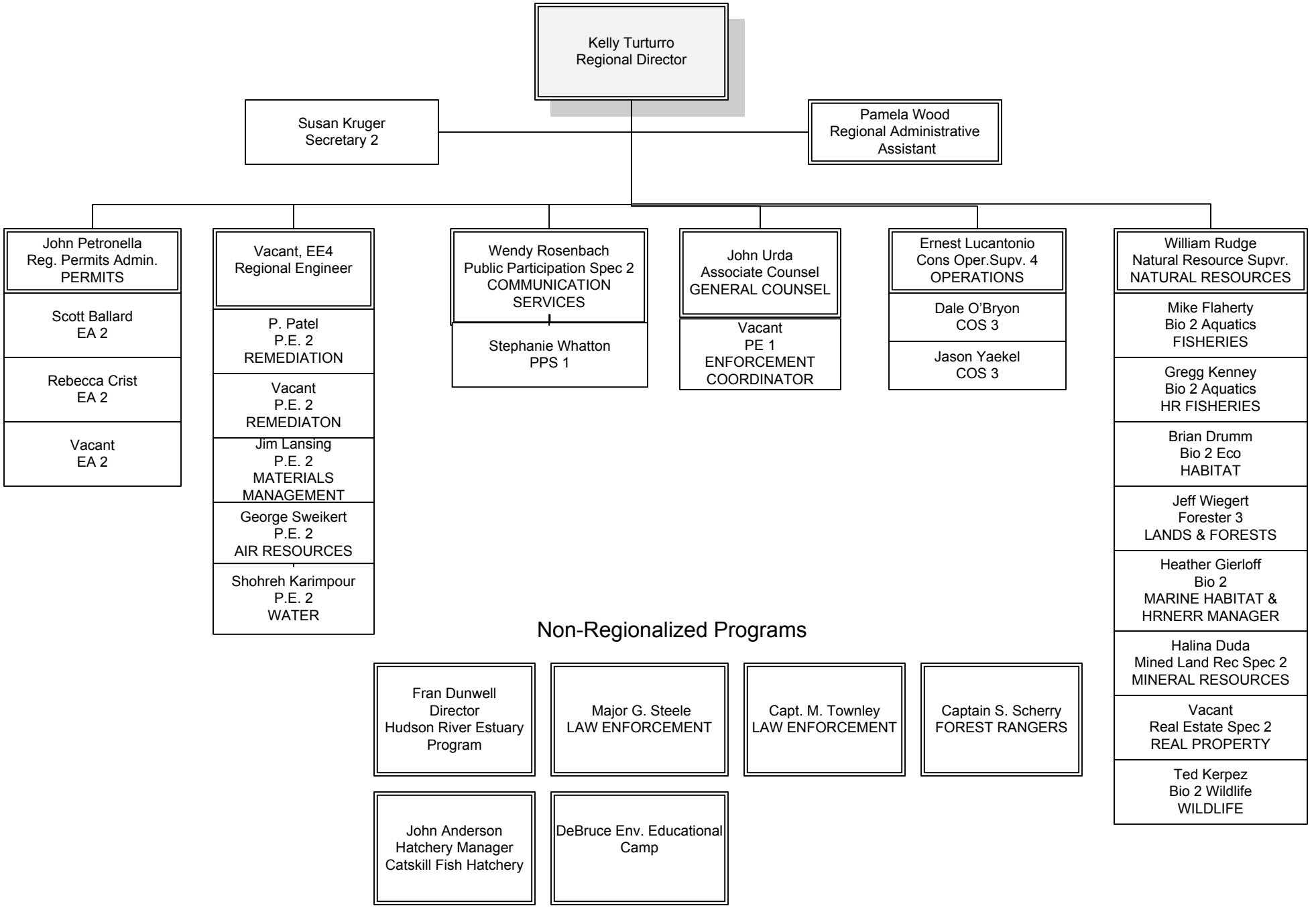
The organization of Reserve staff is depicted in the first attached organization chart. DEC is a matrix of regional and program offices. On a regional basis, the Reserve, as the regional Marine program, reports to the DEC Region 3 Office through the natural resources supervisor. On a programmatic basis, the Reserve reports to the DEC Division of Marine Resources. Organizational charts are also attached for Region 3 and Marine Resources.

Hudson River National Estuarine Research Reserve



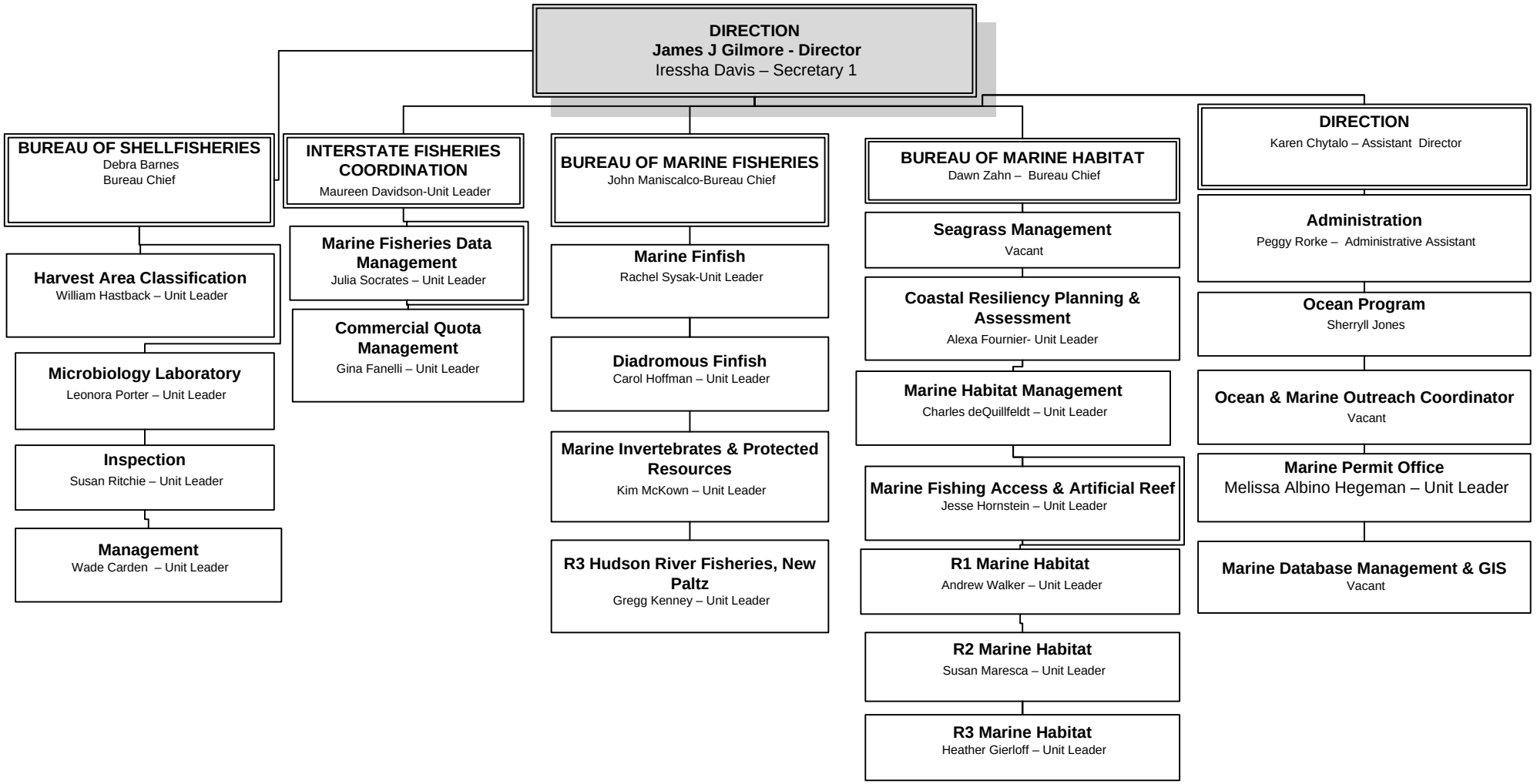
June 2018

REGION 3



DIVISION OF MARINE RESOURCES

June 13, 2018



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Appendix 5

Hudson River Reserve
Research Guidelines

Hudson River National Estuarine Research Reserve (HRNERR)
Research Guidelines

Updated November 30, 2017

These guidelines apply to all research activities involving utilization of the HRNERR component sites (Piermont Marsh, Iona Island, Tivoli Bays, Stockport Flats). Research Guidelines apply to class and group projects as well as to individual investigators.

- All researchers are required to obtain a research permit before working in a HRNERR component site (see table for site specific application information).

- Strict adherence to all permit conditions is required by the permitting agency.

- Please submit your application package THREE MONTHS before your anticipated start date to the Permit Contact and copy the HRNERR Research Coordinator (Sarah Fernald: 845-889-4745 x111; sarah.fernald@dec.ny.gov) and the appropriate Facility Manager (see table) in order to ensure that there will be no overlapping activities within each HRNERR component site.

HRNERR Site	Permit Title	Permit Agency	Permit Contact	Facility Manager
Piermont Marsh	Scientific Research Application and Permit	NYS Office of Parks Recreation and Historic Preservation	Jesse Jaycox (Jesse.Jaycox@ parks.ny.gov)	Clark Alexandre (Clark.Alexandre @parks.ny.gov)
Iona Island	Scientific Research Application and Permit	NYS Office of Parks Recreation and Historic Preservation	Ed McGowan (Edwin.McGowan@ parks.ny.gov)	Elizabeth OLoughlin (Elizabeth.OLoughlin @parks.ny.gov)
Tivoli Bays	Temporary Revocable Permit	NYS Department of Environmental Conservation	Nathan Ermer (Nathan.Ermer@ dec.ny.gov)	Nathan Ermer (Nathan.Ermer@ dec.ny.gov)
Stockport Flats	Temporary Revocable Permit	NYS Department of Environmental Conservation	Jeffrey Rider Jeffrey.Rider@dec.ny.gov	Heather Gierloff (Heather.Gierloff@dec.ny.gov)

- Additional permits from the NYSDEC or USFWS may be required for certain types of work. This may include, but is not limited to, work on listed species and the collection and possession of wildlife. Please submit documentation of all required state and federal permits to the Permit Contact and HRNERR Research Coordinator. All required permits must be in hand prior to initiating work.

- In the Research Methodologies section of the application, please describe what steps will be taken to minimize non-target impacts from site access/foot traffic to sensitive natural resources of the tidal marsh surface.

- For projects lasting more than one year, a new research application must be submitted annually to the appropriate agency. Please copy the HRNERR Research Coordinator and the appropriate Permit Contact and Facility Manager (see table) on your annual submissions.

- Researcher(s) or their representatives are to notify the HRNERR Research Coordinator and the appropriate Facility Manager (see table) of specific study dates at least one week prior to site access to ensure there will be no conflicting activities on those dates.

- All field equipment (traps, measuring devices, etc.) left in the field must be labeled with the Principal Investigator's name, date of installation, and the research permit number.

- Superfluous plot markers and unused equipment must be removed from study sites annually.

- Annual progress reports must be provided to the Permit Contact, the HRNERR Research Coordinator and the appropriate Facility Manager (see table) by December 31st of each study year. Please also include a GIS shapefile of all study site locations.

- Research shall be used for scientific or interpretive purposes only, be dedicated to the public benefit, and not be used for commercial purposes.

- The use of HRNERR component sites or facilities should be acknowledged in any publication resulting from work done at HRNERR component sites.

- Failure to comply with any element of the Research Guidelines may be grounds for rejection of subsequent research applications and/or immediate termination of the project.

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Appendix 6

Hudson River Reserve
Parks/PIPC Research Permit

New York State Office of Parks, Recreation and Historic Preservation
Scientific Research Application and Permitting System

State Parks are an excellent resource for conducting scientific research. The Scientific Research Permitting System enables OPRHP to track and organize research projects and data collected in parks statewide.

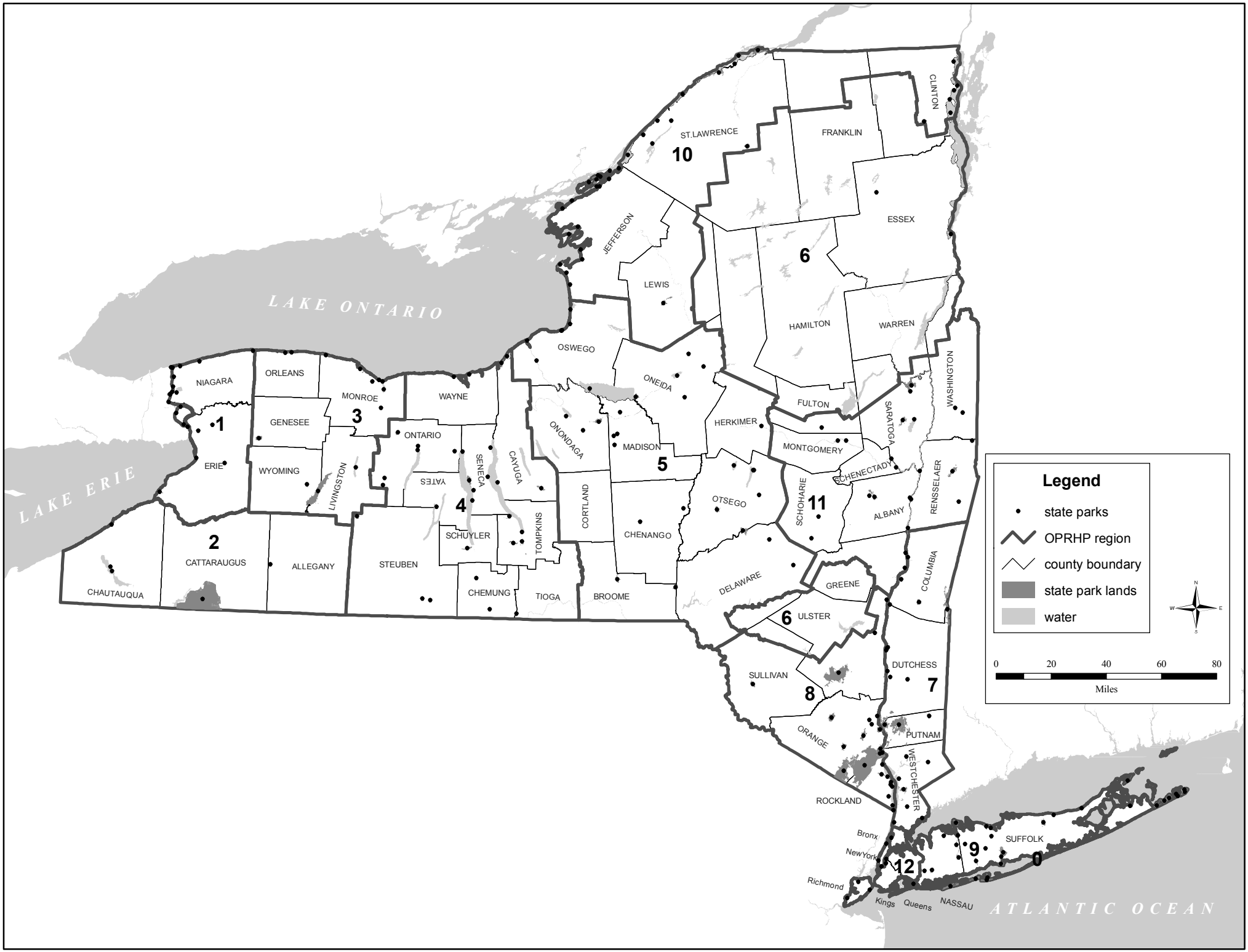
Please submit the Scientific Research Application to the appropriate OPRHP Contact based on the location of the proposed research project (see contact list and park regional map below). After review the application will be accepted or denied based on its applicability to the agency's mission and standards. A signed application will serve as the Scientific Research Permit.

OPRHP Contact List for Scientific Research Applications

Region	Contact
Multiple Regions	Lynn Bogan Lynn.Bogan@parks.ny.gov (518) 473-1406 NYS OPRHP Albany, NY 12238
1 - Niagara	Meg Janis Meg.Janis@ parks.ny.gov (585) 493-3615 1 Letchworth State Park Castile, NY 14427
2 - Allegany	Meg Janis Meg.Janis@ parks.ny.gov (585) 493-3615 1 Letchworth State Park Castile, NY 14427
3 - Genesee	Meg Janis Meg.Janis@ parks.ny.gov (585) 493-3615 1 Letchworth State Park Castile, NY 14427
4 - Finger Lakes	Tom Hughes Tom.Hughes@ parks.ny.gov (315) 492-1756 6105 East Seneca Turnpike Jamesville, NY 13078
5 - Central	Tom Hughes Tom.Hughes@ parks.ny.gov (315) 492-1756 6105 East Seneca Turnpike Jamesville, NY 13078

Region	Contact
7 - Taconic	Jesse Jaycox Jesse.Jaycox@ parks.ny.gov (845) 889-3868 9 Old Post Road PO Box 308 Staatsburg, NY 12580
8 - Palisades	Jesse Jaycox Jesse.Jaycox@ parks.ny.gov (845) 889-3868 9 Old Post Road PO Box 308 Staatsburg, NY 12580
9 - Long Island	Annie McIntyre Annie.McIntyre@ parks.ny.gov (631) 581-1072 Regional Environmental Office PO Box 247 Babylon, NY 11702
10 - Thousand Islands	Casey Holzworth Casey.Holzworth@ parks.ny.gov (518) 584-2000 19 Roosevelt Drive Saratoga Springs, NY 12866
11 - Saratoga / Capital District	Casey Holzworth Casey.Holzworth@ parks.ny.gov (518) 584-2000 19 Roosevelt Drive Saratoga Springs, NY 12866
12 - New York City	Gabriella Cebada Mora Gabriella.CebadaMora@parks.ny.gov (518) 474-1229 NYS OPRHP 625 Broadway Albany, NY 12238

For research occurring in Region 6, the Adirondacks and Catskills, please contact the New York State Department of Environmental Conservation.


LAKE ONTARIO
LAKE ERIE
ATLANTIC OCEAN
ST.LAWRENCE
FRANKLIN
CLINTON
ESSEX
JEFFERSON
LEWIS
HAMILTON
WARREN
WASHINGTON
OSWEGO
ONEIDA
FULTON
SARATOGA
HERKIMER
MONTGOMERY
SCHENECTADY
RENSSELAER
ALBANY
SCHOHARIE
OTSEGO
MADISON
ONONDAGA
CAYUGA
SENECA
YATES
ONTARIO
WAYNE
MONROE
ORLEANS
NIAGARA
GENESEE
WYOMING
LIVINGSTON
ERIE
CORTLAND
CHENANGO
TOMPKINS
SCHUYLER
CHEMUNG
TIOGA
BROOME
STEUBEN
ALLEGANY
CATTARAUGUS
CHAUTAUQUA
DELAWARE
GREENE
COLUMBIA
ULSTER
SULLIVAN
DUTCHESS
PUTNAM
ORANGE
WESTCHESTER
ROCKLAND
Bronx
NewYork
Richmond
Kings
Queens
NASSAU
SUFFOLK
1
2
3
4
5
6
7
8
9
10
11
12
0
Legend
state parks
OPRHP region
county boundary
state park lands
water
0
20
40
60
80
Miles

FOR DEPARTMENT USE ONLY	
APPLICATION NO.	DATE RECEIVED
REGION	PERMIT TYPE

New York State Office of Parks, Recreation and Historic Preservation

☐ **NEW** (Complete sections A-D)
☐ **RENEWAL/MODIFICATION** (Complete Section A-D where appropriate)
☐ **FINAL and/or INTERIM REPORT** (Complete Section E)

SCIENTIFIC RESEARCH APPLICATION AND PERMIT

Instructions: Please type or print. Attach additional information as necessary. Indicate fields not applicable with N/A. Electronic signatures are acceptable. Send application to the appropriate contact.

Section A - Applicant Information

1. **Principal Investigator** (*Last-First-Middle initial*)

2. **Mailing Address** | **Telephone**
Fax
Email

3. **Affiliation** *(Graduate students, include name & phone number of major professor.)*

4. **Names of Field Assistants**

5. **Project Title**

Section B – Project Information

6. **Park and Project Location** (*Include site names with GPS coordinates when applicable and/or attach map.*)

7. **Research Purpose and Methodologies** (*Include objectives, design, methods, equipment & materials, and any collection or disposition of specimens as well as proof of other required permits, if any.*) Attach research proposal if necessary.

Section C – Time Frame

8. **Time Frame** (*start and end dates, including project scoping and clean up*)

Section D – Project Relationships

9. **Project's Relationship to Other Research Projects** *(Note whether related projects are in or near State Parks.)*

Section E – Final Report

10. **Project Report** *(Provide a copy of the final research report when it becomes available. Submittal of interim reports is encouraged.)*

Anticipated date of Final Report:

Attached report(s) and provide comments as deemed necessary:

SCIENTIFIC RESEARCH PERMIT

Standard Conditions and Restrictions:

It is the intention of the NYS OPRHP to further scientific research within the areas administered by it, and to cooperate with authorized workers to the fullest extent compatible with its charge to protect all species of flora and fauna and all soil and geologic material in a natural state insofar as possible.

1. Except for the resources indicated in the permit, the taking or disturbing of resources (including cultural or archaeological materials) is specifically prohibited.

2. Research shall be used for scientific or interpretive purposes only, be dedicated to the public benefit, and not be used for commercial purposes.

3. All research should be done in an inconspicuous manner away from roads, trails and developed areas unless specified in the permit, and shall not cause significant damage to the environment. In some cases the researchers and state parks may agree to location that enhances environmental education opportunities while meeting research and park management goals. Because of the scarcity and/or importance of some resources, the OPRHP may designate other restrictions necessary for the preservation of the area.

4. All field equipment (traps, measuring devices, etc) left in the field must be labeled with the Principal Investigator's name, date of installation, and the OPRHP permit number.

5. A permit from the NYS DEC and USFWS is required for certain types of work. This may include, but is not limited to, work on listed species and the collection and possession of wildlife. State and federal permits must be in hand prior to initiating work and be available for inspection on site.

6. Any research that leads to the discovery of new rare species or ecological communities requires the submission of a Natural Heritage Reporting Form to the New York Natural Heritage Program.

7. The permittee shall submit a summary of information gathered to the contact for the Region where the investigations took place within a year of the research end date (as identified on this permit). The OPRHP further requires that the researcher(s) provide copies of or otherwise make available to the OPRHP any material published as a result of this permit.

8. Researcher(s) or their representatives are to contact the appropriate Facility Manager before beginning, and to present a copy of this permit together with evidence of additional research licenses and permits, if required.

9. Researcher(s) will discuss with the Facility Manager the type and extent of work to be performed. The Facility Manager will describe any rules and regulations that may apply to the work.

10. If research is not conducted in accordance with this permit and/or to the satisfaction of the OPRHP, this permit will be immediately revoked.

11. The permittee shall promptly report any and all unusual incidents directly to the Facility Manager or Park Police. Unusual incidents include, but are not limited to, damage to Park property, accidents, personal injuries, and emergencies involving medical personnel.

12. Permittee shall defend, indemnify and hold harmless the People of the State of New York, the Executive Department, the New York State Office of Parks, Recreation and Historic Preservation and its commissioners, officers, agents and employees from and against damages for injury to or death of persons and for damage to or destruction of property of State Parks or others occurring during Permittee's use of said Premises and caused by the acts, omissions, neglect or misconduct of Permittee or any of its employees, agents, contractors, licensees or guests in the conduct of Permittee's operations under this permit. The Permittee assumes all risk of loss of the Permittee's property or that of its agents, employees, contractors and guests. Permittee's liability is not limited to the insurance coverage provided.

Special Conditions:

I have read the Conditions and Restrictions above and agree to those terms.

APPLICANT'S SIGNATURE | APPLICANT'S NAME (Print or type) | DATE

APPROVAL SIGNATURE | OPRHP PERMIT ADMINISTRATOR | DATE

APPLICANT MUST CARRY THIS PERMIT AT ALL TIMES WHILE IN PARK OR HISTORIC SITE.

PERMIT VALID FROM _____ TO_____

Entrance fees/admission to the park or site will be waived only in accordance to the research identified on this permit; specifically to those individuals identified on this permit and within the time period described on this permit.

Copies to: Permit contact. (Distribute both approved and denied permits.) Version 01/08/2013

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Appendix 7

Resource Protection Authorities and Regulations Affecting Hudson River Reserve Sites including NYSDOS Coastal Consistency Determination

Resource Protection Policies and Regulatory Authorities Affecting Hudson River Reserve Sites

Geology

Surface and subsurface features possessing unique geological characteristics will be protected to preserve those characteristics from unwarranted disturbance or destruction. Visitor access to these features will be controlled to insure their protection and the safety of the visitor.

Pertinent statutes, regulations and/or guidelines:

Environmental Conservation Law (ECL) Article 8 - New York State Environmental Quality Review Act

New York State Parks, Recreation, and Historic Preservation Law, Section 09-05 (lands under OPRHP and PIPC jurisdiction)

Soils

Excavation, mining or removal of loam, gravel, rock, sand, clay, coal, petroleum or minerals or alteration of topography will not be permitted except:

- As related to the collection of geological, geophysical or archaeological data under a research permit
- As necessary to restore dredge spoil islands, pre-disturbance hydrologic flows and natural vegetation communities
- As related to maintenance dredging of the Hudson River Federal Navigation Channel

Areas subject to user impact, such as trails, will be developed and maintained to minimize damage to and loss of soils through application of best-management practices. Particular care will be taken to minimize soil disturbances in the intertidal zone in and along non-tidal wetlands and watercourses and in forests and other plant communities on slopes of more than 10 percent adjoining or draining directly into tributary streams or estuarine environments.

Efforts will be made to stabilize human-induced erosion of shorelines through replanting of native supra- and intertidal vegetation. Shoreline stabilization sites will be closely monitored to determine colonization success. Generally, attempts will not be made to stabilize areas that are eroding from natural causes unless it is necessary to protect resources of unusual value. Eroding areas may not be restored if it is determined that rare and endangered species or other special

resources depend on the erosion. No dredge spoils will be deposited in the Hudson River National Estuarine Research Reserve (Reserve).

Pertinent statutes, regulations and/or guidelines:

Best Management Practices for controlling non-point source pollutants

Executive Law, Article 42 - Waterfront Revitalization and Coastal Resources Act (WRCRA) (Policy 37)

Soil and Water Conservation District Law

Watershed/Hydrology

There will be no human activities or uses of reserve sites that are significantly detrimental or adverse to the maintenance, improvement or conservation of existing surface and ground water supplies and quality. Efforts will be made to maintain and, where necessary, improve existing water quality through consistency reviews and substantive comment on projects outside the reserve. These efforts will seek to prevent or mitigate potential impacts on reserve water quantity and quality.

Spill contingency plans will be incorporated into management planning to ensure a high level of protection for tidal habitats within the reserve. These plans will be reviewed by DEC's Spill Response Unit staff and approved by the reserve manager.

There will be no further restrictions of water movements in either the estuarine environment or in upland streams, ponds and pools. Streambeds and channels will be preserved in their natural state. Efforts will be made to maintain railroad bridges and culverts clear of obstructions. Water control structures, dams, impoundments, breakwaters and canals will not be built, with the exception of minor (and generally temporary) structures for the purpose of scientific research and monitoring. No activities will be conducted on reserve sites that will significantly alter natural water level, reduce flow or both.

Permission for exceptions to this policy may be granted on a case-by-case basis, generally for approved applied research or wetland restoration projects. Restoration of tidal circulation may be pursued (with appropriate environmental quality reviews) where additional culverts or larger railroad bridge openings are needed to restore or maintain functional values of the reserve's tidal wetlands.

Pertinent statutes, regulations, and/or guidelines:

ECL Article 15, Title 5 - Protection of Water

ECL Article 17, Title 8 - State Pollution Discharge Elimination System

ECL Article 24 - Freshwater Tidal Wetlands Act

ECL Article 25 - Tidal Wetlands Act

Federal Clean Water Act, Section 404

Pesticides and Herbicides

The use of pesticides and herbicides will be minimized to prevent contamination of reserve environments and will be used only as part of an approved management-plan activity. Persistent chemicals will not be used. Chemicals will be used only where their use results in no significant impact on non-target organisms, as judged by agency natural resources staff in consultation with the reserve manager.

Railroads and other right-of-way owners will be encouraged to use integrated pest management techniques in or near reserve sites or hand or mechanical harvesting.

Pertinent statutes, regulations and/or guidelines:

ECL Article 33

ECL Article 9, Title 13 - Forest Insect and Disease Control

Air Quality

Activities that have the potential to cause air pollution exceeding New York State air-quality standards are forbidden in the reserve.

Pertinent statutes, regulations and/or guidelines:

ECL Article 19 - Air Pollution Control

Executive Law, Article 42 - WRCRA (Policy 41)

Wetlands

All tidal and non-tidal wetlands located within or along reserve boundaries shall be protected in a natural condition. Wetlands include swamps, freshwater and brackish marshes, unvegetated intertidal sand and mud flats and submerged shallows to a depth of six feet at low tide. For the purpose of this policy, there is no minimum size limit for wetland definition. Generally, no wetland, pond or waterway shall be filled. On a limited basis, the reserve manager will consider exceptions to this policy; for instance, under circumstances that require wetland filling to assure the integrity of the reserve. Any such activities will be subject to the requirements of the State Environmental Quality Review Act (SEQRA) and other applicable authorities.

Efforts will be made to restore wetlands that have been filled, altered as a result of human activities or invaded by non-native species or Phragmites to the extent feasible, practicable and beneficial for the maintenance and protection of special biological resources. Detailed restoration plans are described for each reserve site later in this chapter.

Pertinent statutes, regulations and/or guidelines:

ECL Article 15, Title 5 - Protection of Water (all sites)

ECL Article 25 (Piermont Marsh)

ECL Article 24 (Iona Island, Tivoli Bays, Stockport Flats)

Federal Clean Water Act, Section 404 and 401

Executive Law, Article 42 - WRCRA (Policies 7, 35 and 44)

Vegetation Management

Management efforts will seek to maintain the upland and wetland ecosystems in natural states that are within the natural range of variability exhibited by similar, relatively undisturbed ecosystems in the region. Vegetation management policy will vary according to land use types at reserve sites. In no cases will clear cutting be allowed.

Sensitive areas, such as wetlands, stream and wetland buffers, steep slopes, scenic landscapes and other areas in need of protection from inappropriate or excessive use, will have a limited management policy. Upland vegetation management will be limited to pruning and cutting to promote safety on roads and trails, maintain or establish trails or conduct research that will have limited or no impact on tidal wetlands. Forest resources will be conserved and protected to provide wetland and tributary stream buffers, wildlife habitat and corridors, erosion control and a variety of other beneficial functions. Wetland vegetation management may require public use controls to prevent damage. Vegetation management activities to restore degraded wetlands may be employed as specified and consistent with other policies in this management plan.

For areas where there is a yield of forest or wildlife and/or dispersed recreation, such as hiking, bird watching or hunting, management strategies will be more active. Vegetation may be managed through selective thinning to control exotic invasions or to improve species diversity and stand health to restore upland ecosystems. Old fields may be maintained through mowing or controlled burns to provide habitat for a variety of species requiring open-field habitats.

Areas within reserve sites requiring a high degree of protection, such as natural areas, rare species habitats and historical and archaeological sites, will be governed by the attributes and management needs of the unique resource(s) within these areas. In some areas, the resource(s) may dictate aggressive control of vegetation (e.g., Nutten Hook Ice House); in others, vegetation management will be minimized.

For areas within reserve sites containing developed land, a variety of vegetation management strategies may be undertaken to maintain active areas, including mowing, pruning and selective thinning.

For all sites within the reserve, control of outbreaks of forest insect pests, such as gypsy moth and hemlock woolly adelgid, will be at the discretion of the agency with jurisdiction, provided control methods conform to the pesticides and herbicides policy. In general, outbreaks will be allowed to run their natural course; however, controls may be used to protect important ecological areas. In addition, for all sites, land managers, in consultation with reserve staff, will develop site-specific strategies for responding to catastrophic events such as floods or hurricanes, including prescription of salvage and clean-up activities.

Pertinent statutes, regulations, and/or guidelines:

Forest Harvesting Best Management Practices (all sites)

ECL Article 9

Executive Law, Article 42 - WRCRA (Policy 7)

Wildlife

Wildlife is defined as the wild, introduced and/or exotic vertebrate and invertebrate animals that appear as residents, transients or migrants at reserve sites. In general, balanced wildlife populations will be promoted through the protection of habitats and environmental quality in the reserve, rather than the implementation of species management plans. Occasionally, wildlife management plans will be required for species that are considered to be a threat to the ecological integrity of existing native communities within the reserve or for rare and endangered species

which would be at risk without management. In these instances, reserve staff and wildlife managers will work cooperatively with the involved state agency to develop such a plan.

Public access to key habitats for endangered species of wildlife will be restricted during critical periods to minimize disturbance of affected populations. Research, education and/or management (including harvesting) activities must be conducted under a valid New York State Scientific Collector's permit or New York State hunting, fishing or trapping license. Commercial harvesting of fish and wildlife is addressed in the industrial and commercial activities section of this plan.

Pertinent statutes, regulations, and/or guidelines:

ECL Article 11 - Fish and Wildlife

ECL Article 13 - Marine and Coastal Resources

Executive Law, Article 42 - WRCRA (Policies 8 and 35)

Endangered and/or Threatened Species and Communities

Areas within reserve sites identified by the New York Natural Heritage, the Nature Conservancy or others as possessing endangered, threatened or rare elements--including plant and animal species or communities and other regionally rare elements and taxa--shall be managed to preserve and protect these resources, generally by restricting public access to these areas. Specific management strategies may be required to address life history and habitat requirements. The presence of such elements shall not necessarily preclude all other continued or proposed uses of an area. The flora and fauna at reserve sites will be surveyed, monitored and managed in conjunction with the New York Natural Heritage Program and other involved agency staff.

Pertinent statutes, regulations, and/or guidelines:

Federal Endangered Species Act

ECL Article 11, Title 5

ECL Article 9, Title 15 - Removal of Evergreen Trees and Protected Plants

Exotic and Invasive Species

Exotic and invasive plant and animal species will be discouraged to the extent practicable in core tidal wetland areas. Reserve staff and other involved agency partners will consider ways to

minimize the spread of these species through reduction of existing populations and recruitment sources and incorporate such actions into research and monitoring efforts where feasible. Efforts will be made to avoid the creation of habitat conditions conducive to their spread, such as disturbed soils.

Pertinent statutes, regulations and/or guidelines:
ECL Article 11, Title 5

Structures, Roads and Trails

In all but developed sections of reserve sites, no new buildings, facilities, structures, piers, roads or trails will be constructed, except those accessory to research, education, administration and naturalistic uses of the reserve site. Bird blinds and tree stands are considered to be temporary structures linked to traditional hunting activities that are allowed unless prohibited by regulations. In developed areas, other construction may be considered, provided it is accessory to the use of the lands for recreation, visitor centers, administration and/or maintenance. Such construction may be undertaken by the jurisdictional agency only after the environmental impact of any such construction is assessed under the SEQRA, as appropriate, and the action is approved for consistency with the management plan.

Removal of existing structures will be assessed for environmental impact. With the exception of the illegally constructed squatters' cabins at Stockport, there will be no compulsion to remove existing structures.

Pertinent statutes, regulations and/or guidelines:

ECL Article 8 - New York State Environmental Quality Review Act

National Historic Preservation Act

ECL Article 9, Title 3 - Use of Lands and Forests

Signs and Billboards

Display of signs, billboards or other advertisements will not be permitted on or above reserve sites except to identify the state jurisdiction; to provide notice of the designation as part of the Hudson River National Estuarine Research Reserve (Reserve); to post rules and regulations; to indicate trail locations and destinations, and/or to interpret the natural and cultural history of the site(s).

Pertinent statutes, regulations and/or guidelines:

ECL Articles 3, 9, 11, and 49

Fire

Accidental and natural fires will be controlled where feasible in accordance with applicable state regulations. No fires shall be permitted at reserve sites, with the exception of controlled burns in accordance with DEC prescribed-burns regulations that are part of an approved habitat management action. Fires also may be permitted in fireplaces or grills in developed sections of reserve sites.

Pertinent statutes, regulations and/or guidelines:

OPRHP Rules and Regulations, Part 377

ECL Article 9, Title 11 - Forest Fire Control

Trash, Rubbish and Waste

New York State has a carry-in/carry-out policy on public land. No soil, trash, ashes, garbage, debris, vehicles, appliances, hazardous waste or other offensive materials shall be dumped or deposited on reserve sites. Any such materials that have been deposited illegally will be removed expeditiously. Efforts will be made by enforcement personnel to trace the source of such materials and to compel their removal. Railroads and right-of-way owners will not dispose of railroad ties or other debris in the reserve.

Pertinent statutes, regulations and/or guidelines:

OPRHP Rules and Regulations, Part 375

ECL Article 9, Title 3 - Use of Lands and Forests (DEC lands)

Vehicles

No motorized vehicles will be operated within the reserve, except on access roads where expressly permitted by the jurisdictional agency. All-terrain vehicles are prohibited on all OPRHP and PIPC lands and in DEC wildlife management areas. Motorized boats are not permitted in the Tivoli Bays, except as specifically permitted by posted notice. Personal watercraft are not permitted at any reserve site.

Pertinent statutes, regulations and/or guidelines:

OPRHP Rules and Regulations, Part 375

ECL Article 11

Archaeological and Historical Resources

Reserve sites will be inventoried, as resources permit, to locate sites and objects possessing prehistoric and/or historic significance and plans to protect such sites and objects shall be incorporated into management planning. Research, educational and management activities which may affect significant sites or objects shall require review and approval by appropriate authorities.

Pertinent statutes, regulations and/or guidelines:

National Archaeological Resource Protection Act

National Historic Preservation Act

OPRHP NYS Park, Recreation, and Historic Preservation Law

New York State Education Law 233

ECL Article 9, Title 3 - Use of Lands and Forests

ECL Article 45 - State Nature and Historical Preserve Trust (Tivoli Bays)

Executive Law, Article 42 - WRCRA (Policy 23)

Collection of Natural, Historical and/or Cultural Resources

No plant, animal, mineral or fossil specimens or historic and prehistoric artifacts may be collected at the reserve without applicable state or federal permits, including a reserve research permit. Use of metal detectors is prohibited. The gathering of natural materials for camouflaging hunting blinds is generally allowed but discouraged; it is also prohibited where posted.

Pertinent statutes, regulations and/or guidelines:

National Archaeological Resource Protection Act

NYS Education Law 233

ECL Article 9, Title 3 - Use of Lands and Forests

Habitat Manipulation

Habitat manipulation activities for research purposes will not be permitted if those activities or their resulting short- and long-term consequences have the potential to compromise the representative character and integrity of the reserve or to adversely affect reserve resources.

According to NOAA regulations, habitat manipulation for resource management purposes is not permitted within the reserve except for:

- Protection of public health
- Preservation of sensitive, natural, cultural or historical resources which have been listed or are eligible for protection under relevant state or federal authorities
- Restoration of degraded areas to improve the representative character and integrity of the reserve
- Development or improvement of access, consistent with other policies in this section Manipulations for the purposes of restoration may be allowed under policies for soil, hydrology, wetlands, vegetation, wildlife and fire management, and these may provide opportunities for research.

Pertinent statutes, regulations and/or guidelines:

National Estuarine Research Reserve System Regulations, CFRR, Part 921

National Environmental Policy Act

Executive Law, Article 42 - WRCRA (Policy 7)

Industrial and Commercial Activities

Private and commercial activities are generally not allowed in the reserve; however, approvals may be obtained where the commercial activity is in conjunction with or in support of reserve activities, including such activities as natural history courses, authorized concessions for reserve events or vegetation management. No restrictions apply to activities associated with the exercise of navigation rights, such as commercial fishing and kayaking.

Pertinent statutes, regulations and/or guidelines:

ECL Article 9 - Fish and Wildlife

ECL Article 13 - Marine and Coastal Resources

Executive Law, Article 42 - WRCRA (Policy 7)

STATE OF NEW YORK
DEPARTMENT OF STATE
ONE COMMERCE PLAZA
99 WASHINGTON AVENUE
ALBANY, NY 12231-0001
WWW.DOS.NY.GOV

ANDREW M. CUOMO
GOVERNOR

ROSSANA ROSADO
SECRETARY OF STATE

August 22, 2019

Nina Garfield, Program Specialist
National Oceanic and Atmospheric Administration
NOS, Office for Coastal Management
1305 East West Highway, SSMC4/ 10th Floor
Silver Spring, Maryland 20910

Re: F-2019-0812(DA)
National Oceanic and Atmospheric Administration
Hudson River National Estuarine Research
Reserve 2019-2024 Management Plan
Negative Determination

Dear Ms. Garfield:

On 8/21/2019, the Department of State received the United States Army Garrison's negative determination and supporting information for the above referenced activity. Based on the information provided, the Department concurs with your determination that the Hudson River National Estuarine Research Reserve 2019-2024 Management Plan will not result in any reasonably foreseeable effects to land and water uses or natural resources of the coastal area. Further review of this activity by the Department of State is not necessary.

Thank you for providing this information to the Department of State. If you have any questions regarding this matter, please contact us at (518) 474-6000 and refer to our file # F-2019-0812(DA).

Sincerely,

Matthew P. Maraglio
Supervisor, Consistency Review Unit
Office of Planning, Development and
Community Infrastructure

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Appendix 8

Strategy for Hudson River Reserve Estuary Training Program 2018-2022

Strategy for Hudson River NERR Estuary Training Program 2018-2022

Emilie Hauser, Training Program Coordinator

Hudson River National Estuarine Research Reserve

First Draft April 16, 2018,

Revised September 12, 2018

Accepted by the NERRS CTP Oversight Committee October 22, 2018

Table of Contents

Program Context

The Estuary Training Program (Program, or ETP) 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. The scope of the program coincides with the main goals and objectives of the Hudson River National Estuarine Research Reserve (reserve), alongside the work of the Reserve's management, education, research, stewardship and restoration sectors. While all reserves in the National Estuarine Research Reserve System (NERRS) have a Coastal Training Program (CTP), the Hudson River Reserve uses the descriptive "Estuary" in place of "Coastal".

The Reserve is a state-federal partnership program that manages four federally designated and state-protected sites along 100 miles of the Hudson River Estuary: Piermont Marsh, Iona Island, Tivoli Bays, and Stockport Flats. The Reserve's mission is to improve the health and vitality of the Hudson River Estuary by protecting estuarine habitats through integrated education, training, stewardship and restoration, and monitoring and research programs. The federal partner is New York State (NYS) Department of Environmental Conservation (NYSDEC).

The Hudson River Estuary flows from the federal dam at Troy 152 miles to the Battery in New York City (NYC) Harbor. The estuary watershed covers 4,892 square miles within New York State, part of the larger 12,800-square-mile Hudson-Mohawk river basin (NYSDEC 2018).

The ETP concentrates its efforts in the ten counties from Albany and Rensselaer south to Rockland and Westchester, with a total of 79 local municipalities which have borders along the estuary. Based on county data compiled from 2010 to 2014, the population of these ten counties, which make up most of the watershed, is estimated at 2.8 million people (New York State 2018).

The protection and restoration of the habitats of the Hudson River estuary is a primary Reserve management objective. The habitats can be categorized into:

- River bottom habitat;
- Shallow-water vegetated habitats, including 3,250 acres of submerged aquatic vegetation (SAV) habitat and 2,000 acres of the invasive water-chestnut (*Trapa natans*);
- Intertidal habitats, including 6,750 acres of intertidal wetlands;
- Shoreline habitats – of the over 254 miles north of the Tappan Zee Bridge (located 27 miles north of the NYC Battery), 42% is hardened shoreline, freight and passenger railroads border 28%;

- Tributary habitats to the head of tide.

The anthropogenic threats to these habitats and ecosystems include legacy pollutants, poor water quality from stormwater run-off and combined sewer overflows, unsustainable development of the watersheds and waterfronts, and invasive species. Additionally, effects of climate change include water and air temperature increases, changes in the intensity of storms and precipitation, possible changes in the salt front, and sea-level rise. These impacts can cascade, for example, heavy rains eroded a massive volume of sediment from the upper Hudson-Mohawk watershed during hurricanes Irene and Lee in 2011, deposited them in the lower Hudson, and caused a significant loss of SAV. Since this occurrence, SAV has been slowly recovering.

New York State has adopted projections for sea-level rise (NYSDEC, 6 NYCRR Part 490). For the mid-Hudson region of the Hudson River Estuary, high projections are 9 inches in 2020, 27 inches in 2050 and 71 in 2100.

The Hudson River Estuary's freshwater tidal wetlands (a globally rare habitat) and submerged aquatic vegetation beds are threatened by sea-level rise, especially in conjunction with human activity that disrupts sediment accretion and/or limits migration of these wetlands (Raposa, et al. (2016 and Tabak et al. 2016).

Program Goals, Objectives, and Actions

The goals of the Program are the same as those of the Reserve (see Appendix 1). Objectives and actions specific to the ETP are:

Objective 1. Annually, 90% of participants state that they intend to apply the science-based knowledge and skills relevant to shoreline and river habitats and coastal management gained through the Estuary Training Program.

Actions:

- Assess the most pressing science information and training needs of our audiences.
- Develop relevant curricula and trainings covering science, regulation and policy by using Steering Committee and partner input, findings of needs assessments and literature research.
- Collaborate with external partners and Reserve staff to provide training and technical assistance; work closely with groups such as Shorelines Habitat Adaption Dialogue (SHAD), Hudson River Sustainable Shorelines Project, Hudson River Habitats team, NYSDEC Bureau of Ecosystem Health and Hudson River Estuary Program.
- Use Reserve sites for training and case studies.
- Develop case studies of innovative projects, develop other information resources and use websites and other communication media to reach decision-makers.

- Provide networking opportunities to help decisionmakers increase their effectiveness and ability to conserve, restore, and manage coastal habitats and to enhance ecosystem resilience.
- Fulfill the requirements of NERRS CTP Performance Monitoring Manual (NERRS 2014) and any updates.

Objective 2. Annually, at least two collective and collaborative efforts will receive technical assistance from the Estuary Training Program to address ecosystem health and resilience or other mutual priorities relevant to other to coastal management and Hudson river habitats.

Actions:

- Collaborate on and lead statewide natural and nature-based shoreline work group.
- Support implementation of and outreach and training for the Community Risk and Resiliency Act (CRRA), and other climate and resiliency efforts.
- Support Reserve efforts to expand observations of vegetation trends, sediment dynamics and water levels in Reserve tidal marshes and other Estuary tidal marshes.
- Participate in relevant national, mid-Atlantic regional, and New York State initiatives via involvement in meetings and committees within New York and NERRS.
- Seek out, apply for, and participate on NERRS Science Collaborative research projects relevant to the Hudson River.

Training Needs Identification

Several needs assessments have been conducted in the last year and used to inform this strategy. The ETP:

- consulted a collective group of organizations working on waterfront resilience,
- electronically surveyed 1,000 past training program participants[1],
- conducted interviews with shoreline designers across NYS, and
- interviewed users of abiotic water quality data collected by the Reserve.

Training needs and opportunities will continue to be identified through needs assessments and consultation with the Steering Committee.

Priorities and Opportunities

A complete list of specific issues and topics relevant to the Hudson River Estuary region, identified through these needs assessments, is included in Appendix 3. To

[1] Representative examples of training events conducted over the last five years, along with the audience, and partners are listed in Appendix 2.

prioritize the topics and subjects, the ETP coordinator relied on her own local knowledge and experience as well as the knowledge and opinions of the Steering Committee and other Reserve staff.

Based on the needs assessment, advice and knowledge, and the Program goals, objectives and actions, the ETP will focus on the following topics and sub-topics:

- Hudson River aquatic/shoreline habitats
    - Ecosystem services of aquatic habitats
    - Status and trends of the Hudson River aquatic and shoreline habitats including vulnerability to climate change and options for adaptation
    - Restoration of aquatic habitats including remediated sites
    - Scientific information from Reserve and other sources relevant to habitat management
- Hudson River Sustainable Shorelines Project
    - Monitoring protocol, demonstration sites, designs and scientific research
- Natural and nature-based shoreline protection and use of resiliency measures to reduce risk and promote resiliency in New York State
    - Transferrable outreach tools and/or programming that fosters consistent nature/nature-based shoreline message across NYS coasts (Hudson River, NYS Great Lakes and NYS Marine district).
    - Understanding the permit process and regulations
- Community Risk and Resiliency Act: natural resilience measures in relationship to Hudson River shoreline habitats and in relationship to community resilience.
- Process and technical skills
    - Use of Reserve research (i.e., abiotic dataset)
    - Training on facilitation, project management, and communication skills
    - Use of online mapping tools such as Hudson River Flood Mapper and Digital Coast

The coordinator's involvement in several regional organizations and committees (Appendix 4) will continue to enable her to identify needs and gaps in programming and to identify new training partners; see Appendix 4. For more information on the roles, responsibilities, and expertise of the Steering Committee, see Appendix 5.

Audience

The highest priority training audiences are the professionals and volunteers who make decisions that affect the habitats of the Hudson River Estuary. This audience includes regulators, shoreline stakeholders, land stewards/managers, natural resource managers, scientists, and municipal officials (which further includes elected and appointed officials, volunteer boards, and staff). Past audiences are listed in Appendix 2.

Some members of the ETP's target audience overlap roles, responsibilities, and expertise. For example, "regulators" include staff biologists and ecologists involved in permit decisions within governmental agencies. "Shoreline stakeholders" are concerned with shoreline erosion and shoreline habitat. This latter group may include private and public property-owners, engineers, landscape architects, state and federal permit staff, land and natural resource managers, municipal officials, policy-makers, and advocates.

Program Capacities

Staffing

The ETP is implemented by a full-time coordinator and an annual Student Conservation Association (SCA) member. It is supported by the Reserve administrative and programmatic staff. The coordinator position is supported by the Reserve's operations grant from the National Oceanic and Atmospheric Administration (NOAA).

Infrastructure

The Program is based at the Norrie Point Environmental Center, which includes on-site meeting rooms and opportunities for field programs on the river shore and within Mills Norrie State Park, the neighboring NYS Parks regional office also has meeting rooms. Research Reserve component sites also can serve as field training sites, which can be accessed via the Reserve's fleet of canoes or its power boats.

Funding

Training event expenses are funded by grants, funds from the NYSDEC Hudson River Estuary Program, and by attendee registration fees.

Training Delivery

Training is delivered both in-person and remotely. In-person trainings are offered at Norrie Point and in other venues which are free or low-cost, often in partnership with other organizations. For remote programming, the ETP uses web-conferencing services for all audiences, and uses the NYSDEC video conference system, for NYSDEC staff at their work places. The ETP is fortunate to have many willing training partners. The Reserve has strong working relationships with several governmental agencies (municipal, state, and federal) and stakeholder groups; these important partners collaborate on programming and provide expertise and/or other support, see Appendix 2. New England Interstate Water Pollution Control Commission (NEIWPCC) helps with the management of funds when registration fees are charged. The Hudson River Environmental Society is a consistent partner for day-long research forums. In the next half decade, the ETP anticipates working with the following partners:

- Cary Institute of Ecosystem Studies
- Continuing education granting institutions (see Training Program Marketing).
- Hudson River Environmental Society
- Hudson River Sustainable Shorelines Program

- Metropolitan Waterfront Alliance (Waterfront Edge Design Guidelines Program)
- NEIWPCC
- NERRS Science Collaborative funded research institutions
- New York Sea Grant
- NOAA's Office for Coastal Management
- NYSDEC: Hudson River Estuary Program, Bureau of Ecosystem Health, Office of Climate Change, Division of Marine Resources, Division of Environmental Permits, Division of Environmental Remediation and Great Lakes Program.
- NYS Department of State (NYSDOS) Office of Planning, Development and Community Infrastructure
- NYS Office of Parks, Recreation and Historic Preservation (NYS Parks)
- Scenic Hudson
- Society for Ecological Restoration
- Shoreline design professionals
- Shoreline Habitat Adaptation Dialogue (SHAD)
- Stevens Institute of Technology
- Student Conservation Association
- Waterfront Resilience Coordination Collective
- The Nature Conservancy

Reserve Sector Integration

Reserve staff are involved with ETP program planning and implementation in a variety of ways; for example:

- Habitat restoration staff are expert speakers on invasive species control/management and shoreline and habitat restoration projects.
- Education staff translate science related to ETP issues for Reserve visitors and K-12 audiences and help design/lead canoe trips for field activities of ETP.
- Research staff are expert speakers on 1) Hudson River habitat status and trends which are documented in Hudson River GIS mapping products; 2) aspects of Sentinel Site Application Module 1 (SSAM-1: Coastal Habitat Response to Changing Water Levels); 3) application and interpretation of water quality data; 4) findings of System-wide Monitoring Program (SWMP) and 5) research on marsh buffers and Piermont marsh restoration project. ETP provides outreach for NSC products for currently funded and potential future NSC projects. ETP helps develop outreach products on abiotic data and sentinel sites.
- The current manager (hired in June 2018) has extensive experience with permits and the protection of habitat in the Hudson River and Marine District of NYS.
- The ETP, former manager, and restoration staff have worked together on the Hudson River Sustainable Shorelines Project for over a decade. Education staff translate the findings to share with their audiences.

In addition, all Reserve staff benefit from ETP training events for professional development and fodder for science translation. For example, Reserve staff participate

in Shorelines Habitat Adaptation Dialogue and will collaborate on transferring findings on habitat protection, restoration, and climate change vulnerability and resilience projects. Further, Reserve staff with expertise in habitat restoration as well as knowledge of NYSDEC permit and regulatory aspects are mutually beneficial to the ETP's programming—both as collaborators/experts and audience-members. Finally, the ETP coordinator and other Reserve staff have been principal investigators, or otherwise involved in multiple NERRS Science Collaborative Projects over the last decade (see Appendix 4).

Evaluation Strategies

Indicators of effective training programs include audience members requesting related programming, attending multiple events, and recommending the program to their colleagues. Another measure of success is the number of ETP partners that continue to be interested in collaborating on training events.

Post-event evaluations are administered to participants. These evaluations include three specific questions from the NERRS CTP Performance Measures Manual (NERRS 2014) that measure the effectiveness of the event, the participant's increase in knowledge, and their intention to apply the knowledge they learned. Evaluations also include questions about the training experience and future topics of interest. The responses to the evaluations give crucial information about needed improvements and successful outcomes, ultimately serving as regular, informal needs assessments. As time and capacity allows, we check back with participants after a period of six or twelve months to find out if and how they have used the information learned in the training. The Steering Committee also plays a role in the evaluation of the program, weighing in on the efficacy of programming as per their organization's observations and objectives.

Training Program Marketing

The ETP maintains a database of over 1,000 contacts to market the program. Marketing is usually done by sending emails that contain links to the ETP section of the hrnerr.org website for detailed information and registration. The ETP web pages also have descriptions of past events, as well as recordings of the event and copies of slide presentations when available. The ETP has the capacity to list programs on NYSDEC event calendars and other calendars such as the Living Shorelines Academy. Partners also market the programs on their websites, calendars, by direct email, and by issuing media releases. Most events are filled. A variety of tools are used for promotion and registration including WebEx®, Mail Chimp®, Event Brite®, and SurveyMonkey®.

The program routinely issues continuing education credits to municipal officials, landscape architects, engineers, and American Institute of Certified Planners (AICP). The support provided by NERR Association or Office of Coastal Management for credits through the American Planning Association for AICP credits is crucial in the

ETP filling this continuing education niche in the Hudson Valley, as well as targeting and attracting specific audiences. The Practicing Institute of Engineering, Inc. is used for engineering and landscape architect credits for relevant courses, with fees covered by registration fees or operating funds. Recently, the ETP began offering Society of Ecological Restoration certification credit, which is aimed at professional development for those involved in designing, implementing, overseeing, and monitoring ecological restoration projects around the world. In addition, there is an opportunity to provide continuing education credits for coastal floodplain managers through the Association for State Floodplain Managers.

Conclusion

In the next five years, the ETP will continue with similar programming as in the period 2012-2017: training events on Hudson River habitats, especially shoreline habitats; scientific research, in partnership with the Hudson River Environmental Society; and communication and facilitation skills, with emphasis on science-based information on the conservation and restoration of Hudson River habitats in a changing climate.

Appendix 1. Hudson River Reserve Programmatic Goals

I. Reserve science enhances understanding of the Hudson River Estuary ecosystem, and the results of research are conveyed to decision-makers to meet management needs and support resilient communities and ecosystems.

II. Resource managers have enhanced capacity to protect, manage and restore shoreline and river habitats.

III. People of the Hudson River Valley appreciate the Estuary and the multitude of benefits it provides, understand how to responsibly enjoy and use the river, and engage in multiple levels of stewardship to sustain these resources.

IV. Hudson River Reserve sites are models for restoration and stewardship that foster an understanding of the ecological connections among land, water, and people.

Appendix 2. Selected Training Events and Audiences 2013-2017

Year	**Title of Event**	**Target Audience**	**Main Partner(s)**	**Priority Topics**
2017 & 2016	Sustainable Shorelines Designs: from Long Island to Lake Erie (Webinars 1-7)	Shoreline designers (architects, designers, engineers)	Various organizations, i.e., Waterfront Edge Design Guidelines (Waterfront Alliance)	Sustainable Shoreline Project
2017	Sustainable Shorelines Tools (Webinars 8-9)	Nature/nature-based shoreline promoters and designers	NA	Sustainable Shoreline Project
2017	Hudson River on the Rise	Estuary stakeholders (public and technical)	Scenic Hudson, NYSDEC Hudson River Estuary Program, NYSDOS, NEIWPCC	Resiliency (climate change)
2017	Changing Energy Landscapes in the Hudson Valley	Estuary stakeholders (public)	Hudson River Environmental Society	Green energy
2017	Dams and Sediment in the Hudson (DaSH) Project Workshop	Project advisors	NERRS Science Collaborative, Woods Hole, CBI, NYSDEC	Research
2017	Planning Effective Projects	Estuary stakeholders and beyond	NOAA's Office for Coastal Management	Process / Technical skills
2016	Submerged Aquatic Vegetation: Trends in Hudson River Estuary 2016 Update	Estuary stakeholders (technical)	Cary IES, Hudson River NERR, U of Maryland	Research

2016	Hudson Estuary and Mohawk River: The Coming Together of the Waters	Estuary stakeholders (public)	Hudson River Environmental Society	Estuary science
2016	Adaptive Conservation Planning in the Hudson Valley: Recent Analyses	Estuary stakeholders (public and technical)	Scenic Hudson, NYSDEC Hudson River Estuary Program	Resilience (climate change)
2016	Water Words That Work with Eric Eckl	Estuary stakeholders and beyond	NYSDEC Hudson River Estuary Program	Process / Technical skills
2015	Nature Based Shoreline Protection: New York State Coordinating Meeting	Program managers	NYSDEC Great Lakes, NYSDEC Hudson River Estuary Program, NYS Dept. of State, NYS Parks and HRNERR	Sustainable Shoreline Project
2015	Hudson Valley Community Resiliency- From Planning to Implementation	Estuary stakeholders (public and technical)	Scenic Hudson, CBI and NYSDEC Hudson River Estuary Program	Resiliency (climate change)
2015	Seeing the Hudson River in the 21st Century	Estuary stakeholders (public)	Hudson River Environmental Society	Resilience
2015	Applying the Findings of the Hudson River Sustainable Shorelines Project	Program managers/advisors	Hudson River Sustainable Shorelines Project, NYSDEC Region 4	Research, Sustainable Shoreline Project
2015	Planning and Facilitating Collaborative Meetings	Estuary stakeholders and beyond	NOAA's Office for Coastal Management	Process/ Technical skills
2015	Hudson River Habitats Workshop: Status Protection Challenges and Opportunities to Enhance Resilience	Estuary stakeholders (technical)	Hudson River NERR	General estuary science and Resilience
2014	Applying the Findings of the Hudson River Sustainable Shorelines Project	Program managers/advisors	Hudson River Sustainable Shorelines Project	Sustainable Shorelines Project
2014	Restoration of Submerged Aquatic Vegetation in the Hudson Estuary	Estuary stakeholders (technical)	HRNERR, Cary IES, U of Maryland and Chesapeake Bay Virginia NERR	Research

2014	Sustainable Shorelines Technical Panel Webinar: What Made Shorelines Resilient?	Program managers/advisors	Stevens Institute and Hudson River SSP	Sustainable Shorelines Project
2014	Watershed Influences in a Changed World	Estuary stakeholders (public)	Hudson River Environmental Society	Estuary science and Resilience
2013	Enhancing Habitat and Planning for Resilience: Climate Change and Contaminated Sites on the Hudson Estuary	Estuary stakeholders (technical)	Hudson River Sustainable Shorelines Project, NYSDEC Office of Climate Change and Division of Environmental Remediation	Habitats, Resilience

Appendix 3. Priority Topics from Needs Assessments Conducted in 2017

- Hudson River aquatic and shoreline habitats
    - Ecology of aquatic habitats
    - Ecosystem services of aquatic habitats
    - Status and trends of the Hudson River aquatic and shoreline habitats
    - Restoration of habitats
    - Protecting aquatic habitats under current conditions
    - Protecting estuarine and marine habitats in the future: (e.g., in the face of climate change)
        - Protecting and creating migration pathways for wetlands and SAV
        - Assisting accretion of wetlands
        - Understanding other climate change impacts and vulnerability
    - Impacts from the watershed
- Natural and nature-based shoreline protection and use of resiliency measures to reduce risk and promote resiliency in New York State
    - Outreach/education for shoreline stakeholders
        - Directed at design firms
        - Directed at earth moving and landscaping contractors
        - Directed at property-owners and/or managers
    - Transferrable outreach tools and/or programming (fostering consistent nature/nature-based shoreline message across NYS coasts)
        - Directed at Great Lakes
        - Directed at Marine district
    - Guided field visits to demonstration sites in NYS
        - Promote new monitoring protocol
        - Promote on-the-ground, working sites as viable
    - General community resilience programming
        - NYS Community Risk and Resiliency Act programming
        - NYS Climate Smart Communities: natural resource aspects
        - System-wide risk assessment/resiliency plan workshops

        - Celebrate resilience (i.e., recognize local leaders, create/promote model plan) to reframe climate change discussion
- Process and technical skills
    - Utilizing Reserve research (i.e., abiotic dataset)
        - Promote updated presentations of research
        - Facilitate projects involving research
    - Collective Impact (Hanleybrown, Kania & Kramer, 2012) workshops that target local conservation efforts to foster collaboration rather than overlap in organizations
        - i.e., research tools in the Hudson River Estuary, environmental education efforts in the Hudson River Valley
    - Understanding permit processes
    - Facilitation, project management and communication skills

Appendix 4. Committee and Project Membership

Title	Duration	Role
Hudson River Sustainable Shorelines Project (HRSSP) Four phases funded by NSC.	2008 - ongoing	Outreach and training
Community Risk and Resiliency Act- Natural Resiliency Measures Drafting Team	2015 - ongoing	Technical assistance
Shoreline Habitat Adaptation Dialogue (SHAD)	2017 ongoing	Technical assistance
Hudson River Environmental Society – Executive Board	2010- 2010	Technical assistance
NYS ad hoc Nature Based Shoreline Protection work group	2015- ongoing	Technical assistance
NYS Interagency Adaptation Work Group	2017- ongoing	Networking
Advisory Committee for Waterfront Edge Design Guidelines of the (NYC) Waterfront Alliance	2017	Technical Assistance
NERRS Science Collaborative Projects		
HRSSP (Phase 4) Assessing Ecological and Physical Performance of Sustainable Shoreline Structures - Findlay	September 15, 2015 to September 14, 2018	Outreach and training
Understanding the role coastal marshes play in protecting communities from storm surge and flooding - Sheng	September 15, 2015 to September 14, 2018	Outreach and training
Dams and Sediment in the Hudson - Ralston	November 1, 2016 to October 31, 2019	Training
Resilience Dialogues: Strategies for Conflict Management in Collaborative Science - Feurt	October 1, 2017 to March 31, 2019.	Technical assistance
Successful Adaptation Indicators & Metrics – Moser & Arnott	March2015-November 2017	Training

NSC Transfer Projects		
Convening a Regional (NY-NJ-DE) Dialogue to Advance Sustainable Shorelines along Sheltered Coasts - Hauser	May 2013-May 2014	Technical assistance and training
The Hard and Soft of Shoreline Management: A Dialogue about Perspectives and Tools for New Hampshire	2014	Technical assistance
Enhancing Coordination on Shoreline Management and Resilience Measures in New York State	September 2015 to August 2017	Technical assistance

Appendix 5. Steering Committee

The members of the Steering Committee will help assure communication and coordination between partners and help guide the program. Meetings are held once a year. Between meetings, the Coordinator may contact individual members for assistance and direction with certain projects.

The Steering Committee's roles and responsibilities include program guidance and vision, review of program-scale strategic ETP documents, as well as internal policy and program recommendations.

The committee members also:

- Provide advice and guidance on the niche, priorities, direction, and evolution of the Program.
- Serve as a connector between their agencies and the Program's mutual interests and priorities.
- Collaborate on relevant training events.
- Help evaluate the overall, long-term effectiveness of the program.

Membership is comprised of:

NYSDEC Hudson River NERR – Heather Gierloff, Manager
Sea Grant – Nordica Holochuck, Hudson Estuary Specialist/Extension Associate
NYS Department of State Office of Planning, Development and Community Infrastructure, Climate Change and Resilience Unit – Carolyn LaBarbiera, Coastal Resources Specialist
NYSDEC Hudson River Estuary Program/Cornell University – Laura Heady, Conservation and Land Use Program Coordinator
NYSDEC Division of Fish and Wildlife – Chuck Nieder, Chief, Bureau of Ecosystem Health

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Appendix 9

Draft Management Plan for Piermont Marsh Reserve

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NEW YORK STATE OF OPPORTUNITY | Department of Environmental Conservation | Parks, Recreation and Historic Preservation

DRAFT PIERMONT MARSH RESERVE MANAGEMENT PLAN

December 2017

www.dec.ny.gov | parks.ny.gov

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ACKNOWLEDGEMENTS

This plan was prepared by Brian DeGasperis and Betsy Blair of the Hudson River National Estuarine Research Reserve with support of staff from the New York State Department of Environmental Conservation and Ed McGowan of the New York State Office of Parks, Recreation, and Historic Preservation. We appreciate the input provided by local leaders, county officials, environmental organizations, researchers, educators, and marsh managers during the planning process, and we gratefully acknowledge all the members of the public whose unwavering interest in Piermont Marsh and active participation in scoping and fact-finding meetings significantly improved the content of this plan.

Suggested citation:

New York State Department of Environmental Conservation (NYSDEC). 2017. *Draft Piermont Marsh Reserve Management Plan*. Albany, NY.

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LIST OF ACRONYMS

BAP	Biological Assessment Profile
CEA	Critical Environmental Area
CFR	Code of Federal Rules
Cm	Centimeter
DEC	New York State Department of Environmental Conservation
DOS	New York State Department of State
Ft	Feet
GIS	Geographic Information System
HRNERR	Hudson River National Estuarine Research Reserve
LWRP	Local Waterfront Revitalization Program
M	Meter
NERRS	National Estuarine Research Reserve System
NOAA	National Oceanic and Atmospheric Administration
NYNHP	New York Natural Heritage Program
NYS	New York State
NYSTA	New York State Thruway Authority
OGS	New York State Office of General Services
OPRHP	New York State Office of Parks, Recreation, and Historic Preservation
PPT	Parts per thousand
PIPC	Palisades Interstate Park Commission
SCoRR	Sediment-bound Contaminant Resiliency and Response
SEQRA	State Environmental Quality Review Act
SET	Surface Elevation Table
SSFRP	Secondary School Field Research Program
SWaTH	Surge, Wave, and Tide Hydrodynamics
SWMP	NERRS System-Wide Monitoring Program
USGS	United States Geological Survey
USFWS	United States Fish and Wildlife Service

EXECUTIVE SUMMARY

The Piermont Marsh Reserve is a unique and special place. It hugs the base of Tallman Mountain along the west shore of the Tappan Zee, one of the widest sections of the tidal Hudson River, and extends over 1.5 miles below Piermont Pier. The site's 1,030 acres include the estuary's largest brackish tidal marsh, a broad swath of adjacent shallows, and small areas of upland in the Village of Piermont. Given its proximity, the marsh provides a range of vital services to the Village, including protection of nearby homes and businesses from waves and storm debris. The marsh and shallow-water habitats are regionally rare, ecologically significant, and were historically home to a host of specially-adapted plants and animals. To the dismay of natural resource managers and long-time residents, Piermont Marsh has changed dramatically in recent decades and the diversity of habitats, plants, and animals it once supported is nearly gone. However, the seeds for restoration still remain and action is required to ensure that the diversity of life and services that make the marsh an extraordinary and special place are protected.

Marsh managers and community residents have a strong shared interest in protecting and managing the marsh so that it exists well into the future. Managing for marsh longevity will require a thoughtful, careful, and gradual management approach, with actions focused on building marsh resilience and the capacity to deal with unexpected change. If steps are taken now, key opportunities exist to ensure that the marsh remains resilient and able to provide the beneficial services needed to sustain and support the well-being of people in a rapidly changing world.

This plan will guide management of the Piermont Marsh Reserve for the next decade, including marsh management, habitat restoration, resource stewardship, public access, education programs, and research. It provides a foundation for increased educational programming, greater community participation in stewardship, and direction for collaboration among research partners. Although the plan's horizon is ten years, it establishes a monitoring and adaptive management approach to support marsh resilience and conservation over the long term. Importantly, the plan provides for the protection of both natural and human communities, especially the vital services the marsh provides as a natural wave and debris barrier.

The Piermont Marsh Reserve Management Plan was developed with extensive input from the leaders and residents of the adjoining communities, county officials, environmental organizations, researchers, educators, and marsh managers. It was developed by staff from the New York State Department of Environmental Conservation (DEC) and the New York State Office of Parks, Recreation, and Historic Preservation/Palisades Interstate Park Commission (OPRHP/PIPC), the agencies with jurisdiction over the tidal wetlands and uplands that comprise the Piermont Marsh Reserve.

Planning Process and Goals

In April 2013, DEC issued a permit to the New York State Thruway Authority (NYSTA) for the construction of a new bridge over the Tappan Zee. The permit included a requirement for several habitat restoration projects to be completed as mitigation for unavoidable losses of habitat associated with bridge construction. Given its ecological significance and proximity to the bridge, Piermont Marsh was selected as the location for one of these projects. The project that was initially proposed focused on restoring native plant communities across the entire marsh by eradicating a non-native strain of *Phragmites australis*, a tall reed that has spread through the marsh over the last several decades. Village leaders and residents expressed a wide range of views, both for and against the project. Beginning in summer 2013, DEC and OPRHP staff met with ten different committees and organizations to listen to ideas and concerns about the initial marsh restoration project. Chief among the concerns were the loss of tall marsh vegetation as a storm buffer for the Village of Piermont, and the potential for health and ecological impacts of herbicides on nearby residents and the marsh. Staff listened closely to the public's concerns, studied the issues carefully, and have responded with a dramatically different approach – one that is good for the environment, safe for the community, and responsive to public concerns.

The plan identifies management actions for achieving the following goals:

1. Maintain or enhance the Piermont Marsh Reserve's ability to provide storm protection for neighboring landowners.
2. Sustain the presence of native marsh communities and the biological diversity they support.
3. Promote the structural and functional resiliency of the Piermont Marsh Reserve to storms, sea-level rise, and other disturbances.
4. Increase scientific knowledge, public understanding, and public use and enjoyment of the Piermont Marsh Reserve.

Key Elements of the Plan

Large Marsh Vegetation Buffers for Local Communities

Most of the existing tidal marsh community is dominated by *Phragmites australis*, also known as common reed, a tall non-native perennial grass with stout underground stems that enable it to spread and form dense colonies. The plan provides for retention of 85% (over 200 acres) of this existing marsh community as a vegetation buffer to dissipate wave energy and filter storm debris. This area extends about a half-mile south of the Village of Piermont and a comparable distance north of the hamlet of Palisades. This marsh buffer is retained as a conservative, precautionary measure, in the absence of empirical data about the nature of Piermont Marsh's buffering capacity and tradeoffs of various kinds of marsh vegetation. A NOAA-funded collaborative research project is currently underway to specifically evaluate the marsh's role in buffering adjacent communities.

Native Community Restoration

Historical Context

Until recent decades, Piermont Marsh was mainly a high salt marsh community dominated by saltmeadow cordgrass, also known as salt hay. Along the tidal creeks and at lower elevations, the marsh also supported a low salt marsh community comprised of saltmarsh cordgrass. These two community types sustained a host of fish, crabs, and other wildlife adapted to live in conditions that vary from wet to dry, and salt to fresh. Salt hay was also a vital resource for many residents, who harvested it from their family plots in the marsh. Today, this native community is all but gone from Piermont Marsh, and only found in small areas where *Phragmites* is less dense.

Restoration Strategy

This plan includes small-scale actions to sustain and restore native marsh communities and the fish and wildlife they support. A 10-acre site at the center of the marsh, more than one-half mile from neighboring residential areas, will be treated to reduce the abundance of *Phragmites* and facilitate the return of native plants. If this project is successful in restoring native communities and meeting other performance benchmarks, then two adjoining 15-acre units will be treated (successively) over the next ten years to restore native ecological communities. The total potential restoration is 40 acres, which represents 15% of the entire marsh. This is a very substantial reduction from the original 200 acres identified as a habitat mitigation project in the 2013 DEC permit for replacement of the Tappan Zee Bridge.

Restoration Methodology

Phragmites will be controlled with a combination of three techniques: 1) a limited ground-based application of a registered herbicide (an *aquatic* glyphosate formulation) and non-ionic surfactant (an additive that helps the herbicide coat and penetrate the leaf surface); 2) mowing prior to treatment and again the following winter, with cuttings left in place to serve as mulch until treated areas naturally revegetate within 1-3 years; and 3) solarization (covering with thick plastic) of the restoration area boundary that is not bordered by water to keep untreated plants from spreading into the treated area. The herbicide, applied at a dilute concentration, is absorbed and carried into underground plant parts, and disrupts a specific pathway for amino acid synthesis that is unique to plants and not present in animals.

This combination of methods was selected after considerable analysis of: 1) risks to human health, fish, or other aquatic animals; 2) effects on plant communities; and 3) impacts on water quality and erosion. A variety of alternative control methods were considered, and a summary of the alternatives analysis is included as Appendix A. While these alternative control methods have merit in some contexts, they are not practical or feasible as solitary treatments for managing *Phragmites* in these

environmental conditions and at this scale. When applied according to label instructions and applicable legal requirements using ground-based equipment, aquatic formulations of glyphosate are an approved and highly effective method (True, et al., 2010) for controlling *Phragmites* and the primary tool used by land managers in North America (Hazelton, et al., 2014). DEC and OPRHP/PIPC have experience using herbicides to successfully control *Phragmites* at various sites along the Hudson River, including Iona Island in Bear Mountain State Park.

Herbicide Information

During the scoping process for this plan, many people expressed public health concerns about the use of herbicide at Piermont Marsh at a large scale and near the Village of Piermont. Some people cited concerns about specific brands of herbicide that are *terrestrial formulations* of glyphosate (e.g., Roundup Pro®), which will not be used in Piermont Marsh since they are not registered for use in aquatic settings. Unlike the aquatic formulations, the terrestrial formulations often contain other chemical additives to increase their efficacy. These terrestrial formulations are used extensively in agriculture and residential and commercial landscaping.

Glyphosate is a non-selective, systemic herbicide that controls weeds by inhibiting a specific pathway for amino acid synthesis that is unique to plants and not present in animals. Since 1985, the U.S. Environmental Protection Agency (EPA) has conducted several in-depth evaluations of glyphosate to determine its potential risk to human and environmental health. Based on these evaluations, EPA determined that glyphosate exhibits low toxicity across species, durations, life stages, and routes of exposure. EPA is currently conducting a scheduled reevaluation to ensure that glyphosate continues to meet the statutory standard of no unreasonable adverse effect. In a press release dated December 18, 2017, the EPA announced that "…glyphosate is not likely to be carcinogenic to humans. The Agency's assessment found no other meaningful risks to human health when the product is used according to the pesticide label. The Agency's scientific findings are consistent with the conclusions of science reviews by a number of other countries as well as the 2017 National Institute of Health's Agricultural Health Survey" (https://www.epa.gov/pesticides/epa-releases-draft-risk-assessments-glyphosate).

In addition to following all label requirements, appropriate measures will be taken to minimize the potential for any human exposure to glyphosate in four ways: 1) limiting the duration of use to one to three days per year; 2) applying it only under favorable weather conditions (e.g., calm with prevailing winds blowing away from residential areas); 3) using an appropriate spray height, angle, and droplet size; and 4) applying it at distances of more than one half mile from the Village of Piermont and hamlet of Palisades. Furthermore, DEC and OPRHP will establish an herbicide monitoring and data sharing program to document and evaluate any movement of herbicide beyond the designated treatment areas. The program will be developed in close consultation with local representatives, marsh managers, and pesticide regulators. The monitoring will evaluate herbicide levels prior to, during, and after treatment using best available

techniques. Information will be posted on a publicly accessible website as soon as analyses are completed.

Bird Nest Boxes and Platforms

For many bird species, the availability of nesting sites is a limiting factor. Where natural nesting sites are in short supply, artificial nest boxes and platforms can enhance wildlife habitat and increase bird densities and diversity. To that end, an osprey nesting platform and nest boxes for purple martins (*Progne subis*) and tree swallows (*Tachycineta bicolor*) will be erected at various locations within the Reserve. Nest boxes will be mapped and monitored to ensure their use by target species.

Piermont Marsh Resiliency Monitoring

The Hudson River National Estuarine Research Reserve (HRNERR) will implement monitoring protocols that will qualify Piermont Marsh as a national NERRS "Sentinel Site" for analyzing the impact of sea-level rise on tidal marsh habitat. Staff will install surface elevation tables (SETs) and use feldspar horizon markers to track changes in the elevation of the marsh surface over time. SET data combined with tidal datums and inundation patterns will show whether sediment accretion in Piermont Marsh is keeping pace with increasing rates of sea-level rise. Additional vegetation data will help us interpret whether climate change stressors are causing shifts in the plant communities. These protocols will be used in both managed and unmanaged sections of the marsh to test whether habitat restoration effects the marsh's resilience to climate change. The sentinel site information will inform the current habitat restoration project and guide any future adaptive management to foster the marsh's long-term persistence.

Public Access

DEC and OPRHP access experts will evaluate the site's accessibility and compliance with the federal and state legislation (e.g., Americans with Disabilities Act) and assess opportunities to enhance access for everyone, including people with disabilities.

DEC and OPRHP recognize that opportunities for the public to experience the marsh interior are currently limited. We will explore a potential route for a public marsh boardwalk in consultation with the Village and interested residents. In addition, DEC and OPRHP will explore the costs and benefits of installing researcher access corridors in intensively studied areas of the marsh to reduce and minimize damage to the marsh surface. Any future construction will need to be consistent with tidal wetlands protection regulations, stewardship of the marsh, accessibility needs, and the agencies' ability to provide maintenance.

Education and Interpretation

In 2016, HRNERR expanded education activities at Piermont Marsh and in the adjacent community. HRNERR staff will continue to consult with local organizations and individuals to explore education programs that will meet local needs and be sustainable. HRNERR, working with partners, will organize periodic presentations about current research occurring within the Reserve. DEC and OPRHP will update interpretive information about the marsh and explore ways to make this available online, on site, and through other avenues, including local partnerships.

Opportunities for Citizen Engagement in Stewardship

Citizen science programs, such as monitoring a new eel ladder at the Ferdon Pond dam, coastal clean-ups, and wildlife monitoring, will be fostered and expanded as resources permit.

Building our Knowledge for Future Management

DEC and OPRHP will advance research about the Piermont Marsh Reserve in several ways, including: 1) carrying out a ten-year research agenda; 2) fostering and tracking other scientific research; and 3) promoting collaborations and funding for research that addresses priority management information needs.

In response to strong community interest, HRNERR worked with a group of partners to develop a three-year collaborative research program to evaluate alternative marsh management scenarios and the coastal protection benefits the marsh provides. This work was funded by the NOAA NERRS Science Collaborative, and initiated in 2017. The team will develop predictive models of climate, coastal, and ecological processes. These will be used to evaluate how existing and hypothetical marsh management might affect the kinds and degree of storm protection afforded by the marsh for the Village of Piermont. Choices about marsh management scenarios and community resiliency planning products will be made in consultation with the Piermont Waterfront Resilience Commission, and information about the project will be shared with the community.

INTRODUCTION

PURPOSE AND SCOPE OF PLAN

This plan sets forth the long-term vision and goals for management of the Piermont Marsh Reserve (the Reserve), a large, ecologically significant tidal wetland complex and natural area on the west shore of the Hudson River's Tappan Zee (Figure 1). The plan identifies objectives and preferred strategies for promoting climate resilience, restoring wetlands and native habitats, conducting research and monitoring, facilitating public access, offering education programs, and providing interpretative and scientific information over the next decade.

The plan also will guide the management direction, staff time, fiscal priorities, and resource protection activities of the responsible public agencies. It provides a foundation for increased educational programming about the marsh, greater community participation in stewardship of the marsh, and direction for collaboration among research partners. Although the plan's horizon is ten years, it establishes a monitoring and adaptive management approach to support marsh resilience and conservation over the long term.

MANAGEMENT CONTEXT

Land Ownership

All the Reserve is in New York State ownership except for a small private inholding at the south end of the Reserve. State-owned lands are under the jurisdiction of three public agencies, as depicted in Figure 2. The portion of Piermont Marsh south of the Sparkill Creek and most of the shallows east of the marsh are within the boundaries of Tallman Mountain State Park, which is managed by the Palisades Interstate Park Commission (PIPC) in cooperation with the New York State Office of Parks, Recreation, and Historic Preservation (OPRHP). North of the Sparkill Creek, the remainder of the marsh, uplands east of Rittenberg Field, and a portion of the adjacent shallows extending to the end of Piermont Pier are managed by the New York State Department of Environmental Conservation (DEC). The remaining shallows are under the jurisdiction of the New York State Office of General Services (OGS).

Legal Restrictions on Land Use

The DEC land at Piermont Marsh was acquired using funds from the Environmental Quality Bond Act of 1972 for wetlands preservation. Chapter 659, Title 4, Section 265 (Restrictions on Alienation of Wetlands) states:

Figure 1. Piermont Marsh Reserve location map

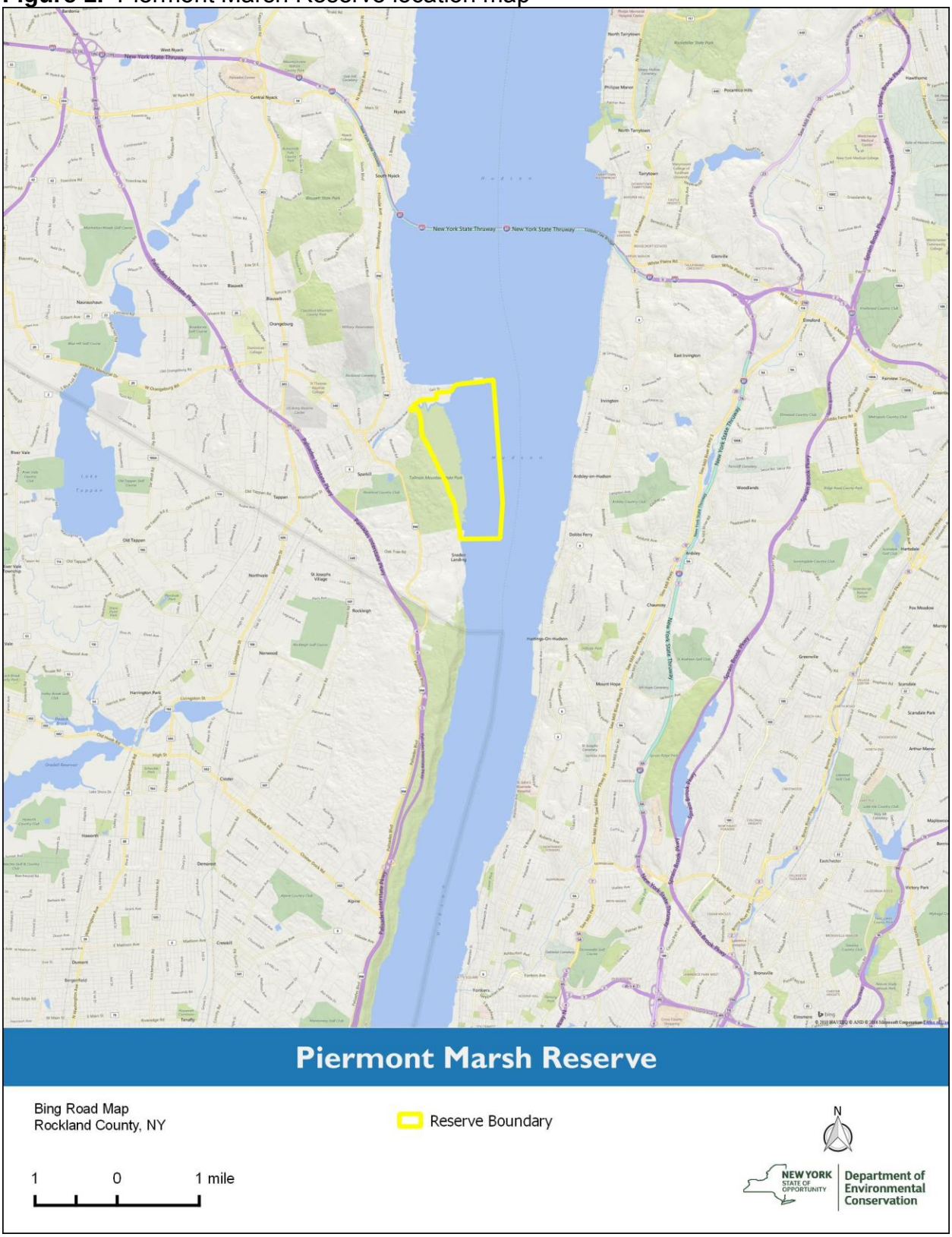
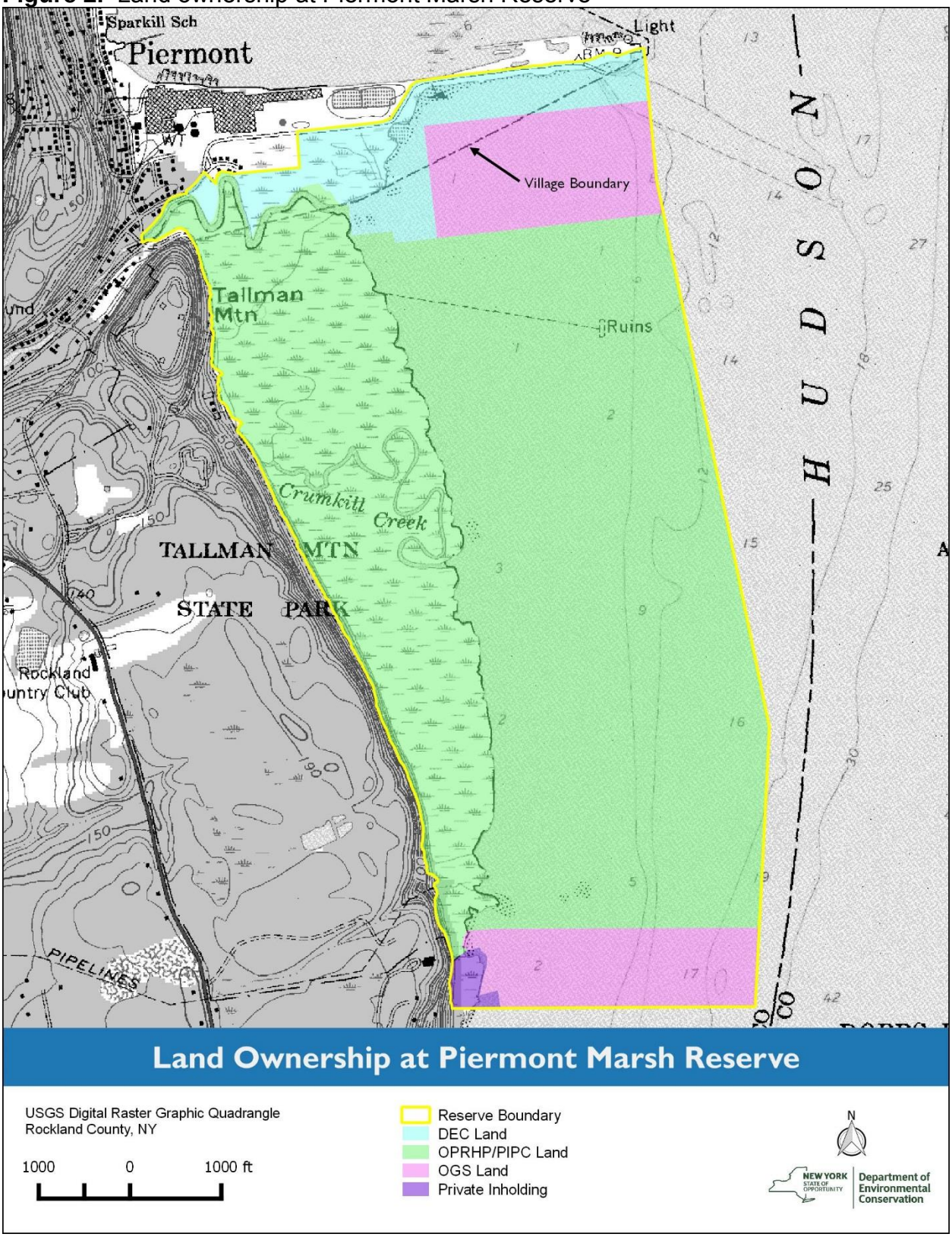


Figure 2. Land ownership at Piermont Marsh Reserve



Any wetlands acquired or restored in part or in whole with state monies pursuant to this title shall not be sold, leased or otherwise disposed of or used for any purposes inconsistent with the character or value of such wetlands.

No structure shall be placed thereon except water level regulation works necessary to preserve, restore or maintain the biological productivity thereof.

PIPC lands shall not be sold for any purposes without the approval of both the New York and New Jersey legislatures. The Palisades Interstate Park Commission may grant easements, licenses, permits and other rights over any lands held by it in either state when, in the opinion of the Commission, they will not interfere with the use and enjoyment of the park by the public.

In addition, management activities at Piermont Marsh must be consistent with New York State laws and regulations.

Agency Missions

The mission of the OPRHP is to provide safe and enjoyable recreational and interpretive opportunities for all New York State residents and visitors and to be responsible stewards of our valuable natural, historic and cultural resources. As part of this mission, § 3.09(15) of the Parks, Recreation and Historic Preservation Law directs OPRHP to: “Enhance the natural resources by providing habitat for various wildlife species including endangered and threatened species of fauna through practices such as ecological restoration, wetland conservation, and the planting of trees, shrubs and herbaceous plants indigenous to the area which act as food and protective cover for fauna.”

DEC’s mission is to conserve, improve and protect New York's natural resources and environment and to prevent, abate and control water, land and air pollution to enhance the health, safety and welfare of the people of the state and their overall economic and social well-being. The mission of DEC’s Division of Marine Resources is to manage and maintain the state's living marine, estuarine and anadromous (species that migrate from salt water to spawn in fresh water) resources, and to protect and enhance the habitat upon which these resources depend to assure that diverse and self-sustaining populations of these resources are available for future generations.

This plan advances and is consistent with the agency missions described above.

Special Designations

Hudson River National Estuarine Research Reserve

In 1982, the National Oceanic and Atmospheric Agency (NOAA) designated the Hudson River National Estuarine Sanctuary, now known as the Hudson River National Estuarine Research Reserve (HRNERR). HRNERR includes four large and ecologically important

tidal wetlands on the Hudson River estuary (Figure 3). Piermont Marsh and the adjacent shallows form the southernmost HRNERR site. DEC is the lead state agency for HRNERR, in collaboration with other state agencies with jurisdiction over the lands within the four HRNERR component sites and in partnership with NOAA. HRNERR is operated under a NOAA-approved management plan (HRNERR, 2009). This Piermont Marsh Reserve Management Plan is consistent with the 2009 HRNERR Management Plan.

HRNERR is part of the National Estuarine Research Reserve System (Reserve System), a network of protected areas representative of the various biogeographic regions and estuarine types in the United States. Reserves are established for long-term research, education and interpretation to promote informed management of the nation's estuaries and coastal habitats (15 C.F.R. Part 921.1(a)). The Reserve System currently consists of 29 reserves in 24 states and territories, protecting over one-million acres of estuarine lands and waters (Figure 4). The Reserve System is a partnership program between the National Oceanic and Atmospheric Administration (NOAA) and the coastal states. NOAA provides funding, national guidance and technical assistance. The state partners (DEC and OPRHP) manage HRNERR sites on a routine basis working collaboratively with local and regional partners.

Reserves respond to societal and ecological needs by providing a platform for research and learning, applying research to management, and practicing coastal stewardship. Each reserve in the national system serves as a place-based living laboratory and classroom where program development, research techniques, and management approaches can be piloted and applied to issues of local, regional, and national significance. This Piermont Marsh Reserve Management Plan is consistent with NOAA's National Ocean Service priorities, which include conserving special coastal places, supporting community climate resilience, and making observations and monitoring change to inform stewardship and management. Activities at each reserve are designed to fulfill the Reserve System's goals as defined in the regulations (15 C.F.R. Part 921(b)).

Piermont Marsh Significant Coastal Fish and Wildlife Habitat

Piermont Marsh was designated a Significant Coastal Fish and Wildlife Habitat (SCFWH) in 1987 by the New York State Department of State (DOS) in recognition of its ecosystem rarity, the presence of vulnerable wildlife species, its regional significance for human use, and an unusual concentration of fish and wildlife species in the area. It was recognized to be irreplaceable. This designation brings an extra level of review to management activities, which must be consistent with the maintenance and recovery of habitat for native fish and wildlife species and the impact assessment considerations in the SCFWH narrative (DOS, 2012).

Figure 3. Location of Hudson River National Estuarine Research Reserve component sites and the Norrie Point headquarters

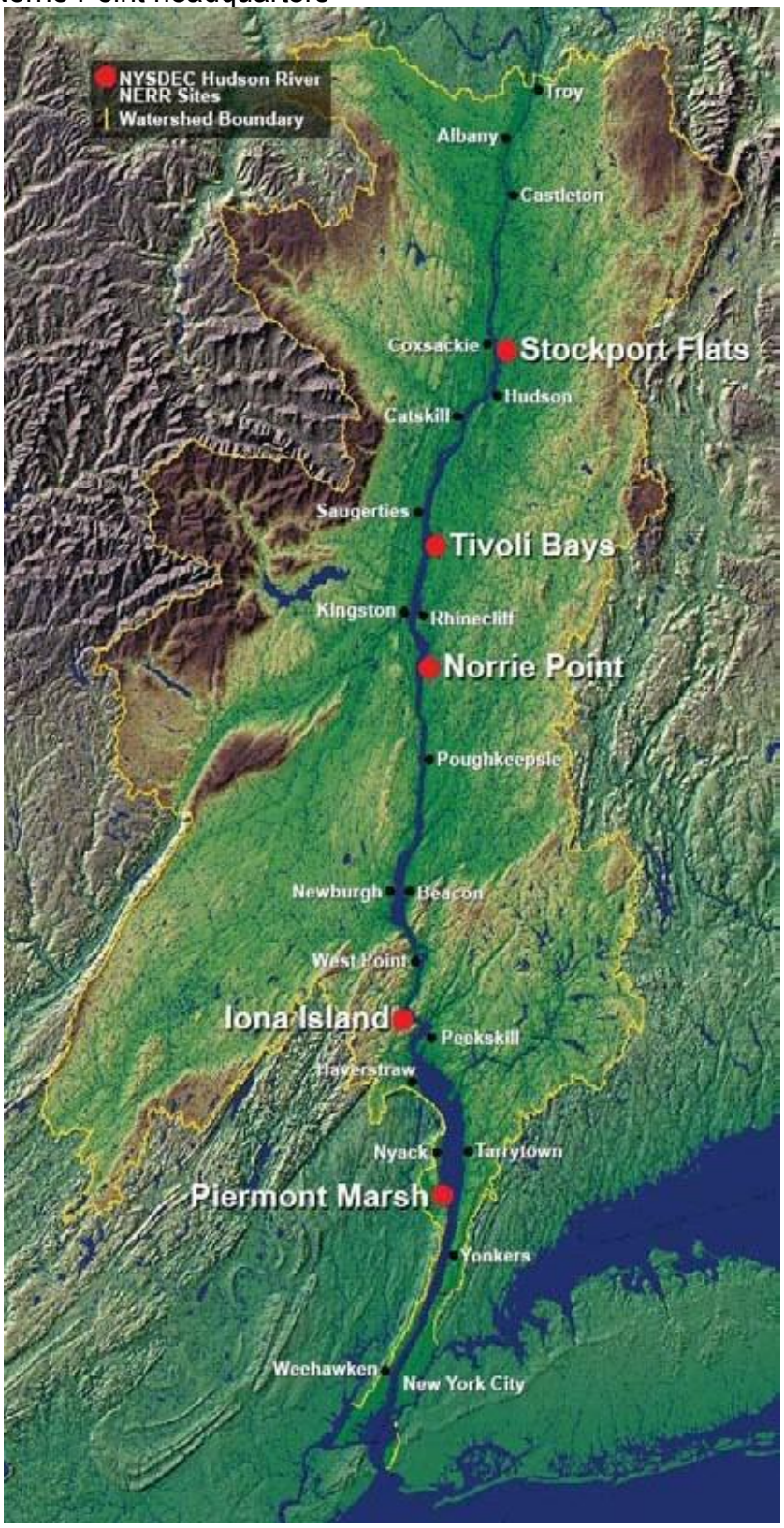
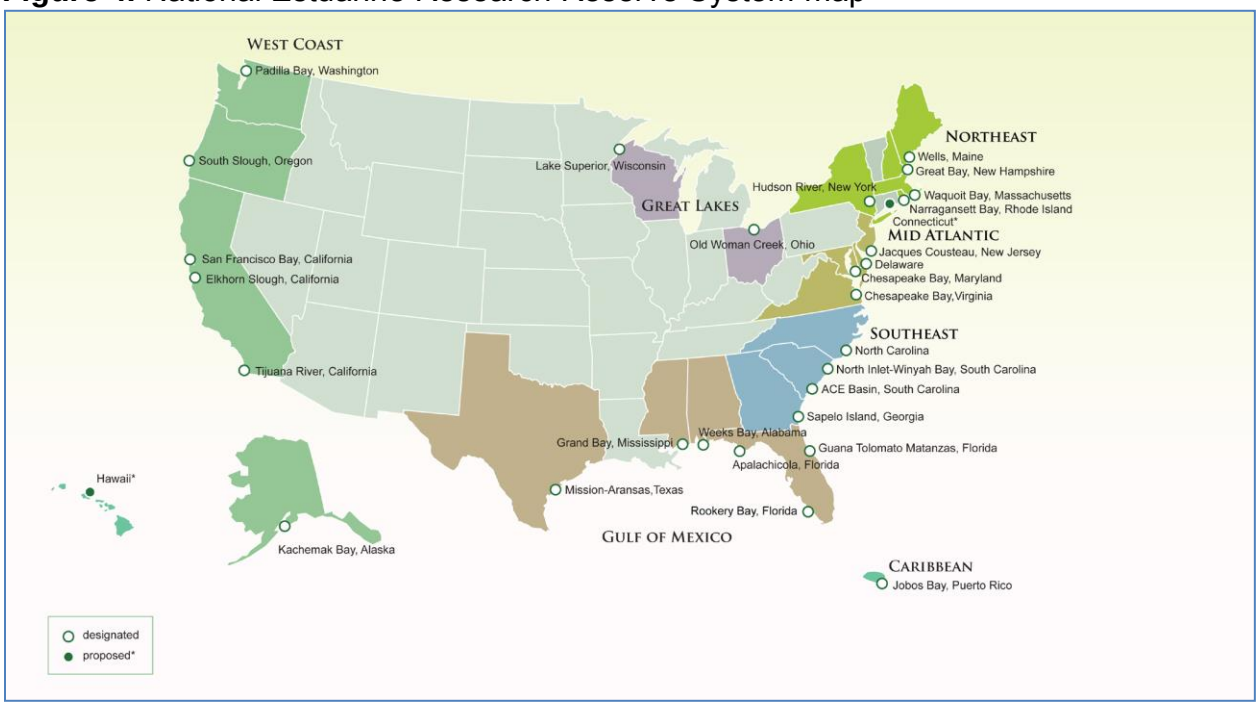


Figure 4. National Estuarine Research Reserve System map



Local and Regional Plans

Resilience Roadmap: Report of the Piermont Waterfront Resilience Task Force

The Piermont Waterfront Resilience Task Force (Task Force) was convened by Mayor Chris Sanders in November 2013 to develop a shared vision for the Piermont waterfront and concrete steps to move Piermont toward its vision for greater resilience. The Task Force identified climate change challenges and risks, engaged in community visioning about the future of Piermont, learned about potential adaptation options, and developed solutions, all the time seeking to align immediate recovery actions with a longer-term perspective of how Piermont will adapt to rising seas and higher floods (Village of Piermont, 2014). The six-person Piermont Waterfront Resilience Commission was established in 2015 and charged with implementing the findings and recommendations of the Task Force.

The Task Force report included two recommendations for Piermont Marsh and one for Piermont Pier. This plan includes actions that will advance the following three recommendations:

- Evaluate ways to enhance the flood-buffering characteristics of Piermont Marsh and to protect the existing marsh area from degradation.
- Research the need for, and feasibility of, assisted marsh adaptation (e.g., through assisted accretion, engineering the outer edge for reduced erosion, etc.).
- Evaluate the benefits of the Pier's current (and potential) uses and hydrologic impacts on Piermont Marsh (i.e., modifications to water flow in the Hudson, which likely support the marsh's persistence). Compare these benefits to the cost of

maintaining the Pier's elevation over the long run to make informed decisions about future public investments toward this asset.

The Task Force Report also included the following recommendation for the commercial core that relates to the marsh over the long term:

- Consider possibilities for long-term redevelopment of the commercial core, which can include allowing/facilitating marsh expansion in a north-south pattern through its center (between Piermont Avenue and Roundhouse Road), and with esplanades along business fronts on both sides, and bridges (walking and driving) to cross the marsh.

Village of Piermont Local Waterfront Revitalization Program

The most recent Village of Piermont Local Waterfront Revitalization Program (LWRP) was approved in 1992 and an update is in preparation to address community resilience. The northern part of the Piermont Marsh Reserve, primarily north of the Sparkill Creek, is within the Village's boundary and identified as Area V in the 1992 LWRP, a conservation area. The LWRP includes the following fish and wildlife policies that apply to this area:

- Policy 7: Significant coastal fish and wildlife areas, as identified on the Coastal Area Map, shall be protected, preserved and, where practical, restored to maintain their viability as habitats.
- Policy 7A: Protect the Piermont Marsh south of the pier and the Sparkill Creek by severely restricting it to passive recreational uses.

Piermont Critical Environmental Area

In 1985, the village board designated three critical environmental areas (CEAs). CEAs are designated by a local or state agency under subdivision 6 NYCRR 617.14(g) to recognize a specific geographical area. One of the Piermont CEAs includes the portion of the marsh north of Sparkill Creek and a portion of the Sparkill Creek corridor. This area was recognized for being an exceptional or unique natural setting.

Under the State Environmental Quality Review Act (SEQRA), CEA designation means that potential impacts on the recognized special characteristics of a CEA warrant specific consideration in determining the significance of any Type I or unlisted actions that may affect the CEA. More information about CEAs can be accessed at: http://www.dec.ny.gov/permits/45500.html.

This management plan includes a recommendation for conserving the portion of the Piermont Marsh/Sparkill CEA within the Piermont Marsh Reserve as a storm buffer for the Village of Piermont, and for research to study how best to manage and protect Piermont Marsh so that it persists despite sea-level rise.

Rockland County Comprehensive Plan

The Rockland County Comprehensive Plan was adopted in 2011. The first recommendation in the Natural Resources chapter is to protect the Hudson River and other significant surface water resources. The plan recognizes the Hudson River as one of Rockland's most valuable environmental resources, significantly affecting land use, commerce, ecosystems, and scenic vistas. A proposed measure for protecting the Hudson River and other significant water resources is to work with DEC's Hudson River Estuary Program and neighboring counties to adopt the goals outlined in the program's *2010-2014 Action Agenda* (see below) and to work to develop a river stewardship ethic.

Hudson River Estuary Action Agenda

DEC's Hudson River Estuary Program helps people enjoy, protect, and revitalize the Hudson River and its valley. Created in 1987 through the Hudson River Estuary Management Act, the program focuses on the tidal Hudson and adjacent watershed, from the Troy Lock and Dam to the Verrazano Narrows in New York City. The program is steered by the Hudson River Estuary Management Advisory Committee, which includes representatives of the commercial fishing industry, recreational anglers, utility companies, local government, educators, researchers, conservationists and other river users. The *Hudson River Estuary Action Agenda 2015-2020* (HREP, 2016) is a conservation and restoration blueprint that guides the work of the Estuary Program and its partners. The *Action Agenda* defines the challenges and identifies practical solutions that can be carried out by civic leaders, policy makers, and citizens working together.

The *Piermont Marsh Reserve Management Plan* supports the realization of four of the five benefit areas identified in the *Hudson River Estuary Action Agenda*, including: 1) Resilient Communities; 2) Vital Estuary Ecosystem; 3) Estuary Fish, Wildlife, and Habitats; and 4) Education, River Access, Recreation, and Inspiration (HREP 2016).

Hudson River Estuary Habitat Restoration Plan

The Hudson River Estuary Habitat Restoration Plan (Miller, 2013) provides the foundation for restoring tidal wetlands, natural shorelines, and shallows, as well as facilitating fish passage up the Hudson River's tributaries. The plan identified intertidal wetlands as a priority habitat for restoration, vital to the health and resiliency of the estuary. The *Piermont Marsh Reserve Management Plan* was developed with consideration of the principles, approaches, and priorities of the *Hudson River Estuary Habitat Restoration Plan*.

Social and Community Context

Nearby Communities

Piermont is one of four incorporated villages within the Town of Orangetown. The village directly abuts the northern extent of the Piermont Marsh, and its boundary includes

about 65 acres of Reserve lands, including marsh, uplands, and underwater shallows south of Paradise Avenue and Ferry Road, and north of the Sparkill Creek. Palisades is an unincorporated hamlet located on the west shore of the Hudson River, just below the south end of Piermont Marsh.

Piermont Marsh, formerly known as the Orangetown Salt Meadow, has been important to community life and the local economy of both communities. An 1877 survey map of the marsh shows 174 separate allotments for harvesting salt hay, presumably to feed livestock and possibly to provide roofing. Salt hay, also known as saltmeadow cordgrass (*Spartina patens)*, is mostly gone from the marsh except in a few locations.

Although nearly all of Piermont Marsh lies outside the Village of Piermont boundary, many residents identify closely with the marsh and consider it a vital component of Piermont's special sense of place. Village residents and visitors pass the northern part of the marsh on walks out onto Piermont Pier. The marsh is also a paddling destination that supports a canoe and kayak rental business. Many local restaurants, shops, and other businesses also benefit from tourism fostered by the marsh.

Vulnerability to Storms and Changing Climate

Flooding along Paradise Avenue (Photo by DEC)

Piermont's location at the confluence of the Sparkill Creek and the Hudson River is both a great asset and a significant challenge, as it experiences periodic waterfront flooding due to storms, high tides, and sea level rise. In 2011, storms Irene and Lee caused significant flooding resulting from stormwater flows in the Sparkill Creek and storm surge in the Hudson River. In fall of 2012, Post-Tropical Cyclone Sandy's historic coastal storm surge resulted in severe damage to homes, marinas, boats, and other businesses (Village of Piermont, 2014). Through the community's experience of these storms and the collective planning for risk reduction and greater resilience, the Village of Piermont has a solid foundation of knowledge about sea level rise and flooding adaptation approaches, and is moving forward to reduce risk and improve resilience.

Piermont leaders and residents are keenly aware that the marsh helps protect the village, especially buffering low-lying areas adjacent to the marsh. During Post-Tropical Cyclone Sandy, marsh vegetation acted as a wave buffer and filter for water-borne debris, which accumulated in the marsh instead of impacting residences and village infrastructure. There is debate about the role of the marsh in reducing unusually high water levels that arise from a combination of high tides, surge, and runoff (Jacob, pers. comm., 2016 and Sheng, pers. comm., 2016). The coastal protection benefits provided by the marsh will be investigated in detail through research described later in the plan.

NATURAL RESOURCES

INTRODUCTION

Piermont Marsh is the largest brackish tidal marsh in the Hudson River estuary, a rarity in this major ecological region. Piermont Marsh Reserve includes the 278-acre marsh that extends 1.5 miles north-south along the west shore of the Hudson River, as well as the adjacent shallows, for a total area of about 1,000 acres. The marsh is south of the Village of Piermont and north of the hamlet of Palisades, in the Town of Orangetown in southeastern Rockland County. Piermont Marsh is among the oldest marshes on the Hudson River (Wong and Peteet, 1999).

This section of the management plan briefly describes the geology, topography, and soils of Piermont Marsh. The property's ecological resources are discussed in more detail and are based on an *Ecological Profile of the Hudson River National Estuarine Research Reserve* (Yozzo, et al., 2005) and surveys and research conducted over the last several decades. Emphasis is on the sensitive natural resources and the threats facing them. The information in this chapter provides the basis for many of the management recommendations discussed in the "Management Approach" chapter.

PHYSICAL SETTING

Geology

Piermont Marsh is bordered on the north by Piermont Pier and to the west by the 150-foot cliffs and talus slopes of the Palisades Ridge. This ridge was formed when molten basalt rock pushed upward through softer sedimentary rocks along fault lines, between 200 and 190 million years ago. The softer rocks gradually wore away, leaving the more resistant Palisades standing as dramatic, vertically jointed basaltic rock (Sirkin and Bokuniewicz, 2006).

Topography

Montalto, et al. (2006) documented the marsh's physical characteristics from 1998-2000. Ground-based topographic surveys using a real-time kinematic global positioning system (RTK GPS) indicated that Piermont Marsh was flat, with the north end at about the same elevation as the south end. The study noted frequent localized depressions where muskrats had been feeding or burrowing between hummocks of tidal marsh plants and in unvegetated shallow salt pannes or shallow ponds. The banks of tidal creeks were steep and nearly vertical near the marsh surface, as is typical of tidal creeks in *Phragmites*-dominated marshes.

Soils

The retreat of the last glaciers about 22,000 years ago was followed by rising sea levels and the creation of estuarine conditions within the Hudson River valley. Evidence of salt marshes in the estuary dates from about 11,000 years ago (Sirkin and Bokuniewicz, 2006). Radiocarbon dating suggests that Piermont Marsh is approximately 6,800 years old (Newman, et al., 1987). The substrate of the marsh soil is an Ipswich mucky peat, and its profile can be described as alternating layers of peats and clays varying in color and texture (Wong and Peteet, 1999) to a depth of at least 43 feet (D. Peteet, pers. comm., May 15, 2017). Estimates of the rate of deposition of marsh sediments vary widely, from 0.06 to 0.60 inches/year (Wong and Peteet, 1999; Yozzo, et al., 2005; Kiviat, et al. 2006).

WATER RESOURCES

Hydrology

The Hudson River estuary is tidal, from the Troy Lock and Dam south to New York City. Hudson River tides are semi-diurnal, with two highs and two lows within a 25-hour period. The mean tidal range varies from 3.2 feet at West Point to about 5 feet at either end of the estuary. The average tidal range at Piermont Marsh is 3.2 feet.

Although tides rise and fall in the marsh's tidal creeks (Sparkill, Kroomis Kill, and Crumkill), most of Piermont Marsh is only irregularly flooded during spring tides (those that occur around the time of full or new moons) up to a dozen times monthly, and during occasional flooding and storm surge events (Montalto, et al., 2006).

The salinity of the Hudson River at Piermont is generally brackish (less than half the salinity of ocean water), although it ranges from fresh to about 12 parts per thousand (ppt) of salt. The Sparkill Creek discharges into the north end of the marsh, draining 11.1 square miles of developed watershed.

Water Quality

HRNERR has been collecting monthly water samples at two locations in Piermont since 1991. The first sampling site is located at the Ferdon Pond dam, above the head of tide, to analyze the watershed input into the Sparkill Creek before it flows through Piermont Marsh. The second sample is collected at the mouth of Sparkill Creek on an outgoing tide to assess whether the marsh has an impact on creek

HRNERR staff collecting water samples at the Ferdon Pond dam (Photo by DEC)

water quality. Standard water quality parameters and nutrient concentrations are analyzed, and weather data are recorded. These data are publicly available through HRNERR. While basic water quality conditions in the marsh are generally representative of estuaries in the Northeast, monitoring of nutrients has identified some areas of concern and potential sources of organic enrichment. Nitrate concentrations in Piermont Marsh and Sparkill Creek are higher than in other HRNERR marshes but typical of a marsh system in a developed watershed. However, water quality remains largely unchanged between the two sampling locations along the creek. This suggests that the marsh does not impact water quality in the creek, perhaps because the creek rarely crests its banks.

Since 1998, Rockland County Soil and Water Conservation District and DEC have been monitoring water quality at six locations along the Sparkill Creek using bottom-dwelling aquatic insects. These insects vary in their sensitivity to water quality, so the presence, absence, and abundance of certain species can be used to determine an overall water quality score. This score is called a Biological Assessment Profile (BAP), which classifies waterbodies as non-, slightly, moderately, or severely impacted. For more details on BAP, visit: http://www.dec.ny.gov/docs/water_pdf/sbusop12.pdf. Monitoring data indicate that the water quality in the lower reaches of the Sparkill Creek is slightly to moderately impacted.

Since 2006, Riverkeeper has been monitoring enterococci levels in water samples collected at various sites along the Hudson River, including Piermont Pier and the Orangetown Sewage Treatment Plant outfall. Enterococci are bacterial indicators of fecal contamination from humans and animals and used to assess the health risk of recreational waters. In partnership with the Sparkill Creek Watershed Alliance, Riverkeeper began monitoring enterococci levels in water samples collected from the banks of the Sparkill Creek in 2011. Monitoring results indicate chronic and severe fecal contamination in the Sparkill Creek upstream of Piermont Marsh. Contamination in the Hudson River downstream of Piermont Marsh is less frequent but still severe. Potential sources of contamination include failing septic systems, leaky sewers, improper sewage treatment, pump station malfunctions during rain events, and runoff. Specific sources of fecal contamination in the Sparkill Creek watershed and the relative contributions of the creek versus the river are currently unknown.

ECOLOGICAL COMMUNITIES

Eleven distinct ecological communities have been identified at the Piermont Marsh Reserve, including brackish tidal marsh, saltwater tidal creek, brackish intertidal mudflat, and floodplain forest (Table 1, Figure 5). Together, these communities form a large and diverse assemblage of wetland and aquatic habitats that are uncommon within the Hudson River estuary. The following community classifications are based on the New York Natural Heritage Program's *Ecological Communities of New York State, Second Edition* (Edinger, et al., 2014). The New York Natural Heritage Program (NYNHP) ranks ecological communities based on their rarity and vulnerability within New York State (S-rank). S1 community types are considered the most imperiled, while S5 communities

are regarded as demonstrably secure. Some communities are given range ranks (e.g., S3/S4), indicating uncertainty about their status.

Table 1. Ecological community types occurring at the Piermont Marsh Reserve

Community Type	Acreage	Percent	S-rank
Tidal River	742.09	72.00	S3
Saltwater Tidal Creek	15.75	1.53	S3
Salt Panne	3.09	0.30	S3
Brackish Tidal Marsh	19.1	1.85	S3/S4
Estuarine Common Reed Marsh	232.02	22.51	Unranked Cultural
Low Salt Marsh	1.62	0.16	S3/S4
Brackish Intertidal Mudflat	7.56	0.73	S1/S2
Estuarine Riprap/Artificial Shore	1.55	0.15	Unranked Cultural
Red Maple-Sweetgum Swamp	0.41	0.04	S1/S2
Floodplain Forest	7.42	0.72	S2/S3
Mowed Lawn	0.10	0.01	Unranked Cultural

Notably absent from the following list of ecological communities is high salt marsh. Prior to the expansion of *Phragmites*, Piermont Marsh supported an extensive high salt marsh community (S3/S4), which was historically harvested for salt hay. This community occurred as a mosaic of patches in a zone extending from mean high tide up to the limit of spring tides. The dominant plant species in this community were saltmeadow cordgrass (*Spartina patens*) and saltgrass (*Distichlis spicata*). Although no sizeable patches of this community type remain at the Reserve, saltmeadow cordgrass and saltgrass persist in some areas where *Phragmites* is less dense and light reaches the marsh surface. High salt marsh is rare in the estuary and a conservation target at the Reserve.

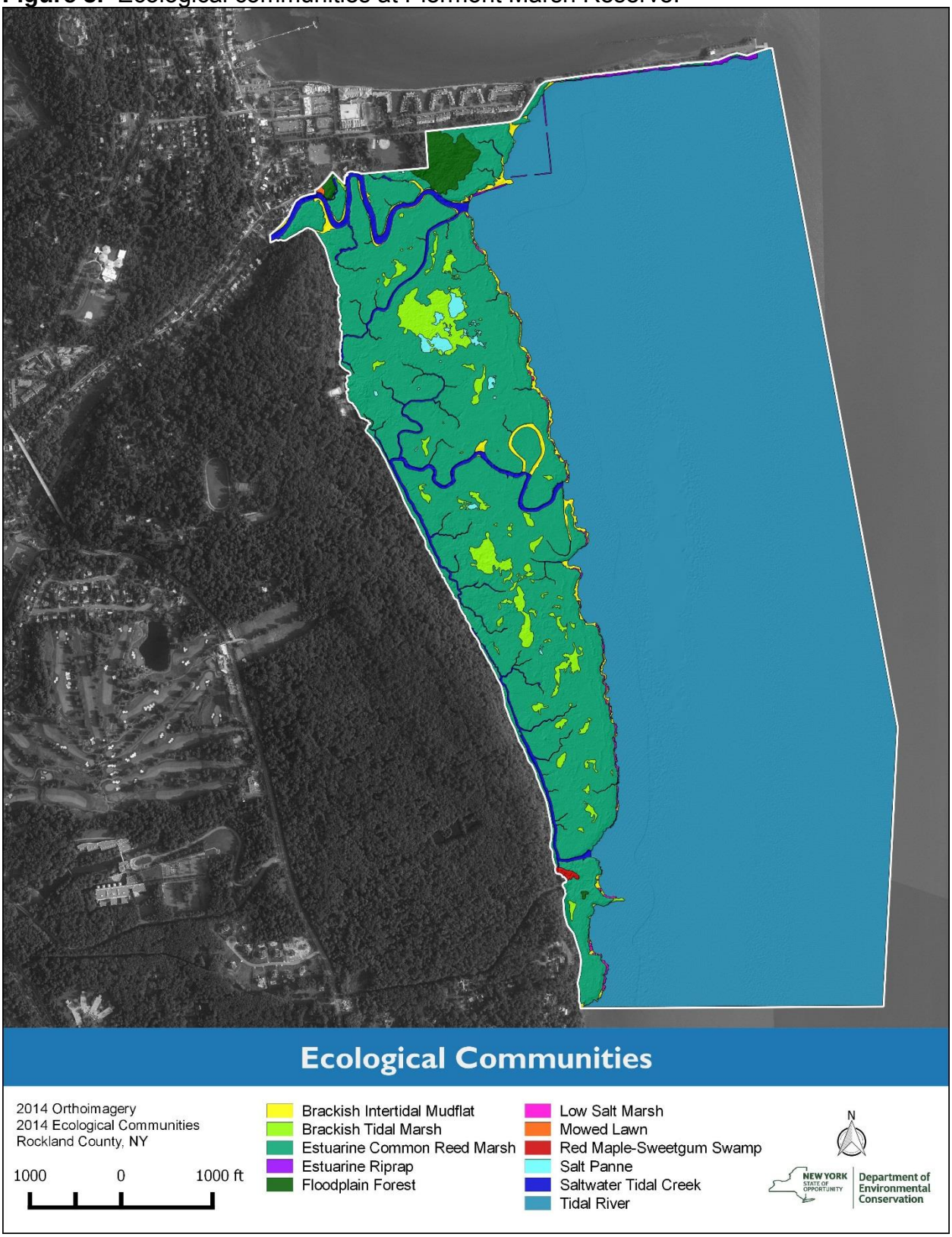
Tidal River (S3)

Portions of the Hudson River with continuously flooded substrates devoid of emergent vegetation are classified as tidal river. Within a tidal river community, there are typically two zones: 1) the deepwater zone, which includes areas where substrates are usually over 2m (6 ft.) deep at low tide; and 2) the shallow zone, which includes submerged areas less than 2m (6 ft.) deep at low tide that lack rooted aquatic vegetation. Most of the tidal river community within the Reserve boundary is within the shallow zone. These shallow waters provide critical habitat for waterfowl, invertebrates, and numerous year-round resident fish, as well as seasonal migrants that enter the river as adults to spawn and return to the ocean afterward.

Saltwater Tidal Creek (S3)

Several named tidal creeks meander through the marsh, including the Crumkill Creek, the Kroomis Kill, and the lower reaches of the Sparkill Creek. Water levels fluctuate with the tides, and two community depth zones are typically encountered: 1) the subtidal,

Figure 5. Ecological communities at Piermont Marsh Reserve.



permanently flooded portion of the creek; and 2) the intertidal portion, including banks and mid-channel bars or terraces exposed at low tide. Although the vertical banks of most creeks are regularly eroded and slump into the creek bottom, the position of the creek beds in the marsh has remained relatively stable, at least since the early 20th century. Smaller unnamed creeks and intertidal rivulets occur on the surface of the marsh and fish use them to access the marsh plain.

Salt Panne (S3)

Salt pannes are shallow depressions on the marsh surface, which are irregularly flooded during spring and flood tides. These depressions are not directly connected to tidal creeks and therefore do not readily drain as the tides recede. In the absence of additional freshwater inputs, the standing water in a panne can evaporate, thereby raising the concentration of salts in the soil water well above that of sea water. Most of the pannes in Piermont Marsh lack vegetation, although saltmarsh fleabane (*Pluchea purpurascens*) and dwarf spike rush (*Eleocharis parvula*) can occasionally be found inside them. Most pannes at Piermont Marsh are confined to a portion of the interior marsh between the Crumkill Creek and the Kroomis Kill. However, recent surveys suggest that several new pannes may also be forming south of the Crumkill Creek. Based on aerial photographs taken of the marsh since 1926, the number and average size of pannes/shallow pools on the marsh plain has increased. The location of some of them also appears to shift over time (B. DeGasperis, pers. comm., February 24, 2016).

Brackish Tidal Marsh (S3/S4)

Brackish tidal marsh community at Piermont Marsh (Photo by Sarah Fernald, DEC)

Portions of the marsh interior support a brackish tidal marsh community. This community occurs in isolated patches within a larger matrix of estuarine common reed marsh. Characteristic species include chairmaker's bulrush (*Schoenoplectus americanus*), three-square bulrush (*Schoenoplectus pungens*), saltmarsh bulrush (*Bolboschoenus robustus*), narrow-leaved cattail (*Typha angustifolia*), rosemallow (*Hibiscus moscheutos*), saltmarsh fleabane, fragrant flatsedge (*Cyperus odoratus*), seaside goldenrod (*Solidago sempervirens*), and saltmarsh aster (*Symphyotrichum subulatum*), a state-listed threatened species. This community type has declined dramatically since the 1960s and has been replaced by an estuarine common reed marsh community. Brackish tidal marshes provide excellent wildlife habitat, with abundant food sources for migratory and wintering waterfowl.

Estuarine Common Reed Marsh (Unranked Cultural)

Estuarine common reed marsh community at Piermont Marsh (Photo by Brian DeGasperis, DEC)

A non-native strain of common reed (*Phragmites australis*) is the dominant vegetation on approximately 85% of the marsh surface. *Phragmites* is a tall, coarse perennial grass with stout rhizomes (horizontal underground stems that can sprout new roots and shoots) that forms dense, high-biomass colonies. *Phragmites* is hyper-dominant in many areas of the marsh, although remnant native plants characteristic of brackish tidal marsh (e.g., chairmaker's bulrush and narrow-leaved cattail) and high salt marsh (e.g., saltmeadow cordgrass and saltgrass) communities can occasionally be intermixed. The abundance of *Phragmites* makes it impossible to classify the majority of the marsh as a natural estuarine community. Although an estuarine common reed marsh can develop at the expense of rare and vulnerable natural communities, it is not devoid of ecological value. At Piermont Marsh Reserve, this community provides several valuable ecosystem services, including soil stabilization, nutrient retention, carbon sequestration, and storm protection for neighboring developed areas. This community also provides foraging, breeding, roosting, and/or migratory stopover habitat for certain species of songbirds and waterbirds (Findlay, et al., 2014).

Low Salt Marsh (S3/S4)

This community mostly occurs along the eastern edge of the marsh, in areas regularly flooded by semidiurnal tides. Narrow bands of this community type can also be found along some of the tidal creeks that meander through the marsh. The vegetation of a low salt marsh is almost entirely composed of smooth cordgrass (*Spartina alterniflora*), a coarse grass that can grow up to 10 feet tall. Other characteristic plant species include dwarf spikerush, and eastern grasswort (*Lilaeopsis chinensis*), a state-listed threatened species. These tiny plants, typically less than 4 inches tall, can also be found growing between cordgrass stems along the Hudson River shoreline. Low salt marshes grade into brackish intertidal mudflats and subtidal communities seaward and brackish tidal marshes and estuarine common reed marshes landward.

Brackish Intertidal Mudflats (S1/S2)

Sparsely vegetated, unvegetated, and algal variants of brackish intertidal mudflats occur on shallow, sheltered, and nearly level areas along the Hudson River shoreline and margins of the Sparkill and Crumkill creeks. These communities are exposed at low tide

and are typically comprised of loosely consolidated deposits of silt and mud. While seemingly barren and devoid of life, mudflats are home to a variety of invertebrates and are prime feeding grounds for shorebirds, including least (*Calidris minutilla*) and semi-palmated sandpipers (*C. pusilla*), and lesser yellowlegs (*Tringa flavipes*).

Estuarine Riprap/Artificial Shore (Unranked Cultural)

Piermont Pier was created in 1838 as the terminus of the Erie Railroad by depositing rock and fill in the marsh and shallows. Consequently, the shoreline along the pier and the north side of the Sparkill Creek are generally composed of coarser stones and gravel. An intertidal sill composed of broken rocks extends through the shallows south of Ferry Road near the east end of Piermont Landing towards the mouth of the Sparkill Creek. This historic rock sill may have been placed to support a dock, prevent erosion and/or reduce wave and current energies in the area. Vegetative cover and species diversity along these artificial shores are typically low compared to natural estuarine shores. However, they provide valuable foraging and resting habitat for shorebirds and basking areas for turtles, including diamondback terrapin.

Red Maple-Sweetgum Swamp (S1/S2)

A small forested wetland dominated by sweetgum (*Liquidambar styraciflua*) occurs at the southern end of the marsh. This community is typically found on somewhat poorly drained seasonally wet flats, usually on acidic gleyed to mottled clay loam or sandy loam. Red maple-sweetgum swamps often occur as a mosaic with upland forest communities. The swamp at Piermont Marsh is particularly unusual in that it abuts a brackish marsh and is tidally influenced. More data are needed to describe this community type and its variants.

Floodplain Forest (S2/S3)

The largest wooded area within the Reserve occurs on the east side of Rittenberg Field along Ferry Road. It was formerly brackish tidal marsh before being used as a municipal waste landfill in the mid-1900s. The landfill has since revegetated and supports an open canopy of eastern cottonwood (*Populus deltoides*) and other tree species adept at colonizing disturbed soils and high-light environments. Given the shallow substrate, many of the canopy trees have been uprooted during wind storms and remain on the ground. The understory is a dense tangle of non-native and ruderal (growing in waste places or on disturbed land) species, including Japanese knotweed (*Polygonum cuspidatum*), Asiatic bittersweet (*Celastrus orbiculatus*), poison ivy (*Toxicodendron radicans*), and grape (*Vitus* sp.). In addition to providing limited habitat value for wildlife, the presence of inorganic refuse, including discarded automobiles, large appliances, and mechanical parts, creates a potential hazard for public access and recreation.

Smaller floodplain forest communities occur along the banks of the Sparkill Creek and near the southern tip of the marsh. At the southern end of the marsh, the floodplain forest is a small island surrounded by estuarine common reed marsh. These hardwood

forests are characterized by their flood regime. Lower areas are flooded every spring, and higher areas are flooded irregularly. Floodplain forests are insect-rich habitats that attract warblers, thrushes and other songbirds. In particular, yellow-throated and warbling vireos, which like to nest in the canopies of riverside trees, are frequently observed in floodplain forest communities. Raptors such as bald eagles and red-shouldered hawks also use riverbank trees as perch sites.

Mowed Lawn

There is a small area of lawn at the DEC pocket park between Paradise Avenue and the Sparkill Creek. The groundcover is dominated by clipped grasses and forbs and maintained by mowing to provide creek access and marsh visibility.

FISH AND WILDLIFE

Fishes

Several studies have estimated the abundance of resident fish species at Piermont Marsh using intertidal lift nets. Mummichogs (*Fundulus heteroclitus*) comprise the majority of the fish community found on the marsh surface. The abundance of larval and juvenile mummichogs is generally lower in the dense *Phragmites* stands than in communities dominated by native vegetation (Hanson, et al., 2002; Osgood, et al., 2006). Other species found on the marsh surface include Atlantic silverside (*Menidia menidia*), white perch (*Morone americana*), and spotfin killifish (*Fundulus luciae*).

The first record for spotfin killifish in the Hudson River drainage was reported at Piermont Marsh (Yozzo and Ottman, 2003). This species is known to inhabit high intertidal marshes along the Atlantic coast, from southeastern Massachusetts to Georgia (Jorgenson, 1969; Hartel, et al., 2002). Spotfin killifish may not necessarily be rare, but their ability to remain concealed and preference for less frequently flooded salt and brackish marshes may have precluded their collection in previous studies.

The Sparkill and Crumkill creeks and shallow offshore waters provide limited spawning and/or nursery habitats for a variety of coastal migratory and resident freshwater fishes, including American eel (*Anguilla rostrata*), alewife (*Alosa pseudoharengus*), blueback herring (*Alosa aestivalis*), American shad (*Alosa sapidissima*), white perch, striped bass (*Morone saxatilis*), bluefish (*Pomatomus saltatrix*), banded killifish (*Fundulus diaphanous*), Atlantic silverside, and mummichog.

Mammals

Only a few studies have focused on the ecology of mammal populations at Piermont Marsh. Several mammal species, such as muskrat, are conspicuous residents of the marsh. Muskrats are known for their burrowing, feeding, and lodge-building activity. They are the primary vertebrate consumer of intertidal marsh vegetation. It is unknown

to what extent muskrat grazing has affected and/or continues to affect plant species composition or richness at Piermont Marsh. However, it is known that muskrat activity increases soil nitrification rates through increased aeration (Connors, et al., 2000). Additionally, muskrat lodge construction contributes to the structural complexity of the intertidal marsh surface, providing nesting and feeding habitat for marsh birds and other vertebrates at the Reserve.

While their impact on the marsh may not be as conspicuous, white-tailed deer (*Odocoileus virginianus*) also forage and seek shelter in its dense vegetation. As deer traverse the marsh, they establish trails that facilitate the movements of smaller wildlife species. Other mammal species, such as the meadow vole (*Microtus pennsylvanicus*), shrews, moles, and bats are likely present but rarely noted due to their ability to avoid detection.

Birds

Least Sandpiper
(Photo by Dave Menke, courtesy of the U.S. Fish and Wildlife Service)

Much of what is known about the birds of the Piermont Marsh Reserve is based on data provided by the Rockland Audubon Society and the *Birds of Rockland County, NY and the Hudson Highlands, 1844-1976* (Deed, 2010). Deed's compilation of county bird records includes numerous species accounts from the Reserve. Historical breeding activity was noted for various species, including the pied-billed grebe (*Podilymbus podiceps*), black-crowned night heron (*Nycticorax nycticorax*), least bittern (*Ixobrychus exilis*), clapper rail (*Rallus crepitans*), Virginia rail (*Rallus limicola*), sora (*Porzana carolina*), common moorhen (*Gallinula chloropus*), marsh wren (*Cistothorus paulstris*), saltmarsh sparrow (*Ammodramus caudacutus*), seaside sparrow (*A. maritimus*), alder flycatcher (*Empidonax alnorum*), and willow flycatcher (*E. traillii*). Over the last ten years, ongoing breeding activity has been confirmed for several species, including the least bittern (Steve Sisti, pers. comm., 2013), marsh wren, and Canada goose (*Branta canadensis*).

At the Piermont Marsh Reserve, swallows (Hirundinidae), blackbirds (Icteridae), and other songbirds likely roost in the estuarine common reed marsh community. Although songbird roosting has not been confirmed at the Reserve, the phenomenon has been observed in other *Phragmites*-dominated habitats in the estuary (Kiviat and Talmage, 2006). Roosts of non-breeding songbirds may involve hundreds or thousands of individuals (Findlay, et al., 2014).

Pannes, mudflats, shorelines, and shallow-water habitats are frequented by various migratory waterfowl, wading, and shorebird species, including canvasback (*Aythya valisineria*), common goldeneye (*Bucephala clangula*), green heron (*Butorides striatus*), lesser yellowlegs, least sandpiper, and semi-palmated sandpiper.

Piermont Marsh has been designated part of the Atlantic Flyway for seasonally migrating birds and is used by many threatened and endangered raptor species such as osprey (*Pandion haliaetus*), northern harrier (*Circus cyaneus*), bald eagle (*Haliaeetus leucocephalus*), and peregrine falcon (*Falco peregrinus*).

Amphibians and Reptiles

Diamondback terrapin (Photo by Margie Turrin)

Few studies of reptile and amphibian populations have been conducted at Piermont Marsh. Common snapping turtle (*Chelydra serpentina*), northern water snake (*Nerodia sipedon*), and diamondback terrapin (*Malaclemys terrapin*) are known to live within the Reserve and can often be observed basking along Piermont Pier. Diamondback terrapins were hunted to near extinction at the turn of the last century and are beginning to show signs of population recovery in the Hudson River and other northeastern estuaries. At Piermont Marsh, terrapins are subject to drowning in crab traps, and their eggs and young may be preyed upon by raccoons. A preliminary population survey conducted during summer 1997 identified eight terrapins (six males, two females) at Piermont Marsh. Although diamondback terrapins were using the marsh system, it was unclear whether they were nesting in the Reserve. The study suggested that dense stands of *Phragmites* might reduce the availability of suitable nesting areas at Piermont Marsh (Simoes and Chambers, 1998).

Invertebrates

At Piermont Marsh, the summer zooplankton assemblage is dominated by copepod larvae. Adult copepods (*Harpacticoida*) and barnacle larvae are also abundant. Spatial and temporal variations in zooplankton distribution in the marsh are determined by variables such as tributary flow, tidal mixing and resuspension, and storm events (Nemazie and Dexter, 1988).

Benthic invertebrate communities associated with the intertidal *Phragmites* stands at Piermont Marsh are dominated by annelids (*Tubificidae* and *Enchytraidae*), insect larvae (*Diptera*) and mollusks (*Sphaeriidae* and *Hydrobiidae*). Taxa richness is greater

in higher elevation *Phragmites* stands than in lower elevation stands (Osgood, et al., 2006).

Other commonly occurring estuarine invertebrates at the Piermont Marsh Reserve include daggerblade grass shrimp (*Palaemonetes pugio*), Atlantic marsh fiddler crab (*Uca pugnax*), and blue crab (*Callinectes sapidus*).

Little is known about the terrestrial invertebrate communities at the Reserve. Brackish tidal marsh and salt panne communities typically support a diverse array of insects and spiders, including ground crickets, mosquitoes, bees, wasps, syrphid flies, and butterflies. Needham's skimmer (*Libellula needhami*), a locally uncommon dragonfly, was recently documented at Piermont Marsh. The larvae of this coastal species are aquatic, whereas adults are terrestrial and found in habitats surrounding ponds, lakes, tidal river areas, and brackish wetlands in New York State.

SIGNIFICANT ECOLOGICAL FEATURES

Priority Ecological Communities

Needham's skimmer (Photo by Betsy Blair, DEC)

Piermont Marsh is one of less than a dozen brackish marshes statewide. Few of the other documented marshes are protected on public land or private conservation land (NYNHP, 2015). The marsh supports an assemblage of ecological communities restricted to a small portion of the estuary where water salinities range from 0.5 to 18 ppt, and the water is less than six feet deep at high tide. All the ecological communities found at Piermont Marsh, with the exception of the Estuarine Common Reed Marsh, Estuarine Riprap/Artificial Shore, and Mowed Lawn communities, are uncommon in the state. These uncommon native communities, which provide critical habitat for the larval and juvenile stages of many fish and invertebrate species and are used for spawning by adults of these species, are locally rare and declining throughout the estuary. Given their rarity and vulnerability, they are priorities for conservation and management. The fact that these individual communities are part of a larger protected wetland complex adds to their significance.

Rare Species

Given their intermediate salinities, brackish marshes support a unique and diverse mixture of saltmarsh and freshwater tidal marsh plant species dominated by grasses,

sedges, and rushes. Many of the species associated with brackish marshes are uncommon in the state. From a conservation perspective, the plants and animals that are restricted to these areas are a high priority due to their vulnerability to extinction.

Two rare plant species and one rare animal species are known to occur at Piermont Marsh (Table 2). These species are protected under New York State Environmental Conservation Law and classified as endangered, threatened, or rare (for plants), or endangered, threatened, or special concern (for animals) based on their level of rarity. In addition, several other rare plant and animal species historically occurred at Piermont Marsh, but have not been documented in recent years.

Table 2. State-listed rare species known to occur at Piermont Marsh

Common Name	Scientific Name	Taxonomic Group	Status
Saltmarsh Aster	*Symphyotrichum subulatum*	Plant	Threatened
Eastern Grasswort	*Lilaeopsis chinensis*	Plant	Threatened
Least Bittern	*Ixobrychus exilis*	Bird	Threatened

Ecosystem Services

In addition to providing habitat for rare plants and animals, Piermont Marsh performs many critical ecosystem services, including production and transport of nutrients and organic matter, removal of nutrients and contaminants, reduction of wave energy during storms, storage of flood water, and trapping of sediment.

Primary Production

Marshes are the primary source of much of the organic matter and nutrients forming the basis of the coastal and estuarine food webs. As marsh vegetation decays, a steady supply of detritus is released into surrounding waters, promoting the secondary production of finfish, shellfish, crustaceans, and birds.

Mudflats are also important contributors to primary production and breakdown of organic materials. Algal communities on mudflats are primary producers and provide a food source for snails and other benthic organisms. Bacterial communities contribute to the breakdown of organic materials.

Attenuation of Wave Energy and Reduction of Storm Surge

Tall, robust marsh plants such as *Phragmites*, saltmarsh cordgrass, and cattail reduce the energy of waves moving shoreward (Gedan, et al., 2011; Duarte, et al., 2013). At the seaward edge of salt marshes, a wave energy reduction of 26% per square meter of vegetation has been reported (Fonseca and Cahalan, 1992). Wave energy reduction decreases with distance into the marsh. The ability of marsh vegetation to reduce wave energy in this manner helps to protect adjacent infrastructure and prevent shoreline erosion (Gedan et al., 2011). Based on limited field observations and quantitative studies, tidal marshes are thought to play a role in buffering storm surge. In a study of

three-dimensional simulations of the reduction of storm surge by vegetation canopies, the effectiveness of vegetation in dissipating storm surge and inundation was found to depend on the intensity and forward speed of the hurricane, as well as the density, height, and width of the vegetation canopy (Sheng, et al., 2012).

Enhancement of Sedimentation/Accretion

Reduction of wave and current energies in tidal marshes causes them to trap sediment. As water moving across the marsh surface slows down, it loses its capacity to carry sediment particles (Nixon, 1982; Gedan, et al., 2011). Sediment then settles on the marsh surface. The large initial reduction in flow velocity at the river edge of tidal marshes concentrates sediment accumulation at this location, contributing to long-term maintenance and development of the marsh (Teal, 1986). Marsh grasses also reduce the velocity of terrestrial runoff. Water leaving the marsh, therefore, carries less particulate material and is less turbid (Desbonnet, et al., 1994).

Storage of Flood Water

Reduction of flow velocities by salt marsh grasses can contribute to flood control. Decreased flow velocities enable water to be transferred into soils and underground watercourses (Desbonnet, et al., 1994), potentially decreasing the impact of flood waters on adjacent upland. Piermont Marsh's ability to store floodwater and reduce still water levels is thought to be minimal given its small size compared to the area of the nearby Hudson River and the stormwater contributions of the Sparkill Creek (Jacob, pers. comm, 2016).

Nutrient Retention

As water flows across the surface of Piermont Marsh, the dense vegetation removes nutrients, especially nitrogen. In particular, the *Phragmites* stands at the Reserve have a superior capacity for nutrient retention relative to native intertidal wetland vegetation (Meyerson, et al., 2000; Findlay, et al., 2003) and contribute to overall water quality in the Hudson River estuary.

SIGNIFICANT ECOLOGICAL THREATS

Changing Climate

The greatest threat to Piermont Marsh is the acceleration in the rate of sea-level rise, which may outpace the marsh's ability to build up sediment and persist long term. If a marsh cannot keep pace with sea level rise, it becomes increasingly flooded and may ultimately drown and become open water. Along the Hudson River estuary, sea level rose about one foot in the 20th century. However, by 2100, sea level is projected to rise between 15 and 75 inches in New York City and the lower Hudson Region (Horton, et al., 2014; NYSDEC, 2015, Table 3). These projections take into account all known

components of sea-level rise and are based on advances in physical understanding, climate modeling and computing. They also incorporate observational data from recent storms, including Tropical Storm Irene and Post-Tropical Cyclone Sandy.

Table 3. Sea Level Rise Projections for New York City/Lower Hudson Region

Time Interval	Low Projection	Low-Medium Projection	Medium Projection	High-Medium Projection	High Projection
2020s	2 inches	4 inches	6 inches	8 inches	10 inches
2050s	8 inches	11 inches	16 inches	21 inches	30 inches
2080s	13 inches	18 inches	29 inches	39 inches	58 inches
2100	15 inches	22 inches	36 inches	50 inches	75 inches

Piermont Marsh has kept up with sea-level rise by building up or accreting sediment at the marsh surface. With sea level rising faster than before, there is uncertainty about how much more sediment will be available for the marsh to build up and, hence, how resilient it will be. There is a projected increase in frequency of "heavy rainfall events" (Rosenzweig, et al., 2011) which may result in higher than normal upland erosion, high turbidity, and increased deposition of sediment into marshes and shallows. This occurred during Tropical Storms Irene and Lee in 2012 (Ralston, et al., 2013) when 2.7 *million* tons of sediment—about five times the annual average—washed into the upper estuary from the watershed. In this instance, most of that sediment remained in the upper estuary in the months after the storm, at least temporarily trapped in the freshwater tidal part of the estuary. In the future, these storms may increase potential sediment inputs to Hudson River tidal marshes, to an extent depending in part on marsh elevation (which determines how long a marsh is flooded by tides bearing sediments) and marsh location relative to sediment inputs.

Regional analyses, such as the Sea Level Affecting Marsh Migration (SLAMM) models, have been run to assess potential impacts of sea-level rise on Hudson River tidal marshes. This modeling is based on information about marsh vegetation and height, rates of marsh vertical buildup, and other factors, some of which have been measured, while others are estimated. These initial analyses suggest that between now and 2085, Piermont Marsh may convert from irregularly flooded (high) marsh to regularly flooded marsh, and potentially to tidal flats and open water under higher sea-level rise scenarios (Tabak, et al., 2016; NYSERDA, 2014). There is evidence that more salt pannes are developing in the marsh, though the reasons for this are not well understood and may be the result of one or more factors.

Adding to this complexity, the *ClimAID Report* (Rosenzweig, et al., 2011) also projects increased heat, with more frequent and longer heat waves (three or more days at or above 90 °F). Total annual precipitation is expected to increase slightly, but delivered less frequently in heavier rainfall. The report states that even with this slight increase in rainfall, hotter temperatures will drive more evaporation, and drought is likely to increase, especially during warmer months. This in turn, may lead to greater salinity intrusion into the estuary and more saline waters at Piermont. Some species, including *Phragmites*, have a limited tolerance for saline water.

Given the vulnerability of Piermont Marsh and other Hudson River intertidal marshes to sea-level rise and other climate changes, there is a need to closely monitor marsh health and integrity, and to take steps to enhance the structure, function, and resiliency of the marsh for the benefit of fish, wildlife, and public well-being.

Non-Native Invasive Species

Many of the rare species and native plant communities at Piermont Marsh have declined over the past several decades, largely due to the spread of a Eurasian strain of *Phragmites australis*. Since the 1960s, *Phragmites* coverage at Piermont Marsh has increased by nearly 60 percent, in a pattern consistent with the invasive Eurasian strain (Winogrond and Kiviat, 1997). This increase has been accompanied by a corresponding loss of native species. Once established, *Phragmites* shades existing vegetation and hinders the germination and growth of other species (Niedowski, 2000). As a result, complex communities of native plants at Piermont Marsh have been replaced by hyper-dominated stands of *Phragmites*.

As *Phragmites* has replaced native plant communities in the Reserve, it has altered the composition and physical structure of the marsh for fish and wildlife species. By altering the physical environment in the marsh, the expansion of *Phragmites* can result in the decline of wildlife habitat, including that needed to support migratory bird assemblages and native, resident animal species (Raichel, et al., 2003; Shriver, et al., 2004; Guntenspergen and Nordby, 2006; Wells, et al., 2008). Although the positive and negative impacts of *Phragmites* can vary by taxa, species, and life stage (Kiviat, 2010), it has been shown to be detrimental to many of the conservation priorities at the Reserve. For example, *Phragmites* is used as foraging and roosting habitat for various bird species (Kiviat, 2005). However, the breeding activity of marsh-dependent bird species found at the Reserve, such as marsh wren and least bittern, is often lower in *Phragmites* than in other plant communities (Kiviat and Talmage, 2006; Wells, et al., 2008; Kiviat, 2010).

Phragmites proliferation can carry negative social and economic consequences, too. Thick patches of *Phragmites* reduce access for boating, fishing, and bird watching in nearby river areas, and they create potentially serious fire hazards to structures due to the amount of standing dry biomass during the dormant season (Niering and Warren, 1980).

Other non-native invasive species have been documented both within (e.g., purple loosestrife) and around the periphery of the marsh (e.g., Asiatic bittersweet, Japanese knotweed). Although populations of these species have the potential to expand and impact native ecological communities, staff have determined that they do not pose an immediate threat to critical resources within the Reserve.

Visitor Impacts

The north end of Piermont Marsh, especially the area south of the Kroomis Kill that has several shallow ponds or pannes, has been the focus of concentrated study by scientists and students who access it by canoe and informal foot paths. These paths have widened over time and multiplied as the marsh surface has broken down and visitors sought firmer ground. Areas around the pannes have become trampled, with a loss of vegetation cover. Research equipment and markers have been left in place long after projects have been completed. Marsh managers are exploring options to improve researcher access, and are more actively managing research activities in the marsh to protect marsh surface integrity, maintain vegetation, and reduce human impacts on habitat.

Water Quality

Since 2010, the lower Sparkill Creek has been on the Section 303(d) List of Impaired Waters (NYSDEC, 2016). Aquatic life and recreational uses are impaired by pathogens, organic inputs, nutrient enrichment, and toxicity attributed to sewage discharges and urban runoff.

While water quality, nutrient loading, and fecal contamination issues are a concern within the Sparkill Creek, they do not currently pose a significant threat to the marsh. The interior of the marsh is irregularly flooded, so the daily tide cycle only influences the marsh and tidal creek edge to about 60 feet from the closest water source, either Sparkill Creek, other tidal creeks, or the Hudson River. This water is only reaching the interior of the marsh 10-12 times a month (Montalto, et al., 2006). Most of the research linking nutrient enrichment to marsh loss has focused on tidal, low-marsh systems that are frequently flooded (Blum, 1993; Darby and Turner, 2008a; Darby and Turner 2008b; Turner, 2011; Anisfeld and Hill, 2012; and Deegan, et al., 2012). However, recent studies of nutrient enrichment on high-marsh systems with less frequent inundation, lower salinities, and perennial grass and sedge dominance like Piermont Marsh suggest that moderately elevated nutrient levels may not impede the growth of native grasses (Wejrowski, 2013) and, in some cases, may give plants the enhanced ability to tolerate sea-level rise (Langley, et al., 2013).

Erosion

Slump-block erosion has been observed along the Hudson River shoreline of Piermont Marsh. Fresh slump-block undercutting and calving is visible along much of the shoreline. This erosion can occur when the relatively unconsolidated sediments that underlie the vegetative rhizome layer of the marsh are dislocated by hydraulic

turbulence, leaving the rhizome layer above it intact. Eventually, the rhizome layer becomes completely unsupported by the sediments, and blocks of vegetated marsh (still held together by the rhizome and root network) fall into the river. HRNERR staff have compared the morphology and location of the marsh edge over time and found the average rate of erosion between 1926 and 2013 to be approximately 0.5-1 ft/year (B. DeGasperis, pers. comm., July 24, 2015).

Slump block caused by erosion along the Hudson River shoreline of Piermont Marsh (Photo by AKRF, Inc.)

EXISTING CONDITIONS AND MANAGEMENT

PUBLIC ACCESS

Access to the interior of Piermont Marsh is inherently limited by soft soils, tides and intermittently flooded conditions, a network of tidal creeks, and dense vegetation. The tidal creeks and marsh edges are best viewed by canoe or kayak. However, residents and visitors can enjoy close views of Piermont Marsh and its adjacent shallows from several land locations in the Village of Piermont and Tallman Mountain State Park. These access points are described below.

Access to DEC lands at the Piermont Marsh Reserve is via Paradise Avenue and Ferry Road in the Village of Piermont. Parking is available in the Village's parking area on Paradise Avenue, adjacent to the ball field. DEC lands adjoin the south side of Piermont Pier, which extends one mile into the river and provides the northern boundary of the Reserve, although it is not part of it. A DEC parking area at the east end of the pier on the south side of the road provides free parking for 12 vehicles. Parking outside this area is by local permit only. From Piermont Pier, visitors have exceptional views of the marsh, shallows, Hudson River, and Tappan Zee.

Access to PIPC-held uplands adjacent to Piermont Marsh is via a bike and foot trail in Tallman Mountain State Park along the marsh edge. Views of the marsh and the Tappan Zee can be enjoyed from a scenic overlook within the park from the north picnic area. Both Piermont Pier and the bike/foot trail are level, firm ground and generally accessible to people with disabilities. Parking is available near the swimming pool in the park.

The accessibility of state lands within and adjacent to the Piermont Marsh Reserve, including parking areas, interpretive signs, and trails, has not yet been evaluated with respect to compliance with the Americans with Disability Act.

INTERPRETIVE SIGNS

Several years ago, DEC installed a three-sided interpretive kiosk overlooking the marsh on PIPC lands at the east side of the pathway near the swimming pool. Low-profile wayside signs interpreting the marsh were also installed on DEC lands in a small park on Paradise Avenue, although these require frequent cleaning to remain visible. More recently and with the support of the village and a community member, DEC worked with an eagle scout who rebuilt and

Newly installed Fishes of the Hudson River interpretive sign on Ferry Road (Photo by Chris Bowser, DEC)

replaced a *Fishes of the Hudson River* interpretive sign on DEC lands near the dogleg on Ferry Road.

CULTURAL AND HISTORICAL RESOURCES

Little is known about historic sites and cultural artifacts within and adjacent to the marsh. Virtually all PIPC lands within the Reserve are tidal wetlands. DEC lands include a mix of tidal wetlands and upland fill associated with the original construction of the pier and railroad yard. Pilings that remained from an old ferry dock on the south side of the east end of the pier have gradually worn away from storms and ice. Docks that extended across the shallows to the channel south of the pier have similarly been erased with time.

RECREATIONAL USES

Fishing

Angler catching a striped bass along Piermont Pier (Photo by Bonnie K. Aldinger)

The Piermont area offers excellent warm water recreational fishing opportunities that vary seasonally and from year to year, with blue crabs and both marine and estuarine fish present. People typically fish both the shallows adjacent to Piermont Pier at the north end of the Reserve, as well as the deeper waters at the end of pier. The area is notable for striped bass in spring and blue crabs in summer. In dry years, when river water is saltier due to limited freshwater inflow, marine species such as bluefish are occasionally present.

Bird Watching

The Piermont area also offers excellent bird-watching opportunities in and along the marsh and river. Piermont Pier is recognized by the Rockland Audubon Society as a local birding hotspot (http://www.rocklandaudubon.org/HOTSPOTS.htm). Rockland Audubon's website lists a wide variety of resident and migratory songbirds, waterbirds, and birds of prey, as well as migrants, escapees, and other unusual birds by season.

Paddling

The shallows and tidal creeks of Piermont Marsh are best experienced by canoe or kayak, though visitors would do well to avoid low tides when waters can become too shallow to navigate, and soft mudflats are exposed. Canoes and kayaks are available

for rent from a canoe livery located along the Sparkill Creek on Paradise Avenue. Visitors with their own canoes may also park in the DEC lot near the end of Piermont Pier and hand launch from the shoreline.

Hunting and Trapping

Hunting at Piermont Marsh is currently limited to waterfowl in the shallow water areas under DEC and OGS jurisdiction at the northern and southern ends of the Reserve (see Figure 2). Hunting is not allowed in any portion of the Reserve owned by OPRHP. The presence of residential and commercial development adjacent to the north end of the marsh restricts, but not does prohibit, waterfowl hunting over water. Per state regulations, waterfowl hunting with a firearm or bow, over water, is allowed near dwellings or public structures as long as neither are within 500 feet (for a firearm) or 150 feet (for a bow) in the direction of discharge. DEC will facilitate waterfowl hunting access by allowing hunters to use the existing public hand launch for canoes, kayaks, and other appropriate watercraft.

Recreational trapping is not permitted within the Piermont Marsh Reserve.

VISITOR-USE REGULATIONS

Both DEC and OPRHP/PIPC lands are closed during hours of darkness. All regulations on public use of state-owned tidal wetlands apply. Permitted uses at and near the Piermont Marsh Reserve include: nature study, hiking, canoeing, boating, and picnicking at day-use facilities located in adjacent Tallman Mountain State Park, and mountain biking along the Tallman Mountain bike trail. Fishing is permitted, and a valid state fishing license is required to fish on tributaries to the Hudson River. Prohibited activities include: camping, swimming, trapping and operating all-terrain vehicles and motorized personal watercraft including, but not limited to, Jet Skis®, WaveRunners®, Sea-Doos®, wet bikes, and surf jets. As indicated above, hunting is limited to waterfowl and only allowed on the shallow water areas under DEC and OGS jurisdiction. Collection of plants, animals, artifacts or any other materials is strictly controlled and requires one or more state and/or HRNERR permits. A permit is required to conduct research in the marsh. The HRNERR research guidelines and OPRHP research permit application can be found in Appendices B and C, respectively.

EDUCATION ACTIVITIES

Public Education Programs

Piermont Marsh and areas adjacent to Piermont Pier are used for a variety of formal and informal education programs. These include middle and high school field programs on the pier hosted by partners at the Lamont-Doherty Earth Observatory, work in the marsh by the Lamont-Doherty Secondary School Field Research Program (see below), public fishing programs hosted by HRNERR educators and DEC's I Fish NY Program, and public canoe trips offered by DEC.

DEC's I Fish NY Program held at Piermont Pier in 2016 (Photo by Chris Bowser, DEC)

Lamont-Doherty Secondary School Field Research Program

The Lamont-Doherty Secondary School Field Research Program is operated in consultation with the Reserve and PIPC using Piermont Marsh as the main research site. Founded in 2005 by Lamont-Doherty Earth Observatory scientists, this program brings high school teachers and their students together with Lamont-Doherty scientists for six weeks in the summer to do research projects on plants, fish, water quality, soils, and other topics. The program works with teachers and students from several New York City public high schools, including the Young Women's Leadership Schools of East Harlem and Queens and the Urban Assembly New York Harbor School. Participants include a high percentage of typically under-represented groups in science, technology, engineering, and math programs, including women, underserved ethnic groups, and students from a diverse range of economic backgrounds. The program has been successful in attracting students and affirming their interest in science and technical careers.

STEWARDSHIP

Ferdon Pond Dam Eel Ladder

"Eel-evator" being installed on the Ferdon Pond dam (Photo by Chris Bowser, DEC)

HRNERR staff designed and installed a suspended eel ladder for assisting juvenile eels in their passage up the Sparkill Creek from the Hudson River to the watershed. This unique trap-and-pass "eel-evator" was created for use on the Ferdon Pond dam, the first barrier upstream of tidewater. It is small and lightweight and was designed to be safely lifted and lowered from a sturdy walkway at the top of the dam. It will be deployed each spring and removed for the winter, in cooperation with the Village of

Piermont, the Rockland County Division of Environmental Resources, and several volunteer residents.

Pilot *Phragmites* Control

Geotextile installed at Piermont Marsh in 2015 (Photo by Brian DeGasperis, DEC)

Beginning in 2014, the Lamont-Doherty Secondary School Field Research Program undertook a series of pilot *Phragmites* control projects. Students used black geotextile to cover small areas of previously flattened *Phragmites* in the northeast part of the marsh to deprive the plants of sunlight, and in time kill the rhizomes (underground horizontal stems) and roots. It presented an opportunity to study the impacts of this technique on the seed bank, recovery patterns, and sediment surface, among other effects. Marsh managers will work with program leaders to determine how best to advance this project, including duration of the experimental approach, monitoring strategies, and next steps.

RESEARCH AND MONITORING

The National Estuarine Research Reserve System (NERRS) mission specifies that reserves are protected and managed to afford opportunities for long-term research, particularly work that addresses coastal management issues identified as significant. HRNERR seeks to promote federal, state, public, and private use of its sites to conduct estuarine research. The following sections briefly describe recent management-oriented research and monitoring at Piermont Marsh.

Vegetation Mapping

DEC co-produced vegetation maps for all four HRNERR sites in 1991, 1997, and 2005. These were delineated from aerial photographs interpreted for 20 categories of tidal wetland vegetation and field checked. Multiple inventories were conducted so that vegetation change over time could be analyzed. In addition, Piermont Marsh was included as part of a 2007 tidal wetlands inventory (interpreted for 13 vegetation categories) produced for the entire Hudson River estuary. Most recently, vegetation was inventoried at Piermont Marsh in 2014 and 2015 by the New York State Thruway Authority's consultant AKRF, Inc. Two of these ArcGIS maps (Hudson River NERR Vegetation, 2005 and Hudson River Estuary Tidal Wetlands, 2007) are available to the public via the NYS GIS Clearinghouse (http://gis.ny.gov/). Other ArcGIS maps and project reports are available through HRNERR.

Water Quality Monitoring

As part of the NERRS System-Wide Monitoring Program (SWMP), HRNERR staff have collected a time series of water quality parameters (temperature, salinity, total suspended solids, dissolved oxygen, pH) and nutrient concentrations (ammonia, nitrate, phosphate, sulfate, chloride and chlorophyll a) within Piermont Marsh and Sparkill Creek since 1991. The use of standardized instrumentation and protocols for data collection at reserve sites across the country establishes the NERRS as a coordinated network of coastal observation sites for detecting and understanding environmental change.

Surge, Wave, and Tide Hydrodynamics (SWaTH) Network

Following Post-Tropical Cyclone Sandy in 2012, the United States Geological Survey (USGS) began construction of an overland Surge, Wave, and Tide Hydrodynamics (SWaTH) Network along the northeastern Atlantic Coast, from North Carolina to Maine. This network of collaborating partners features the integration of long-term tide gage networks, with real-time rapid-deployment gages and mobile storm-tide sensors. The USGS installed receiving brackets in 2016 north and south of Piermont Pier, co-located with a real-time gage at end of the pier and deployed in a transect of three sensors perpendicular to the shoreline through the marsh. Brackets were surveyed to permit rapid deployment and recovery of instruments and data dissemination in the hours and days immediately after an event. USGS will deploy sensors only during severe nor'easters or tropical cyclones. Sensors installed surrounding the pier will provide information on tidal and wave characteristics, timing and extent of inundation, and interactions with local landforms. In addition, the sensor transect through the marsh will provide information on how vegetation dissipates wave-setup and inform management for community and marsh resiliency.

Sediment-bound Contaminant Resiliency and Response (SCoRR) Network

The USGS Sediment-bound Contaminant Resiliency and Response (SCoRR) Project has been implemented from Maine to Virginia to accomplish the following objectives: 1) develop a strategy to assess sea-level rise and storm-derived changes in contaminant threats to humans and ecosystems; 2) demonstrate the strategy by conducting a pilot implementation in the northeastern U.S.; and 3) deliver interpretive products that map, measure, and evaluate vulnerability from contaminant threats. In response to the potential landfall of Hurricane Joaquin, the SCoRR team collected a baseline sediment core sample from Piermont Marsh adjacent to the swimming pool at Tallman Mountain State Park on October 15, 2015. Samples are being analyzed by four different USGS laboratories, and data will be publicly released through the USGS SCoRR mapper. The SCoRR team plans to collect a comparison sample after the impact of a significant storm surge.

Other Scientific Activity at Piermont Marsh

Many scientists from a wide variety of institutions have used Piermont Marsh as a research site to explore many topics. A bibliography of scientific reports and published work is available from the HRNERR research coordinator. Several scientists have been based at the nearby Lamont-Doherty Earth Observatory and Columbia University. Many graduate and undergraduate student projects related to Piermont Marsh have been fostered and partially supported by HRNERR, including one NERRS Graduate Research Program project and 21 Polgar Fellowship Program projects. The Tibor T. Polgar Fellowship is a student research program by the Hudson River Foundation in cooperation with HRNERR to provide a summertime grant and research funds for eight graduate and undergraduate students to conduct research on the Hudson River. The objectives of the program are to gather important information on all aspects of the Hudson River, with a concentration on the four marshes of HRNERR, including Piermont Marsh. Application information and a complete set of Polgar Fellowship reports can be found at www.hudsonriver.org/?x=polgar.

Scientific Research Permits

DEC and OPRHP instituted a research permit requirement and process for planning work in Piermont Marsh. All researchers are required to obtain a research permit from OPRHP before undertaking work at the Piermont Marsh Reserve. Applications to obtain a research permit are reviewed by OPRHP/PIPC biologists and the HRNERR research coordinator to prioritize space assignments, minimize conflicts among research projects, manage environmental impacts, and ensure compliance of projects with all regulations and standards. The HRNERR research guidelines and OPRHP research permit application can be found in Appendices B and C, respectively.

MANAGEMENT APPROACH

PLANNING PROCESS

DEC and OPRHP staff have collectively developed this plan over the course of two years, following extensive engagement with leaders of the Village of Piermont and Rockland County, residents, and people representing a broad range of environmental, research, and educational interests on the topics of marsh management and the marsh's role in protecting the Village.

Scoping

Following the April 2013 announcement that Piermont Marsh was to be the site of a habitat restoration project focused on enhancing the marsh community, as part of the mitigation for construction of a new Tappan Zee Bridge, village leaders and residents expressed keen interest in the project.

Beginning in summer 2013, DEC and OPRHP staff met with ten different committees and organizations to listen to ideas and concerns about this project. One significant concern was the potential impact of marsh management on storm risk and community resiliency, especially in the wake of Post-Tropical Cyclone Sandy's $20 million of damage to the Village. A second prominent concern centered on the potential human health and ecosystem impacts of herbicide use in proximity to the Village. Other issues were identified as well. Some wished to retain *Phragmites* for its aesthetic value, while others desired a return to historic village views of the marsh that are now blocked by *Phragmites*. Many were concerned that underlying water quality had been a driving factor in the shift from native to non-native vegetation, and that agency budget constraints will preclude long-term maintenance of any restored areas.

Subsequently, four fact-finding meetings were held in 2014-2015 on technical topics to address community questions and inform management planning. Each forum featured invited experts on the meeting topic. Topics included Piermont Marsh habitats and biological diversity (September 30, 2014), water quality and the marsh (November 13, 2014), the marsh's role in providing storm protection for the Village (January 7, 2015), and marsh vegetation management options (May 21, 2015). Meeting summaries and presentations are available at: https://www.hrnerr.org/piermont-marsh/.

Fact-finding meeting held on January 7, 2015 (Photo by Ed McGowan, OPRHP/PIPC)

Goal Setting

The following four goals were established for Piermont Marsh. Development of these goals was heavily informed by extensive public comments, derived from agency missions and policies, and developed to be consistent with the *HRNERR Revised Management Plan*, the Piermont Marsh Significant Coastal Fish and Wildlife Habitat designation, and neighborhood-based recommendations for Piermont Marsh in the Piermont Waterfront Resilience Task Force's Resilience Roadmap (2014).

Goal 1: Maintain or enhance the Piermont Marsh Reserve's ability to provide storm protection for neighboring landowners.

Goal 2: Sustain the presence of native marsh communities and the biological diversity they support.

Goal 3: Promote the structural and functional resiliency of the Piermont Marsh Reserve to storms, sea-level rise, and other disturbances.

Goal 4: Increase scientific knowledge, public understanding, and public use and enjoyment of the marsh.

Plan Development

To achieve these goals, agency staff developed and considered several potential management scenarios through a detailed, multi-step process. Staff reviewed published literature about the marsh and consulted with past and current researchers. They collected new information about marsh habitats, trends, and conditions via field surveys and new vegetation mapping. They reviewed many case studies of habitat restoration and considered the results of sea-level rise and marsh inundation modeling (Tabak, et al., 2016). They also researched and assessed alternative vegetation management approaches.

The result is this draft plan, which is intended to be a conservative, balanced approach to marsh management for the next ten years, one that will yield highly relevant information about the role of *Phragmites* in buffering the southern portion of the Village from waves and storm-borne debris; inform us about how the marsh is keeping up with sea-level rise and how management can foster the long-term survival of the marsh; help restore rich natural communities that support fish and wildlife; and provide a foundation for understanding and appreciating the marsh.

MANAGEMENT OBJECTIVES

The following management objectives fall under the four goals identified by DEC and OPRHP in 2013. These were shaped not only by the significant ecological features, threats, and opportunities at the site, but also by stakeholder interests in the marsh.

Goal 1: Maintain or enhance the Piermont Marsh Reserve's ability to provide storm protection for neighboring landowners.

- *Objective 1.1:* Through 2026, retain at least 85% of the marsh surface (over 200 acres) as an unmanaged vegetative buffer to dissipate wave energy and filter storm debris on the south side of the Village and along the shoreline near Palisades.

- *Objective 1.2:* By 2019, work with the Village and other partners to develop predictive models of climate, coastal, and ecological processes to evaluate alternative marsh management scenarios, especially their impacts on wave attenuation and debris removal.

Goal 2: Sustain the presence of native marsh communities and the biological diversity they support.

- *Objective 2.1:* By 2026, restore native ecological communities on up to 40 acres of brackish tidal marsh.

- *Objective 2.2:* Within the designated restoration area, increase the abundance of marsh specialist birds and marsh breeding birds by 25% over the next five years.

- *Objective 2.3:* Over the next ten years, increase the abundance of larval and juvenile marsh surface fishes by 15% in the designated restoration area.

Goal 3: Promote the structural and functional resiliency of the Piermont Marsh Reserve to storms, sea-level rise, and other disturbances.

- *Objective 3.1:* Over the next ten years, monitor sediment accretion rates in both actively managed and unmanaged areas in the marsh, and identify the range of marsh surface elevations needed in actively managed areas to keep pace with sea-level rise and support target plant communities.

- *Objective 3.2:* Over the next ten years, minimize visitor impacts to the surface of the marsh.

Goal 4: Increase scientific knowledge, public understanding, and public use and enjoyment of the Piermont Marsh Reserve.

- *Objective 4.1:* By 2018, evaluate the Piermont Marsh Reserve's accessibility and compliance with the Americans with Disabilities Act and comparable state legislation, and by 2019 assess the need for and feasibility of developing increased public access for everyone, including people with disabilities.

- *Objective 4.2*: Increase marsh education opportunities by offering public field programs (at least two per year), school programs (number to be determined),

and public presentations (one to two per year), and update and increase public access to information about the marsh.

- *Objective 4.3*: Create new opportunities for citizen engagement in stewardship of Piermont Marsh.

- *Objective 4.4:* Implement a research agenda to increase scientific knowledge about the marsh and generate information pertinent to marsh management.

MANAGEMENT ACTIONS

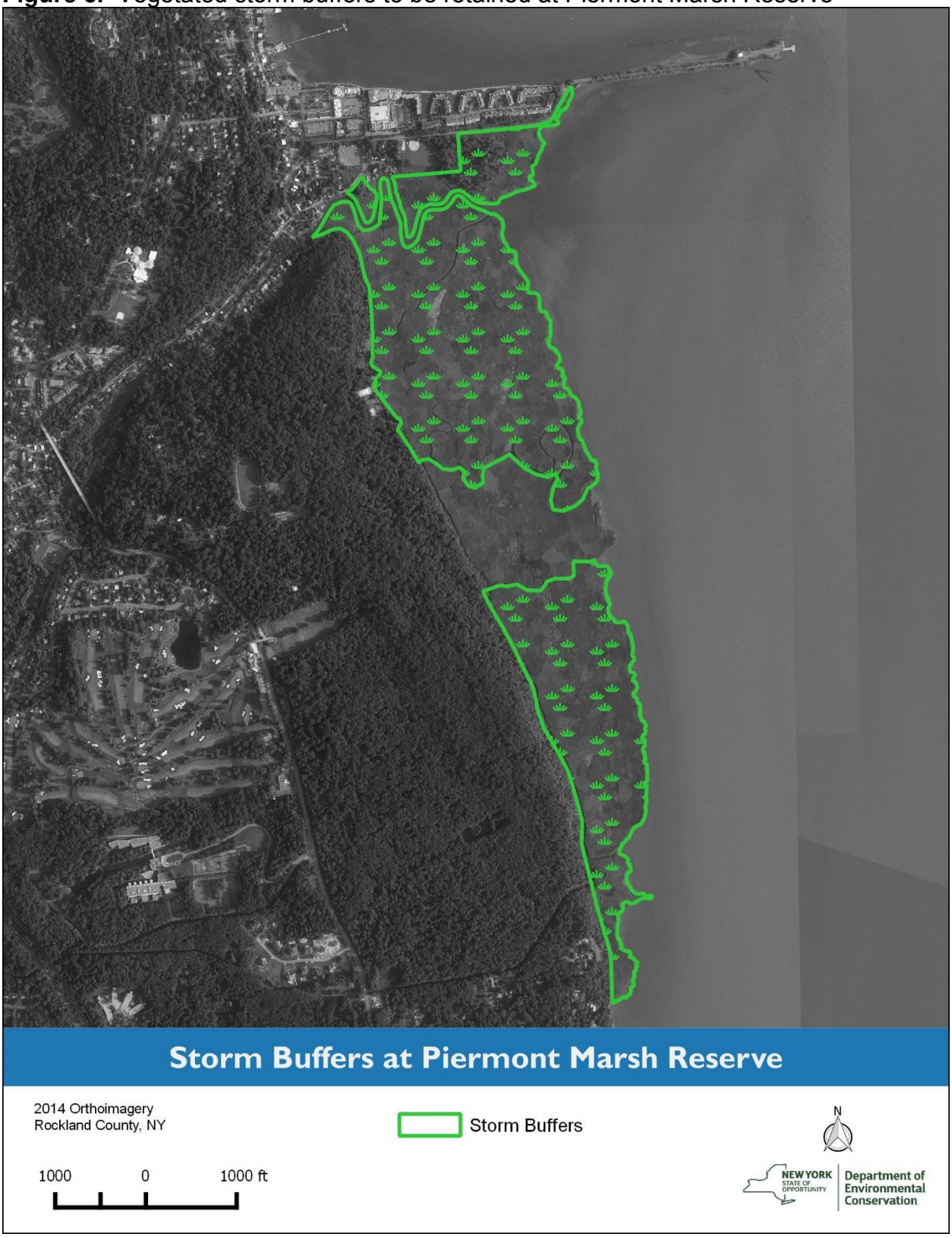
The following sections detail management actions that will enable Piermont Marsh Reserve managers and partners to realize the goals and objectives defined above. We have developed these actions based on the current state of knowledge about the Reserve and an exploration of alternative ways to meet the management objectives. As we implement them, we will monitor to learn about the impacts of these management actions, use the results to update and supplement our knowledge, and adjust management actions accordingly. Our focus will be on learning and adapting, through partnerships of managers, scientists, and other stakeholders who collaborate to create and maintain a sustainable Piermont Marsh.

Goal 1: Maintain or enhance the Piermont Marsh Reserve's ability to provide storm protection for neighboring landowners

Retain Vegetated Storm Buffers
Objective 1.1

For the next ten years, a one-half-mile vegetated buffer will be retained south of the Village of Piermont to maintain Piermont Marsh's storm-buffering capacity for neighboring landowners (Figure 6). This buffer will extend from the Village south to Crumkill Creek. A second large vegetated buffer will be maintained in the southern part of the marsh, from the Sneden's Landing area of Palisades north approximately one-half mile. Together, these vegetated buffers, dominated by *Phragmites*, constitute 85% of the marsh and over 200 acres. Only limited vegetation management, associated with small-scale experimental research, will be permitted in these areas. Protection of these very large buffers is a highly conservative approach pending the results of the collaborative study described in the following section. This study will inform subsequent decisions about the size and composition of the buffers to be maintained long term.

Figure 6. Vegetated storm buffers to be retained at Piermont Marsh Reserve



Evaluate Piermont Marsh's Role in Storm Protection
Objective 1.2

In response to strong community interest, HRNERR worked with a group of partners to develop and fund a three-year collaborative research program to evaluate alternative marsh management scenarios and the coastal protection benefits the marsh provides. The team will develop predictive models of climate, coastal, and ecological processes. These will be used to evaluate how existing and hypothetical marsh management might affect the kinds and degree of storm protection afforded by the marsh for the Village of Piermont. Choices about marsh management scenarios and products will be made in consultation with the Piermont Waterfront Resilience Commission, and information about the project will be shared with the community, also in consultation with the Commission.

The project team includes researchers, marsh managers, and community representatives from the University of Florida, University of Miami, NASA Goddard Institute, United States Geological Survey, Hudson River National Estuarine Research Reserve, Palisades Interstate Park Commission, the Consensus Building Institute, and the Piermont Waterfront Resilience Commission. This project began in November 2016. The research was funded by the National Estuarine Research Reserve System Science Collaborative.

Goal 2: Sustain the presence of native marsh communities and the biological diversity they support

Restore Priority Ecological Communities in Center of Marsh
Objectives 2.1, 2.2, and 2.3

Native Marsh Restoration

A maximum of 40 acres, which represents approximately 15% of the entire marsh, will be restored in three success-dependent phases over the next ten years through a partnership among the New York State Thruway Authority (as partial mitigation for impacts on habitats associated with construction of the Governor Mario M. Cuomo Bridge), DEC, and OPRHP (Figure 7). A detailed implementation plan is being developed to guide the three phases of this project, which will begin with 10 acres in 2018 (Figure 8, Table 4). The restoration area is located in the middle of the marsh, more than one-half mile from both the Village of Piermont and Palisades. This site was selected because it supports existing native plant communities, it is as far as possible from neighboring landowners, and it is mostly surrounded by river or tidal creeks, which are natural barriers to *Phragmites* reinvasion.

Figure 7. Potential restoration area south of Crumkill Creek

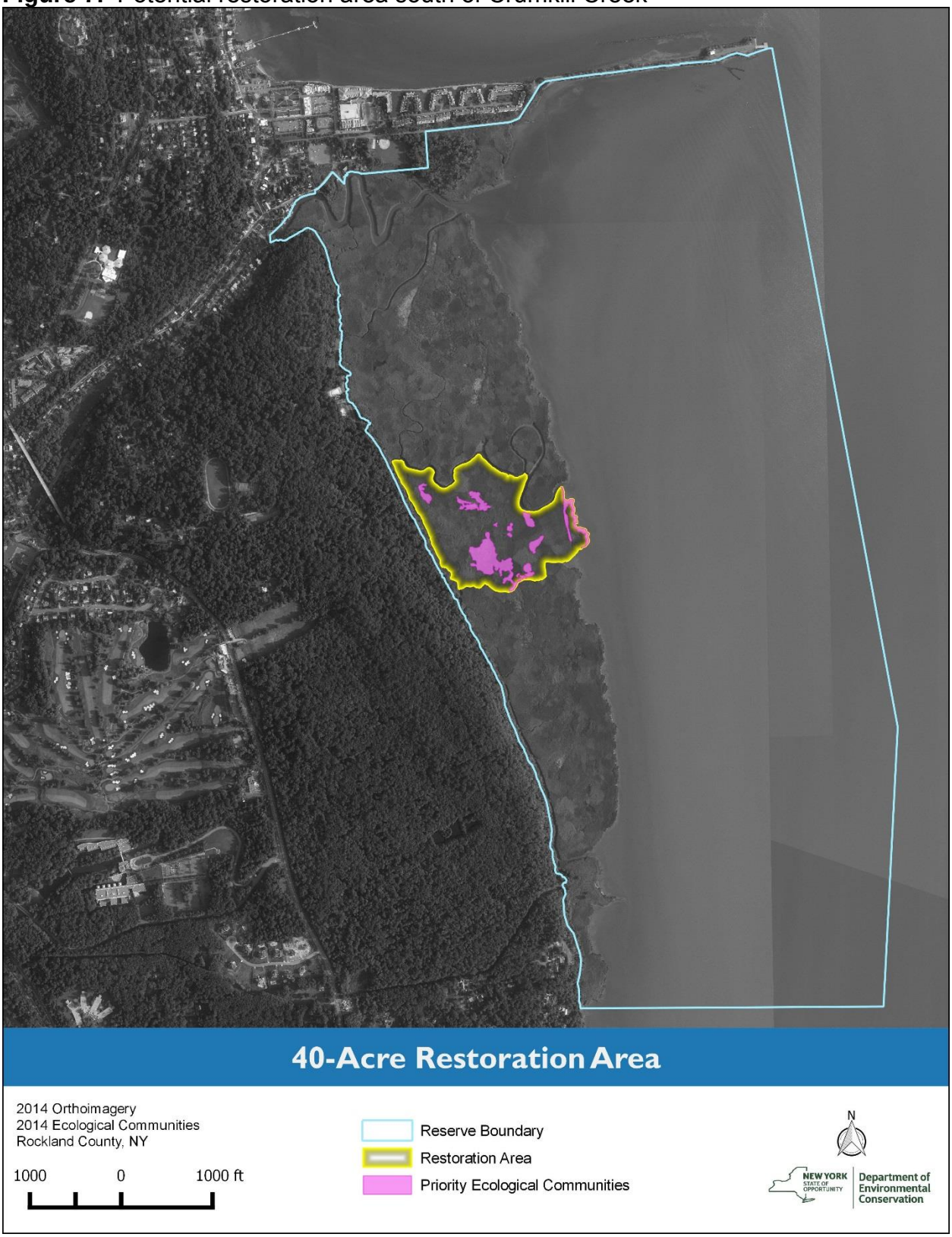


Figure 8. Phased restoration of up to 40 acres south of Crumkill Creek

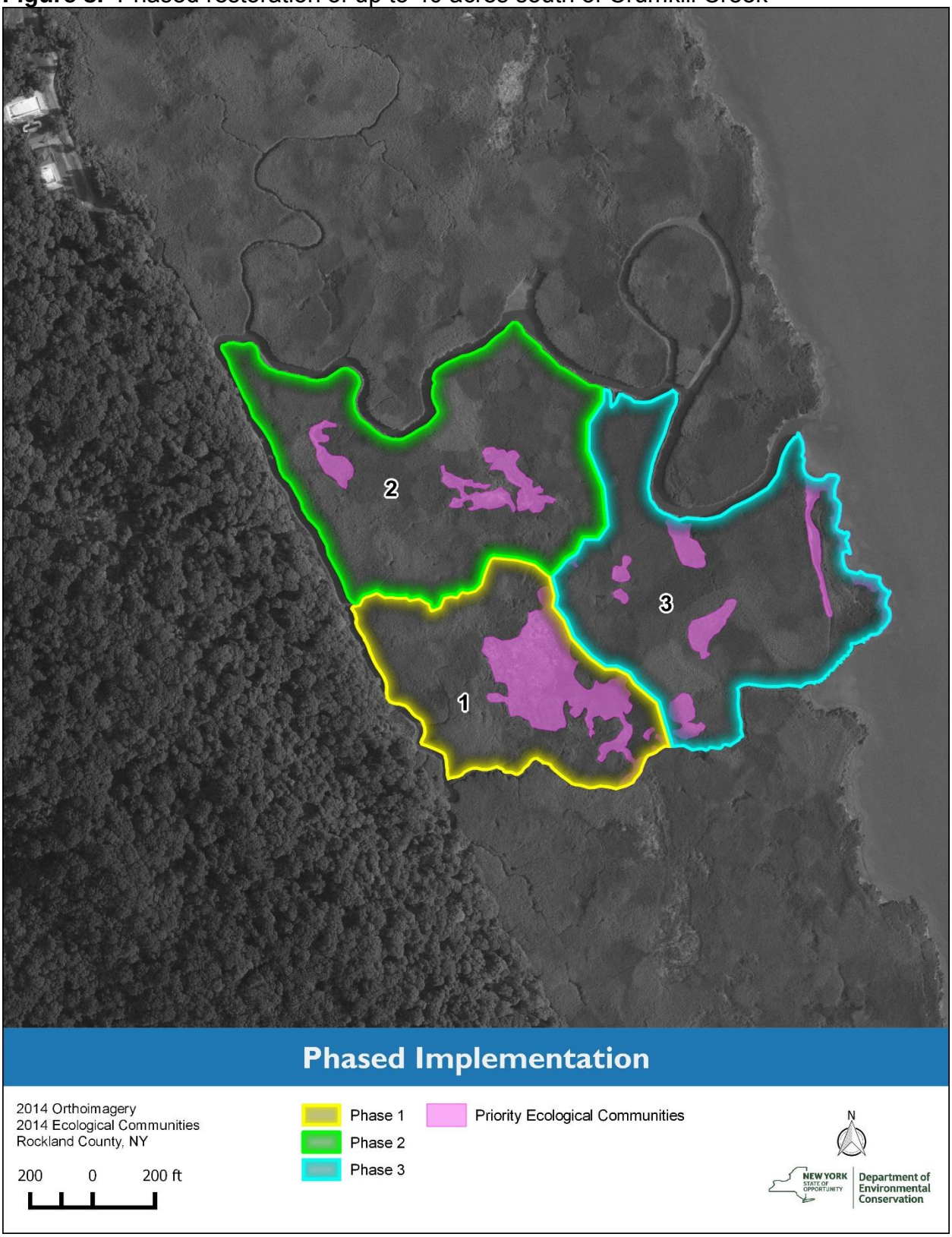


Table 4. Proposed schedule for restoring native marsh communities

Task	Acreage	Schedule
Phase 1	10	2018
Phase 2	15	2021*
Phase 3	15	2024*
Long-Term Maintenance	40	2025 onward

*Movement to the next phase of restoration is contingent upon meeting performance benchmarks established for the previous phase. As such, the schedule for Phases 2 and 3 is subject to change based on the results of post-treatment monitoring.

Native ecological communities currently comprise approximately 12% (five acres) of the restoration area. As is the case marsh-wide, the expansion of *Phragmites* directly threatens the persistence of these existing native communities. Therefore, management actions in this area will focus on restoring and expanding existing priority ecological communities by reducing invasive *Phragmites* cover.

Phragmites control will be achieved using a combination of methods, including mowing, wetland-approved herbicide application, and solarization (covering with geotextile). These techniques have been successfully used to restore desired natural communities, rare plants, and marsh-nesting birds at the Iona Island Reserve, Constitution Marsh, Tivoli Bays, and other tidal marshes in the region. The Piermont Marsh Reserve project will benefit from lessons learned in the past two decades about the timing of treatments, feasibility and efficacy of methods, and restoration of native plants and animals.

When applied according to label instructions and applicable legal requirements using ground-based equipment, herbicide is an approved and highly effective method (True, et al., 2010) for controlling *Phragmites* and the primary tool used by land managers in North America (Hazelton, et al., 2014). While alternative control methods have merit in some contexts, they are not practical or feasible as solitary treatments for managing *Phragmites* in these environmental conditions and at this scale (Kiviat, 2010; Ontario Ministry of Natural Resources, 2011; Findlay, et al., 2014). See Appendix A for an evaluation of *Phragmites* management methods for Piermont Marsh.

During Phase 1, approximately ten acres of *Phragmites* will be controlled using a limited ground-based application of an aquatic formulation of glyphosate in combination with a non-ionic surfactant, which helps the herbicide coat and penetrate the leaf surface so it can be absorbed and transported to the plant roots and rhizomes. Glyphosate is a non-selective, systemic herbicide that controls weeds by inhibiting a specific pathway for amino acid synthesis that is unique to plants and not present in animals. Only certain formulations of glyphosate are registered for aquatic use (e.g., Rodeo®, AquaPro®, Aquamaster®) by the United States Environmental Protection Agency (EPA) and approved for use in New York State. The terrestrial formulations of glyphosate (e.g., Roundup Pro®, Landmaster®, Ranger Pro®) differ from those registered for aquatic use in that they often contain other ingredients that are added to increase their effectiveness. Improper use of terrestrial formulations in aquatic habitat is a violation of state and federal laws.

During the winter preceding the initial herbicide treatment, the Phase 1 site will be mowed to remove the dead standing *Phragmites* stems from the previous growing season. Mowing the site in advance of the herbicide application will improve the efficacy of the chemical treatment by clearly delineating the management area and increasing access to live *Phragmites* stems. Herbicide treatment will take place over 1-3 days in late August through September and only under optimal weather and tidal conditions to minimize non-target impacts. Where *Phragmites* is mixed with native vegetation, herbicide will be applied by a certified pesticide applicator, or someone working under their direct supervision, using a low-volume spot treatment method (e.g., backpack spraying, stem injection, etc.). In areas where *Phragmites* is dominant, herbicide will be applied by a certified pesticide applicator, or someone working under their direct supervision, using a sprayer on a small amphibious vehicle that is capable of driving across the marsh surface. The treatment area will be mowed during the winter following herbicide application to mulch the dead plant material and accelerate the establishment and growth of native plant species. In the years following the initial treatment, low-level maintenance spraying will likely be necessary to address any remaining *Phragmites* or incipient invasions. Geotextile will be installed along the southern boundary of the restoration area to create a barrier to limit *Phragmites* reinvasion from adjacent unmanaged areas. The remaining three sides of the restoration area are bordered by water, which will serve as a natural barrier to *Phragmites* reinvasion.

Restoring native plant communities in the central portion of the marsh while retaining extensive *Phragmites*-dominated buffers to the north and south, will promote a mosaic of habitats across the Reserve to meet multiple goals and objectives. *Phragmites* control will promote the reestablishment of native ecological communities, including brackish tidal marsh, high salt marsh, and low salt marsh. These native communities complement the habitat values and ecosystem services *Phragmites* provides by adding structural and functional complexity to the marsh and serving as important nursery habitat for marsh fish and as foraging, nesting, and migratory stop-over habitat for marsh birds.

Herbicide Monitoring and Data Sharing Program

The aquatic formulation of glyphosate has been reviewed and approved by both the EPA and New York State for use in wetlands, and the treatment area is a significant distance from both the Village of Piermont and Palisades. However, given the community concerns about potential herbicide exposure, DEC and OPRHP will establish an herbicide monitoring and data sharing program to evaluate and document herbicide use and evaluate whether herbicide moves beyond the treatment areas. The program will be developed in close consultation with local representatives, marsh managers, and pesticide regulators. The monitoring will evaluate herbicide levels prior to, during, and after treatment using best available techniques. Information will be posted on a publicly accessible website as soon as analyses are completed.

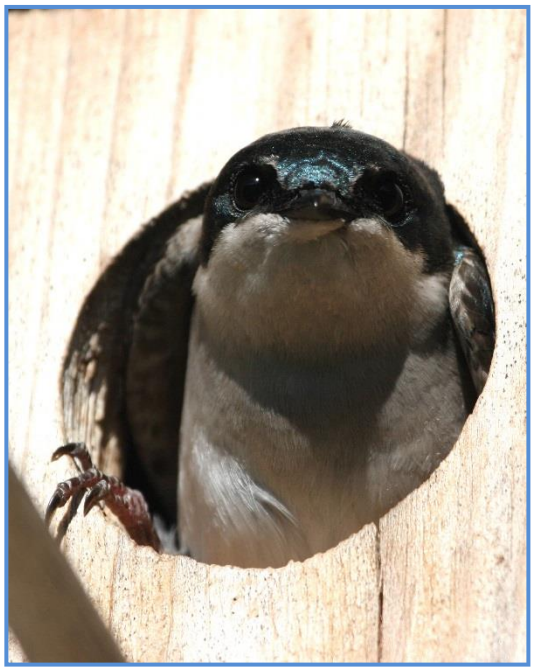
Restoration Monitoring

Extensive pre- and post-treatment monitoring will be conducted according to a detailed monitoring plan to assess native marsh recovery and resiliency, including changes in marsh elevation, biota, sediment accretion, and hydrology. Monitoring data will be used to evaluate progress toward restoration goals and detect and address any issues through an adaptive management process. Performance benchmarks (e.g., achieving ≥ 75% native plant cover) will be used to appropriately time the three phases of the project. Movement to the next phase of restoration will occur only after all established benchmarks for the previous phase have been met. If performance benchmarks are not reached, restoration will not proceed to the next phase, and corrective actions will be taken as needed.

Phases 2 and 3 will each add approximately 15 adjoining acres of restored marsh. Pending a comprehensive evaluation of Phase 1, the proposed methods for implementing and monitoring these subsequent phases are the same as described above.

Install Bird Nest Boxes and Platforms Objective 2.2

For many bird species, the availability of nesting sites is a limiting factor. Where natural nesting sites are in short supply, artificial nest boxes and platforms can provide birds with an alternative. While they cannot fully replace natural nesting sites, artificial nesting structures can enhance wildlife habitat and increase bird densities and diversity. To that end, an osprey nesting platform and nest boxes for purple martins (*Progne subis*) and tree swallows (*Tachycineta bicolor*) will be erected at various locations within the Reserve. Nest boxes will be mapped and monitored to ensure their use by target species. Monitoring is a critical part of a nest box program to avoid promoting the proliferation of non-native species and ensure that boxes are maintained in good condition.



Tree swallow in a nest box
(Photo by Donna Dewhurst, courtesy of USFWS)

Goal 3: Promote the structural and functional resiliency of the Piermont Marsh Reserve to storms, sea-level rise, and other disturbances.

Monitor Marsh Surface Elevation and Rates of Sediment Accretion Objective 3.1

HRNERR staff reading a surface elevation table at Tivoli Bays in Annandale, NY (Photo by DEC)

The HRNERR Research Program will implement monitoring protocols that will qualify Piermont Marsh as a NERRS Sentinel Site for analyzing the impact of sea-level rise on tidal marsh habitat. This national initiative includes the installation of surface elevation tables (SETs) and use of feldspar horizon markers to track changes in the elevation of the marsh surface over time. SET data combined with tidal datums and inundation patterns will show whether sediment accretion in Piermont Marsh is keeping pace with sea-level rise. Additional vegetation data will show whether climate-change stressors are causing shifts in the plant communities. These protocols will be implemented both within the *Phragmites* treatment area and in a reference area that will not be treated to test whether *Phragmites* treatment impacts the marsh's resilience to climate change. The DEC and OPRHP/PIPC restoration team will identify the range of marsh surface elevations needed in actively managed areas to keep pace with sea-level rise.

Reduce Visitor Impacts to Marsh Study Areas Objective 3.2

Piermont Marsh is an excellent venue for conducting marsh research and training young scientists. Several investigators have explored interesting and important topics in the marsh, primarily accessing the sites by canoe and a network of pathways. We previously noted that foot traffic in the marsh has resulted in damage to the marsh surface integrity, particularly in the northern half. To minimize further impacts and to foster marsh recovery, DEC and OPRHP/PIPC will explore options for installing elevated walkways primarily intended to get researchers to and from research sites in consultation with the research community actively using Piermont Marsh. One option is to install permanent walkways along the most intensively used routes and to supplement these with short extensions to less-visited sections of the marsh using footers and moveable decking. For any of these improvements we will seek to minimize impact; all will require a tidal wetlands permit prior to construction.

Goal 4: Increase scientific knowledge, public understanding, and public use and enjoyment of the Piermont Marsh Reserve.

Explore Opportunities to Enhance Public Access
Objective 4.1

DEC and OPRHP access experts will evaluate the site's accessibility and compliance with the federal and state legislation (e.g., Americans with Disabilities Act) and assess opportunities to enhance access for everyone, including people with disabilities.

Several residents expressed interest in having a boardwalk to view portions of the marsh interior, and others recommended that a boardwalk be built on DEC lands north of Sparkill Creek. We took a close look at this idea and met with both the mayor and area educators to walk the site and explore the desirability and usability of such a trail/boardwalk. The proposed route would begin at Rittenberg Field and follow along the Sparkill Creek before looping north to rejoin Ferry Road near the dogleg. It would cross the old landfill, which has refuse and debris emerging at the surface, and tidal wetlands along the east side. Unless the trail is routed directly along the shoreline, *Phragmites* would significantly limit visibility. The route was evaluated based on whether it would substantially add to the waterfront access already present in the village, augment opportunities for education about the marsh, and/or likely be used by residents, visitors, or educators. Given Piermont's remarkable waterfront access for pedestrians and several areas that currently serve as outdoor classrooms, we determined that this new trail/boardwalk route did not generate any significantly novel opportunities for access. We also considered installation and maintenance challenges, particularly routing over the landfill and repairing after storm damage, before ruling out this option.

DEC and OPRHP/PIPC recognize that opportunities to experience the marsh interior are currently limited. We will explore a potential route for a marsh boardwalk in another part of the marsh in consultation with the village and interested residents. Any future construction will need to be consistent with tidal wetlands regulations, stewardship of the marsh, accessibility needs, and the agencies' ability to provide maintenance.

Increase Marsh Education Opportunities
Objective 4.2

Interpretive Information

DEC will update interpretive information about the marsh and explore ways to make this information available online, on site, and through other avenues, potentially local partnerships.

School and Public Programs

In 2016, HRNERR expanded existing and developed new education opportunities at Piermont Marsh and in the adjacent community. HRNERR staff will continue to consult with local organizations and individuals to explore education programs that will meet local needs and be sustainable over the long term. Programmatically, this will include a modest but consistent number of school and public offerings implemented directly by DEC education staff, as well as additional support for regular programming by local partners.

Public canoe program held at Piermont Marsh in 2016 (Photo by Chris Bowser, DEC)

Public Forums on Science in the Marsh

HRNERR, working with partners, will organize periodic presentations about current research on marsh buffers and other topics, and on the marsh restoration project, showcasing interesting, important, and unusual findings. We anticipate these will take place once or twice a year, depending on local interest.

Create Opportunities for Citizen Engagement in Stewardship Objective 4.3

Citizen Science

The Ferdon Pond dam eel ladder will be installed each spring and removed before winter, assuming it passes eels and retains needed community support. Community and student volunteers, under the supervision of DEC staff in partnership with the Rockland County Division of Environmental Resources, will count eels trapped in the eel ladder on their migration from the Sargasso Sea to freshwater habitats, and pass them upstream, where they will grow to adulthood.

Installation and Monitoring of Nest Boxes and Platforms

Volunteer partners from local communities and/or members of the Palisades Interstate Park League of Naturalists, will be sought to build and monitor nest boxes for selected birds in and adjacent to the marsh, in coordination with OPRHP and DEC. Monitoring data will be collected by volunteers and retained in a long-term database.

Coastal Cleanups

DEC will seek partners, such as Keep Rockland Beautiful, to host or co-host periodic marsh and shoreline cleanups to remove marine debris that may be hazardous to wildlife and/or a potential source of pollution.

Marine debris deposited in Piermont Marsh during Post-Tropical Cyclone Sandy (Photo by Sarah Fernald, DEC)

Increase Scientific Knowledge about Piermont Marsh Objective 4.4

In addition to the ongoing research and monitoring described in the "Existing Conditions and Management" chapter, DEC and OPRHP will advance research about the Piermont Marsh Reserve in several ways, including: 1) implementing priority research projects; 2) fostering and tracking other scientific research; and 3) promoting funding for and attention to other priority management information needs. A research permit system exists and will be used to track research projects, reduce visitor impacts, and provide a vehicle for sharing information among researchers and with the public.

The following research priorities and information needs were identified during the fact-finding and management planning processes by agency staff, community members, and a team of local scientists at the Lamont-Doherty Earth Observatory.

Research Priorities

In addition to the habitat restoration and sentinel site monitoring described above, the following projects will inform adaptive management actions in the Piermont Marsh Reserve.

Investigate options for minimizing marsh edge erosion and promoting lateral accretion

Tidal marshes can experience significant land loss through erosion and retreat of their perimeter edges. As waves intercept the marsh edge, they can dislodge sediment and remove pieces of marsh, leading to a lateral retreat of the edge and loss of marsh area. Sea-level rise is predicted to cause more rapid erosion of marsh boundaries due to increases in water depth and wave heights. The installation of sills, artificial reefs, protective breakwaters or other subtidal structures could potentially protect the marsh edge and promote lateral accretion. However, it is unknown how these nearshore structures would affect the movement of intertidal organisms and impact natural processes (e.g., sediment transport).

Investigate the feasibility and impacts of management approaches needed for the marsh to keep pace with accelerating sea-level rise

Sediment accretion rates at Piermont Marsh are currently keeping pace with sea-level rise. However, if rates of sea-level rise eventually exceed sediment accretion rates, additional management measures, such as thin-layer sediment addition, may help ensure long-term persistence of the marsh. Prominent examples of wetland restoration sites that have incorporated thin-layer sediment additions from dredge spoil include Gateway National Recreation Area (New York City), several National Wildlife Refuges in Rhode Island, San Francisco Bay, and numerous sites along the Mississippi River Delta region of Louisiana (Schrift, et al., 2008).

Investigate the impact of Piermont Pier on sediment accretion and wave energy in Piermont Marsh.

The Piermont Waterfront Resilience Task Force recommended an evaluation of the benefits of the pier's current and potential uses and hydrologic impacts on Piermont Marsh, as part of an assessment of the costs and benefits of long-term maintenance of the pier. Since the pier likely plays an important role in the marsh's persistence, this topic is included as a research priority.

Investigate elevating the large wrack piles deposited by Post-Tropical Cyclone Sandy to enhance the marsh's ability to provide storm protection for the village.

The areas where large amounts of wrack were deposited during Post-Tropical Cyclone Sandy remain elevated above the rest of the marsh surface. These areas could potentially be augmented to support robust plant species (e.g., woody shrubs) and enhance the marsh's ability to provide storm protection for neighboring landowners. However, the long-term stability of these wrack piles is unknown. These wrack piles are also currently supporting a diverse assemblage of native plants, including some rare and uncommon species.

Other Information Needs

The following research needs were identified during the management planning process to address critical knowledge gaps about the marsh and inform future management decisions. These needs will be addressed with the assistance of (or by) research partners and collaborators, as time and resources allow.

Plants and Wildlife

- ***Investigate least bittern distribution, abundance, productivity, and habitat requirements***. The least bittern is the smallest member of the heron family in North America. Least bitterns occur in freshwater and brackish marshes with tall, dense emergent vegetation such as cattails, sedges, and rushes interspersed with woody shrubs and open water. Recent surveys of Piermont Marsh have documented at

least one breeding pair of least bitterns in 2009, 2010, and 2013. The U.S. Fish and Wildlife Service considers the least bittern to be a “Bird of Conservation Concern” (USFWS 2008), and it is a threatened species in New York State. In New York, declines in the Hudson River least bittern population have been documented over the last 20 years except at certain sites where management of invasive plants, such as *Phragmites* and purple loosestrife, has occurred (NYNHP, 2009). A national effort is underway to survey secretive marsh bird species, including least bittern, with a goal to estimate the population status and long-term trends.

- ***Study the impacts of Canada geese on smooth cordgrass growth and productivity***. Recent surveys of the Piermont Marsh shoreline have documented significant grazing on smooth cordgrass. The herbivory appears to be correlated with an increase in Canada goose foraging and nesting activity in the area. Smooth cordgrass is a foundational species in the lower intertidal zone and helps stabilize and protect the marsh edge from erosion.

- ***Develop genetic markers which can be used to identify New England bulrush (Bolboschoenus novae-angliae) from tissue samples***. This species historically occurred along the creeks and ditches throughout Piermont Marsh but has not been documented since 1984. New England bulrush is found in brackish marshes along tidal creeks and rivers. This species is probably of hybrid origin because its characteristics and habitat preferences are intermediate between the freshwater species river bulrush (*Bolboschoenus fluviatilis*) and the salt water species sturdy bulrush (*Bolboschoenus robustus); Flora of North America*, 2002; NYNHP, 2010). Without flowers or fruits, it is not currently possible to differentiate it from the other co-occurring species of *Bolboschoenus*. New England bulrush is endangered in New York State because of its extreme rarity (fewer than five remaining populations) and vulnerability to extirpation. The remaining populations of this species are particularly vulnerable to *Phragmites* invasion.

New England bulrush
(Photo by Ed McGowan, OPRHP/PIPC)

- ***Investigate habitat requirements of New England bulrush***. See rationale above.

- ***Study diamondback terrapin distribution, abundance, productivity, and habitat requirements***. The diamondback terrapin is locally uncommon and the only species of turtle in North America that spends its life in brackish water. They inhabit marshes that border quiet salt or brackish tidal waters and can also be found in mudflats, shallow bays, coves, and tidal estuaries. Adjacent sandy, dry upland areas are required for nesting. Anecdotal observations suggest that diamondback terrapin are using habitats on and around the pier. This species was nearly wiped out by

gourmet consumption around the turn of the 20th century. The loss of salt marsh habitat and sandy nesting habitat continues to threaten this species.

- ***Investigate feasibility and sustainability of creating nesting islands for diamondback terrapin***. See rationale above.

- ***Conduct field surveys to characterize uncommon ecological communities***. Additional data is needed to characterize the flora and fauna of uncommon ecological communities at the Piermont Marsh Reserve. In particular, more information is needed on the biological composition and environmental features of the red maple–sweetgum swamp, floodplain forest, brackish intertidal marsh, and brackish tidal creek (as a variant of Saltwater Tidal Creek) communities.

- ***Characterize benthic aquatic and infaunal invertebrate communities***. Little is known about the invertebrate communities within the tidal channels and marsh sediments at the Reserve. Benthic invertebrates are essential members of estuary food webs and play a critical role in nutrient cycling and sediment bioturbation. Within the Reserve, they are likely to be important as both prey to higher consumers, such as fish within the tidal channels, and as contributors to nutrient cycling and detrital processing within sediments.

Ecosystem Services

- ***Develop ecosystem nutrient budgets for carbon, nitrogen, and phosphorus***. Marshes have a significant impact on the fluxes of nutrients between land and estuary. Marsh nutrient dynamics are influenced by a variety of factors including hydroperiod, salinity, microbial populations, invertebrate communities, and dominant vegetation. For example, *Phragmites*-dominated marshes effectively capture and sequester carbon and also tend to accumulate greater nitrogen in leaves and pore water than comparative marshes dominated by native species. Developing a detailed nutrient budget will allow us to better understand the ecosystem services currently provided by the marsh to the estuary and how these may change due to management actions.

ADMINISTRATION and BUDGET

ADMINISTRATIVE FRAMEWORK

Administration of the Piermont Marsh Reserve and execution of this management plan will be accomplished through a multi-agency collaboration. The Tallman Mountain State Park manager, the PIPC science director, the OPRHP natural resources steward for the Palisades region, and HRNERR manager, HRNERR research coordinator, and DEC habitat restoration biologist will function as a management team and coordinate as needed on all aspects of the management plan.

Table 5 provides a list of annual operation and management actions that will be implemented by staff of the identified agency. Table 6 provides a schedule for non-annual restoration, stewardship, and management activities by year, with cost and funding source identified.

TEN-YEAR SCHEDULE OF MANAGEMENT ACTIONS AND BUDGET

The following tables outline a schedule for the implementation of proposed management actions and their projected costs.

Table 5. Annual Operations Activities, 2017-2026

Activity	Cost or Effort	Lead Agency
Maintain 12-car parking area on Piermont Pier.	2 staff days	DEC
Conduct Reserve education programs.	6 staff days	HRNERR
Coordinate research permits.	4 staff days	HRNERR & OPRHP/PIPC
Monitor Ferdon Pond dam eel ladder & engage citizen scientists.	12 staff days	HRNERR
Monitor marsh elevation.	6 staff days	HRNERR
Maintain wayside exhibits at pocket park.	1 staff day	HRNERR

Table 6. Schedule of Management Actions, 2017-2026

Schedule of Additional Management Actions	Estimated Cost and Staff Effort*	Lead Agency
2017		
Facilitate three-year collaborative study to evaluate marsh's role in storm protection.	10 staff days	HRNERR project team

2018		
Facilitate three-year collaborative study to evaluate marsh's role in storm protection.	10 staff days	HRNERR project team
Finalize restoration monitoring plan. Conduct pre-restoration monitoring in Phase 1 treatment and reference areas.	$50,000 20 staff days	DEC
Install permanent sediment elevation tables in restoration and reference areas. Install boardwalk platforms to access HRNERR Sentinel Site infrastructure.	$17,510 20 staff days	DEC
Initiate Phase 1 10-acre habitat restoration. Mow untreated *Phragmites* at Phase 1 site during winter preceding the initial herbicide application. Also mow treated *Phragmites* at Phase 1 site during winter following herbicide application.	$20,000 8 staff days	DEC
Construct and install nest boxes and osprey platform.	$750 6 staff days	OPRHP/PIPC
Conduct accessibility review of access and interpretive facilities and features.	6 staff days	DEC
Identify priority routes for research access and assess alternate designs for elevated walkways. Seek permits and funding for walkway design.	5 staff days	DEC
2019		
Facilitate three-year collaborative study to evaluate marsh's role in storm protection.	10 staff days	HRNERR project team
Monitor Phase 1 restoration and reference areas. Spot-treat remaining *Phragmites* at Phase 1 site.	$53,000 20 staff days	DEC
Explore feasibility and impact of a publicly, accessible marsh boardwalk.	10 staff days	DEC
Bid contract for installation of elevated walkways for research, if permit and funding are received.	10 staff days	DEC
2020		
Monitor Phase 1 restoration and reference areas. Spot-treat *Phragmites* at Phase 1 site as necessary. If performance benchmarks for Phase 1 are being met, conduct pre-restoration monitoring in Phase 2 treatment and reference areas.	$72,000 20 staff days	DEC
Install elevated research walkways.	$100,000 20 staff days	DEC
2021		
Monitor Phase 1 restoration and reference areas. Spot-treat *Phragmites* at Phase 1 site as necessary. If performance benchmarks for Phase 1 are met, initiate Phase 2 15-acre habitat restoration. Mow untreated *Phragmites* at Phase 2 site during winter preceding the initial herbicide application. Also mow	$72,000 22 staff days	DEC

treated *Phragmites* at Phase 2 site during winter following herbicide application.		
2022		
Monitor Phase 1 and 2 restoration and reference areas. Spot-treat *Phragmites* at Phase 1 and 2 sites as necessary.	$85,000 22 staff days	DEC
2023		
Monitor Phase 1 and 2 restoration and reference areas. Spot-treat *Phragmites* at Phase 1 and 2 sites as necessary. If performance benchmarks for previous phases are being met, conduct pre-restoration monitoring in Phase 3 treatment and reference areas.	$110,000 25 staff days	DEC
2024		
Monitor Phase 1 and 2 restoration and reference areas. Spot-treat *Phragmites* at Phase 1 and 2 sites as necessary. If performance benchmarks for Phases 1 and 2 are met, initiate Phase 3 15-acre habitat restoration. Mow untreated *Phragmites* at Phase 3 site during winter preceding the initial herbicide application. Also mow treated *Phragmites* at Phase 3 site during winter following herbicide application.	$95,000 25 staff days	DEC
2025		
Monitor Phase 1, 2, and 3 restoration and reference areas. Spot-treat *Phragmites* at Phase 1, 2, and 3 sites as necessary.	$87,000 20 staff days	DEC
2026		
Monitor Phase 1, 2, and 3 restoration and reference areas. Spot-treat *Phragmites* at Phase 1, 2, and 3 sites as necessary.	$87,000 20 staff days	DEC

*****All estimates of cost and staff effort are preliminary and will be refined once the restoration monitoring plan is finalized.

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APPENDIX A: Evaluation of *Phragmites* Management Methods for Piermont Marsh

Method	Description	Pros	Cons	Considerations for Piermont Marsh	References
Burning	Prescribed fire is used to remove above-ground biomass during the growing season and/or dead plant material during the dormant season.	Effectively removes dead plant material and prevents the spreading of plant fragments and seeds to other areas. Increases light availability for native plant species and facilitates native plant recruitment. Can be applied to large areas.	Ineffective as a single control strategy because rhizomes are rarely impacted. Most effective when coupled with hydrologic restoration or herbicide application. Can stimulate *Phragmites* expansion. Non-selective and can negatively impact native plant and wildlife species. Implementation is limited by the season, and fuel and weather conditions. Safety risks associated with an escaped fire and smoke inhalation.	Fire containment and short-term air quality concerns near developed areas. Removal of dead plant material may deplete wave-attenuation functions.	1, 3, 5, 6, 7

Mowing	Mechanical cutting is used to reduce above-ground biomass during the growing season and/or mulch dead plant material during the dormant season.	Effectively removes dead plant material. Increases light availability for native plant species and facilitates native plant recruitment.	Ineffective as a single control strategy because rhizomes are rarely impacted. Most effective when coupled with water-level manipulation or herbicide application. Must be repeated several times a year. Can stimulate *Phragmites* growth. Labor intensive. Frequent use of mowing equipment can cause compaction and leveling of the marsh surface. Equipment can spread plant fragments and/or seed to other areas. Must be continued in perpetuity unless below-ground biomass is addressed.	Frequency of treatment can limit recovery of native species and marsh functions, including wave and surge attenuation.	1, 2, 3, 5, 6, 7

Ditching/ Dredging/ Physical Barriers	Physical barriers are created to slow or prevent the expansion of *Phragmites* stands. Can be used to increase inundation while simultaneously removing rhizomes.	Can effectively contain *Phragmites* in discrete areas. Can increase habitat and structural diversity.	Large-scale dredging to remove rhizomes and lower marsh surface may threaten marsh resilience to sea-level rise and climate change. Wetland regulations usually prohibit excavation in tidal marshes. May inadvertently spread rhizome fragments. Can potentially destabilize the marsh surface. Does not facilitate native species recovery in currently invaded areas. Costly to remove excavated material from the site.	Altering the marsh surface could exacerbate interior ponding and increase erosion. May negatively impact wave and surge attenuation.	3, 7
Flooding (water-level manipulation)	Water levels in a marsh are raised to drown *Phragmites*. Surface water levels must be maintained at a minimum depth of six inches for a minimum of one year. Effectiveness of this method is increased if plants are cut prior to flooding.	Periodically increasing water levels can effectively prevent reinvasion. Potential benefits for waterbirds and fish.	Non-selective and can negatively impact native plant and wildlife species. Can negatively impact soils and marsh functions, including wave and surge attenuation. Wetland regulations usually prohibit construction of an impoundment in a tidal wetland	Contingent upon impoundments that enable water-level manipulation; unlikely to be feasible in this setting. More effective in higher salinity waters.	3, 5, 6, 7

Solarization (cover, black plastic)	Black plastic or geotextile is used to cover areas of cut or flattened *Phragmites*. Soils must reach minimum temperatures to effectively kill rhizomes.	Effective for treating recent, small-scale invasions. Does not require special equipment or machinery. Can be implemented by volunteers.	Labor intensive. Limited to small stands. Requires several years to successfully kill plants, during which time ecosystem services and marsh functions are compromised. Can kill the native seedbank and soil biota. Non-selective and can negatively impact native plant and wildlife species.	Only practical for very small-scale control projects. Local projects have incorporated use of herbicide to increase effectiveness.	3, 5, 7
Grazing (livestock)	Livestock are contained within treatment areas to graze on *Phragmites*, thereby reducing above-ground biomass.	Does not require the use of heavy machinery. Above-ground biomass is consumed, making the removal of plant material from the marsh unnecessary.	Ineffective as a single control strategy because rhizomes are rarely impacted. Livestock may preferentially feed on native marsh plants. Trampling by livestock can prevent native plant recovery and destabilize the marsh surface. Livestock can spread seeds and plant fragments to other areas. Must be continued in perpetuity unless below-ground biomass is addressed.	Not recommended for soft sediment marshes due to health concerns for animals and potential impacts to the marsh surface. Livestock management would be labor intensive in a tidal wetland environment. Not recommended for tidal wetlands where nutrients released by grazers can be directly transported to surface waters.	1, 3, 4, 7, 8

Herbicide	Wetland-formulated herbicide is applied to growing plants to kill above- and below-ground biomass.	Effective on both above- and below-ground portions of the plant. Requires limited use of heavy machinery. Application method can be tailored to avoid non-target species. Limited impacts to marsh surface. Practical for small and large-scale projects.	Human health and environmental concerns over toxicity of glyphosate and additives to improve herbicide effectiveness. Periodic follow-up treatments may be necessary. Non-selective and can negatively impact native plant species, depending on application method.	Successfully used to manage *Phragmites* in other Hudson River tidal marshes.	1, 2, 3, 5, 6, 7
Biocontrol	Intentional introduction of natural predators or grazers to reduce invasive species abundance.	Minimal cost and labor beyond initial release of biocontrol agent.	Potential for newly introduced species to negatively impact native flora and fauna.	Biocontrols for *Phragmites* are not approved in New York State.	1, 3, 5, 7, 9

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APPENDIX B: Hudson River National Estuarine Research Reserve Research Guidelines

Updated November 30, 2017

These guidelines apply to all research activities involving utilization of the HRNERR component sites (Piermont Marsh, Iona Island, Tivoli Bays, Stockport Flats). Research Guidelines apply to class and group projects as well as to individual investigators.

- All researchers are required to obtain a research permit before working in a HRNERR component site (see table for site specific application information).

- Strict adherence to all permit conditions is required by the permitting agency.

- Please submit your application package THREE MONTHS before your anticipated start date to the Permit Contact and copy the HRNERR Research Coordinator (Sarah Fernald: 845-889-4745 x111; sarah.fernald@dec.ny.gov) and the appropriate Facility Manager (see table) in order to ensure that there will be no overlapping activities within each HRNERR component site.

HRNERR Site	Permit Title	Permit Agency	Permit Contact	Facility Manager
Piermont Marsh	Scientific Research Application and Permit	NYS Office of Parks Recreation and Historic Preservation	Jesse Jaycox (Jesse.Jaycox@ parks.ny.gov)	Clark Alexandre (Clark.Alexandre @parks.ny.gov)
Iona Island	Scientific Research Application and Permit	NYS Office of Parks Recreation and Historic Preservation	Ed McGowan (Edwin.McGowan@ parks.ny.gov)	Elizabeth OLoughlin (Elizabeth.Oloughlin @parks.ny.gov)
Tivoli Bays	Temporary Revocable Permit	NYS Department of Environmental Conservation	Nathan Ermer (Nathan.Ermer@ dec.ny.gov)	Nathan Ermer (Nathan.Ermer@ dec.ny.gov)
Stockport Flats	Temporary Revocable Permit	NYS Department of Environmental Conservation	Region 4 Natural Resources Supervisor	Reserve Manager

- Additional permits from the NYSDEC or USFWS may be required for certain types of work. This may include, but is not limited to, work on listed species and the collection and possession of wildlife. Please submit documentation of all required state and federal permits to the Permit Contact and HRNERR Research Coordinator. All required permits must be in hand prior to initiating work.

- In the Research Methodologies section of the application, please describe what steps will be taken to minimize non-target impacts from site access/foot traffic to sensitive natural resources of the tidal marsh surface.

- For projects lasting more than one year, a new research application must be submitted annually to the appropriate agency. Please copy the HRNERR Research Coordinator and the appropriate Permit Contact and Facility Manager (see table) on your annual submissions.

- Researcher(s) or their representatives are to notify the HRNERR Research Coordinator and the appropriate Facility Manager (see table) of specific study dates at least one week prior to site access to ensure there will be no conflicting activities on those dates.

- All field equipment (traps, measuring devices, etc.) left in the field must be labeled with the Principal Investigator's name, date of installation, and the research permit number.

- Superfluous plot markers and unused equipment must be removed from study sites annually.

- Annual progress reports must be provided to the Permit Contact, the HRNERR Research Coordinator and the appropriate Facility Manager (see table) by December 31st of each study year. Please also include a GIS shapefile of all study site locations.

- Research shall be used for scientific or interpretive purposes only, be dedicated to the public benefit, and not be used for commercial purposes.

- The use of HRNERR component sites or facilities should be acknowledged in any publication resulting from work done at HRNERR component sites.

- Failure to comply with any element of the Research Guidelines may be grounds for rejection of subsequent research applications and/or immediate termination of the project.

APPENDIX C: New York State Office of Parks, Recreation and Historic Preservation Scientific Research Application and Permit

FOR DEPARTMENT USE ONLY	
APPLICATION NO.	DATE RECEIVED
REGION	PERMIT TYPE

New York State Office of Parks, Recreation and Historic Preservation

☐ **NEW** (Complete sections A-D)
☐ **RENEWAL/MODIFICATION** (Complete Section A-D where appropriate)
☐ **FINAL and/or INTERIM REPORT** (Complete Section E)

SCIENTIFIC RESEARCH APPLICATION AND PERMIT

Instructions: Please type or print. Attach additional information as necessary. Indicate fields not applicable with N/A. Electronic signatures are acceptable. Send application to the appropriate contact.

Section A - Applicant Information

1. **Principal Investigator** (*Last-First-Middle initial*)

2. **Mailing Address** | **Telephone**
Fax
Email

3. **Affiliation** *(Graduate students, include name & phone number of major professor.)*

4. **Names of Field Assistants**

5. **Project Title**

Section B – Project Information

6. **Park and Project Location** (*Include site names with GPS coordinates when applicable and/or attach map.*)

7. **Research Purpose and Methodologies** (*Include objectives, design, methods, equipment & materials, and any collection or disposition of specimens as well as proof of other required permits, if any.*) Attach research proposal if necessary.

Section C – Time Frame

8. **Time Frame** (*start and end dates, including project scoping and clean up*)

Section D – Project Relationships

9. **Project's Relationship to Other Research Projects** *(Note whether related projects are in or near State Parks.)*

Section E – Final Report

10. **Project Report** *(Provide a copy of the final research report when it becomes available. Submittal of interim reports is encouraged.)*

Anticipated date of Final Report:

Attached report(s) and provide comments as deemed necessary:

SCIENTIFIC RESEARCH PERMIT

Standard Conditions and Restrictions:

It is the intention of the NYS OPRHP to further scientific research within the areas administered by it, and to cooperate with authorized workers to the fullest extent compatible with its charge to protect all species of flora and fauna and all soil and geologic material in a natural state insofar as possible.

1. Except for the resources indicated in the permit, the taking or disturbing of resources (including cultural or archaeological materials) is specifically prohibited.
2. Research shall be used for scientific or interpretive purposes only, be dedicated to the public benefit, and not be used for commercial purposes.
3. All research should be done in an inconspicuous manner away from roads, trails and developed areas unless specified in the permit, and shall not cause significant damage to the environment. In some cases the researchers and state parks may agree to location that enhances environmental education opportunities while meeting research and park management goals. Because of the scarcity and/or importance of some resources, the OPRHP may designate other restrictions necessary for the preservation of the area.
4. All field equipment (traps, measuring devices, etc) left in the field must be labeled with the Principal Investigator's name, date of installation, and the OPRHP permit number.
5. A permit from the NYS DEC and USFWS is required for certain types of work. This may include, but is not limited to, work on listed species and the collection and possession of wildlife. State and federal permits must be in hand prior to initiating work and be available for inspection on site.
6. Any research that leads to the discovery of new rare species or ecological communities requires the submission of a Natural Heritage Reporting Form to the New York Natural Heritage Program.
7. The permittee shall submit a summary of information gathered to the contact for the Region where the investigations took place within a year of the research end date (as identified on this permit). The OPRHP further requires that the researcher(s) provide copies of or otherwise make available to the OPRHP any material published as a result of this permit.
8. Researcher(s) or their representatives are to contact the appropriate Facility Manager before beginning, and to present a copy of this permit together with evidence of additional research licenses and permits, if required.
9. Researcher(s) will discuss with the Facility Manager the type and extent of work to be performed. The Facility Manager will describe any rules and regulations that may apply to the work.
10. If research is not conducted in accordance with this permit and/or to the satisfaction of the OPRHP, this permit will be immediately revoked.
11. The permittee shall promptly report any and all unusual incidents directly to the Facility Manager or Park Police. Unusual incidents include, but are not limited to, damage to Park property, accidents, personal injuries, and emergencies involving medical personnel.
12. Permittee shall defend, indemnify and hold harmless the People of the State of New York, the Executive Department, the New York State Office of Parks, Recreation and Historic Preservation and its commissioners, officers, agents and employees from and against damages for injury to or death of persons and for damage to or destruction of property of State Parks or others occurring during Permittee's use of said Premises and caused by the acts, omissions, neglect or misconduct of Permittee or any of its employees, agents, contractors, licensees or guests in the conduct of Permittee's operations under this permit. The Permittee assumes all risk of loss of the Permittee's property or that of its agents, employees, contractors and guests. Permittee's liability is not limited to the insurance coverage provided.

Special Conditions:

I have read the Conditions and Restrictions above and agree to those terms.

APPLICANT'S SIGNATURE	APPLICANT'S NAME (Print or type)	DATE

APPROVAL SIGNATURE	OPRHP PERMIT ADMINISTRATOR	DATE

APPLICANT MUST CARRY THIS PERMIT AT ALL TIMES WHILE IN PARK OR HISTORIC SITE.

PERMIT VALID FROM _____ TO_____

Entrance fees/admission to the park or site will be waived only in accordance to the research identified on this permit; specifically to those individuals identified on this permit and within the time period described on this permit.

Copies to: Permit contact. (Distribute both approved and denied permits.) Version 01/08/2013

APPENDIX D: Summary of Public Comments on Draft Management Plan

(To be completed following the end of the public comment period)

Appendix 10

Public Notices, Comments, and Responses

Federal Register Notification
Press Release
ENB Notice
Publication list for Plan Advertisement
Scenic Hudson Comments
Hudsonia Comments
Response to Comments

LEGAL STATUS

LEGAL STATUS

National Estuarine Research Reserve System

A Notice by the National Oceanic and Atmospheric Administration on 03/06/2019

DOCUMENT DETAILS

Printed version:
PDF (https://www.govinfo.gov/content/pkg/FR-2019-03-06/pdf/2019-03969.pdf)

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AGENCY:

Office for Coastal Management, National Ocean Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce

ACTION:

Notice of Public Comment Period for the Hudson River National Estuarine Research Reserve Management Plan revision.

SUMMARY:

Notice is hereby given that the Office for Coastal Management, National Ocean Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce is announcing a thirty-day public comment period for the Hudson River National Estuarine Research Reserve Management Plan revision. The revision of the existing management plan is necessitated by the applicable requirements of the National Estuarine Research Reserve System. The Hudson River Reserve revised plan will replace the plan approved in 2009.

SUPPLEMENTARY INFORMATION:

Pursuant to15 CFR 921.33 (/select-citation/2019/03/06/15-CFR-921.33)(c), a state must periodically update its management plan for a National Estuarine Research Reserve. The Hudson River National Estuarine Research Reserve revised plan will replace the plan previously approved in 2009. NOAA issues this notice of a public comment period for the revised plan under 15 CFR 921.33 (/select-citation/2019/03/06/15-CFR-921.33)(a).

The revised management plan outlines the administrative structure; the research/monitoring, stewardship, education, and training programs and priorities of the reserve; plans for including inholdings within the existing boundary into state ownership; and facility development priorities to support reserve operations.

The Hudson River Reserve takes an integrated approach to management, linking research and education, coastal training, and stewardship functions. The New York Department of Environmental Conservation has outlined how it will administer the reserve and its core programs by providing detailed actions that will enable it to accomplish specific goals and objectives. Since the last management plan, the reserve has: Provided technical expertise to coastal communities to reduce risks to natural hazards; expanded monitoring programs; installed a sentinel site for monitoring marsh ecosystem response to sea level rise; conducted training workshops; implemented K-12 and public education programs; installed a water level observation station that is compliant with NOAA's National Water Level Observation Network; restored hydrologic flows at Gay's Point in the Stockport Flats component; and established itself as a regional leader in the design and implementation of living shorelines. The total number of acres within the reserve boundary is 5,000 acres. The revised management plan will serve as the guiding document for the Hudson River Reserve for the next five years.

NOAA's Office Coastal Management will be conducting an environmental analysis in accordance with the National Environmental Policy Act on the proposed approval of the Reserve's revised management plan. The public is invited to provide comment or information about any potential environmental impacts of the proposed action, and these comments will be used to inform the decision making process.

The Hudson River Reserve Management Plan revision may be viewed at: *https://www.dec.ny.gov/lands/4915.html (https://www.dec.ny.gov/lands/4915.html)*. Comments on the revision may be submitted to the Reserve's Manager, Heather Gierloff (*heather.gierloff@dec.ny.gov (mailto:heather.gierloff@dec.ny.gov)*) by April 5, 2019.

FOR FURTHER INFORMATION CONTACT:

Nina Garfield at (240) 533-0817, or Kim Texeira at (240) 533-0781, of NOAA's Office for Coastal Management, 1305 East-West Highway, N/ORM5, 10th floor, Silver Spring, MD 20910.

Start Printed Page 8088

Dated: February 25, 2019.

Keelin Kuipers,

Deputy Director, Office for Coastal Management, National Ocean Service, National Oceanic and Atmospheric Administration.

[FR Doc. 2019-03969 (/a/2019-03969) Filed 3-5-19; 8:45 am]

BILLING CODE 3510-08-P

PUBLISHED DOCUMENT

For Immediate Release: 02/05/2019

Contact: Lori Severino | (518) 402-8000
PressOffice@dec.ny.gov

DEC RELEASES DRAFT MANAGEMENT PLAN FOR HUDSON RIVER NATIONAL ESTUARINE RESEARCH RESERVE

Plan Available for Public Comment through March 15

The New York State Department of Environmental Conservation (DEC) today announced the release of the Draft Hudson River National Estuarine Reserve (HRNERR) Management Plan for public review and comment. The reserve is operated as a partnership between DEC and the National Oceanic and Atmospheric Administration (NOAA) and the plan provides a necessary foundation to help manage the federally designated and state-protected sites along 100 miles of the estuary.

"With our federal, state, and community partners, a revitalized Hudson River Estuary is allowing more New Yorkers to connect with its beauty and bounty each year," said **DEC Commissioner Basil Seggos.** "More work remains to be done, and that is why this management plan is an important tool to bolster our progress so current and future generations can benefit from the estuary's remarkable natural resources."

The mission of the Hudson River National Estuarine Research Reserve is to improve the health and resilience of the Hudson River Estuary by conserving estuarine habitats through integrated education, training, stewardship, restoration, monitoring, and research programs.

The 2019 Draft Management Plan is an update of the 2009 plan and will guide the management of the Hudson River National Estuarine Research Reserve for the next five years. The draft plan provides a foundation for education programs, professional training, research, public access, and resource stewardship, and continues the reserve's commitment to the following core practices:

- Engaging local communities and citizens to improve stewardship of estuary resources;
- Understanding stakeholder needs and seeking meaningful partnerships to guide program planning and implementation;
- Using collaborative approaches to address complex estuary issues;
- Integrating staff activities to maximize the transfer of research and monitoring to inform decision making and community-based stewardship;
- Aligning with the Hudson River Estuary Program and other programs to promote stewardship of the Hudson River estuary;
- Informing decision-making in the mid-Atlantic and North Atlantic where appropriate through collaborations with other National Estuarine Research Reserves; and

- Leading by example through innovating, testing, and applying best management practices.

The public is encouraged to comment on the 2019 Draft Management Plan through March 15, 2019. DEC will review and address all comments received. The draft management plan is posted on the NYS DEC website.

Comments, questions, and/or requests can be directed to: Heather Gierloff, Hudson River National Estuarine Research Reserve Manager, Norrie Point Environmental Center, 256 Norrie Point Way, P.O. Box 315, Staatsburg, NY 12580; (845) 2889-4745 x 118; or heather.gierloff@dec.ny.gov.

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19-25

Environmental Notice Bulletin

Draft Hudson River National Estuarine Research Reserve Management Plan

The public is invited to comment on the Draft Hudson River National Estuarine Research Reserve (Research Reserve) Management Plan. The mission of the Research Reserve is to improve the health and resilience of the Hudson River estuary by conserving estuarine habitats through integrated education, training, stewardship, restoration, monitoring and research programs. The 2019 Management Plan is an update of the 2009 plan and will guide the management of the Research Reserve for the next five years. New York State Department of Environmental Conservation (NYS DEC) will consider all public comments as it finalizes the management plan.

A copy of the plan is posted on the NYS DEC's website at: https://www.dec.ny.gov/lands/4915.html.

Comments will be accepted by the contact listed below until March 15, 2019.

Contact: Heather Gierloff, Research Reserve Manager, Norrie Point Environmental Center, 256 Norrie Point Way, P.O. Box 315 Staatsburg, NY 12580, Phone: (845) 889-4745 x 118 or heather.gierloff@dec.ny.gov

HRNERR Management Plan Announced in the following Newsletters, websites and Bulletin

NYS DEC Environmental Notice Bulletin (ENB)

Websites
HRNERR Website
NYS DEC Website

NYS Department of Environmental Conservation February 5, 2019 Press Release lead to the announcement being included in the following Newsletters and publications:

Hudson RiverNet
Date- 2/05/2019
Audience -News from the NY DEC Hudson River Estuary Program

Making Waves
Date 02/22/2019
Audience – News from the NYS DEC Division of Water

Applied Web NY
Date 2/05/2019
Audience-Public Officials, employees, volunteers, associations, charities, public groups and the media

New York AgConnection
Date 02/06/2019
Audience-Subsidiary of USAgNet.com serving the needs of the New York agricultural community

Daily Freeman
Date 02/05/2019
Audience – Hudson Valley Residents of Ulster and Dutchess Counties

Hudson River Valley Greenway
Date 03/04/2019
Audience -

Federal Register
Date 03/05/2019
Audience – Interested public throughout the Nation

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VIA EMAIL AND U.S. MAIL

May 1, 2019

Heather Gierloff, Reserve Manager
Hudson River National Estuarine Research
Norrie Point Environmental Center,
256 Norrie Point Way, P.O. Box 315, Staatsburg, NY 12580
heather.gierloff@dec.ny.gov.

Re: Comments Draft Hudson River National Estuarine Reserve (HRNERR) Management Plan

Dear Ms. Gierloff-

Scenic Hudson would like to provide the following comments on the Draft Hudson River National Estuarine Reserve (HRNERR) Management Plan released by New York State Department of Environmental Conservation on February 5, 2019. Per our conversation, we understand the public comment period closed on March 15th, however we hope our comments will be taken into consideration as the final plan is prepared. We deeply appreciate the opportunity to offer Scenic Hudson's perspective on this important planning document.

Scenic Hudson is a 501(c)(3) organization based in Poughkeepsie, NY dedicated to preserving the Hudson Valley's unique landscapes, creating parks that connect people to the Hudson River and fighting threats to the river and natural resources that are the foundation of the region's prosperity. To protect and promote the valley's scenic, ecological, recreational, historic and agricultural resources, we combine land acquisition, citizen-based advocacy and sophisticated planning tools to create environmentally healthy communities that support smart economic growth. We have been a crusader-advocate for the valley since 1963 and the largest environmental group focused on the Hudson River and its watershed communities.

GENERAL COMMENTS

Our vision for the Hudson River Estuary is that the Hudson Valley will be a community of informed and engaged citizens working to make the region a model of vibrant riverfront cities and towns linked by inviting parks and trails, beautiful and resilient landscapes, and productive farms. All of the goals NERR'S programs are critical components in realizing that vision through its management plan: 1) creating a stable environment for research through long-term protection of National Estuarine Research Reserve resources; 2) addressing coastal management issues identified as significant through coordinated research of the estuary; 3) providing enhanced public awareness and understanding of estuarine areas and suitable opportunities for public education and interpretation; 4) promoting federal, state, public and private use of one or more reserves within the system when such entities conduct estuarine research; and 5) conducting and

coordinating estuarine research within the system and gathering and making available information necessary for improved understanding and management of estuarine areas. Scenic Hudson applauds NERR'S achievements in each of these objectives over the last five years and notes that the proposed draft management plan's objectives and activities are setting the stage for even greater success over the next five years. Of particular importance to the Hudson Valley's future is the Program's ability to gather and make available to land use and waterfront decision makers the information necessary for improved understanding and management of estuarine areas.

SPECIFIC COMMENTS AND GENERAL RECOMMENDATIONS

Threats and Stressors

We share the program's concerns with Climate Change, Coastal Development, and Communities at Risk, the introduction and spread of non-native and invasive species and the increasingly rapid decline in water quality throughout the estuarine watershed. We note that two of these threats/stressors have become exceptionally acute since the last HRNERR Management Plan was implemented.

Climate Change: Along the estuary's 300-plus miles of shoreline, riverfront communities are experiencing increased flooding from changing rainfall and storm patterns and greater inundation from rising sea level. Community leaders, regulators, landowners, and business owners are faced with important decisions about where and how to invest in shoreline infrastructure. Because of the impacts of Superstorm Sandy, Irene, Lee and other recent major storms, pressure is growing to alter shorelines to hold back the waters and control erosion. These decisions will affect community waterfront use—and determine the future of vital near-shore river habitats. It is abundantly clear that the Hudson Valley estuarine region's livelihood relies on having the best science and current information available. We commend the NERR's program for making this a priority goal and investing resources and expertise in projects that model best management planning in the region.

Communities at Risk: Given the recent development of a feasibility study (NY & NJ Harbor & Tributaries Focus Area Feasibility Study, HATS) from the Army Corps of Engineers (ACOE) to build storm surge barriers to manage damage from high-impact storm events, we urge the NERR'S program to prioritize involvement in the identified "Communities at Risk" threat. The habitats and shorelines of the estuary could be significantly impacted by physical barriers being proposed by the ACOE. We note that NERR'S scientific expertise and its significant knowledge of the estuary's unique and irreplaceable ecosystems and knowledge of the relationship between local, state and federal programs tasked with managing the resource could be an incredible asset to the broader estuarine community as it labors to understand the ACOE's complicated proposals. We encourage NERRS to participate in the on-going public process as the HATS advances.

We understand that the Hudson River NERR'S program is engaged in a climate adaptation impact project with the Stevens Institute of Technology to help provide to data to the ACOE's assessment

of hydrological impacts of barriers for this issue. Yet we hope that local communities can be encouraged to access the NERR'S expertise as part of their efforts to identify potential impacts to local waterfronts as a result of building storm surge barriers in the NY-NJ Harbor.

Education Program

Overall, the management plan touches on important goals and objectives that Scenic Hudson believes are essential for the future of Environmental Education in the Hudson Valley. We are deeply impressed with the HRNERR programs "A Day in the Life of the Hudson River" and the "Eel Project" which are very successful at engaging participants. We note especially the ability of these NERR programs to foster a renewed interest in the value and stewardship of the unique resources of the Hudson Estuary to thousands of students and dozens of communities from the harbor to the Mohawk valley.

Scenic Hudson is concerned about an emerging deficiency that has been noted by many organizations focused on environmental education and fostering environmental stewardship in younger generations. In many parts of the Hudson Valley region there is an urgent need for a dedicated outreach effort to schools/communities that do not traditionally work with or are unable to access programs from natural resource managers like the HRNERR programmatic staff and facilities. This includes environmental justice areas—as defined by New York State—and schools that serve low-income communities.

Finally, we bring to your attention an opportunity that we recommend be included in the management plan. Within the draft plan's public outreach strategy is a proposal to "Present or table at several popular festivals each year, including the Clearwater Revival, the Beacon Sloop Club Strawberry Festival, and others." Because of the emphasis placed on the HRNERR programmatic staff's limited resources to table at different community events it might be advantageous and a better use of staff time to find new events that reach diverse populations that might not currently be served or exposed to environmental programming.

Research and Monitoring Program

We strongly support the management plan's focus on providing information to stake-holders in the Hudson River Estuary and nationally. Engaging in both system-wide monitoring and locally focused monitoring allows researchers to build knowledge useful to local and national communities.

In particular, we commend HRNERR's research on marsh resilience in the face of sea level rise and climate change. The long-term data available from HRNERR, along with continued monitoring of vegetation and sediment profiles, are vital to understanding on-going changes to our tidal wetlands, as well as the ecosystem services they provide. In particular, continuation of the long-term data sets that stretch back to the 1990's will be critical in future assessments of long-term (multi-decade) trends.

Much of the fate of the Hudson's tidal wetlands will depend on accretion rates in relation to sea level rise and we support research that further elucidates sediment accretion rates in the estuary. However, horizontal migration is also key to adaptation of these wetlands to sea level rise, and some of the most compelling places to study these changes in Hudson River tidal wetlands are outside of HRNERR sites. Thus, we encourage HRNERR scientists to work with partners to research a diversity of sites, including areas will were not historically wetlands but are projected to be in wetland migration pathways.

Submerged aquatic vegetation (SAV) beds are a critical habitat type in the Hudson, and one that is subject to annual changes in distribution. Continued regular monitoring and mapping of SAV beds by professional scientists, in conjunction with citizen science efforts, provide local decision-makers and conservation managers with critical information on the health and location of this resource. Already, maps of changes to SAV distribution before and after Hurricane Irene has proven useful to resource managers along the Hudson.

As stakeholders, including the NYS Dept. of Environmental Conservation (DEC) and the Hudson River Estuary Program in particular, look to improve aquatic connectivity through dam removals and other methods, a better understanding of the ramifications of dam removal in Hudson River tributaries, gained through the research such as the Dams and Sediment in the Hudson (DaSH) project, will be extremely useful.

We appreciate the establishment of the Turkey Point tidal gauge to support tide predictions and particularly to document sea level rise rates in the upper Hudson estuary. The benefits of this strategic investment are appreciated by both the environmental and maritime trade communities.

Stewardship and Restoration

Building Habitat and Ecosystem Resilience: We encourage the HRNERR plan to consider sites which are currently above the high water line but may be good candidates for future tidal wetlands, both for research and preservation.

Phragmites control: We recommend careful consideration of the biological and social implications of applying glyphosate and other pesticides to wetlands and other natural areas to control Phragmites. We strongly support efforts at controlling Phragmites physically though methods such as inundation, solarizing, and mowing where feasible. We encourage further research into methods to control Phragmites and other invasive species without the use of pesticides, and into potential non-target impacts of pesticide use on Phragmites in the estuary's wetlands. Hudsonia's Phragmites Management Sourcebook for the Tidal Hudson River (https://hudsonia.org/wpcontent/files/Sourcebook%20for%20Reed%20Management%20April07.pdf) provides additional information and resources.

We strongly support Objective 3. Scenic Hudson has in fact already completed maps of projected future tidal wetland distributions that we feel could be extremely informative in efforts to

improving tidal connectivity and ensuring migration pathways are conserved—see the Protecting the Pathways interactive map at scenichudson.org/tidalwetlands.

Land Acquisition

We strongly support Objectives 1 and 2, particularly the focus on sea level rise and other climate change impacts in Objective 2. We encourage HRNERR to consider areas outside of current boundaries with regard to pathways for marsh migration in the face of sea level rise and advocacy for the transfer of OGS owned lands to other state agencies who may better steward them.

We urge HRNERR to continue its collaboration between the state's natural resource agencies and the region's land trust community to identify strategic priorities for land acquisition in order to identify and implement the HRNERR's Management Plan's coastal and underwater land management objectives that strengthen climate resiliency, estuarine habitat connectivity and public access goals.

In closing, we would like to express our deep appreciation for the HRNERR program and its participation and commitment to the shared vision of a healthier and restored river as part of the 'Hudson We Share" initiative. We believe the recently finalized Hudson River Comprehensive Restoration Plan and its twelve ecosystem goals are compatible with many of the proposed objectives and goals within the draft management plan and we encourage HRNERR to look for opportunities to combine resources with the broad network of non-profit organizations, local land management groups and the state and federal authorities that came together to create this dynamic restoration plan for the river.

We congratulate the HRNERR staff in particular for collecting and coordinating the very best Hudson river research possible within the program's operational boundaries and look forward to working with HRNERR to improve the function and health of the estuary's natural systems, increase our region's ability to strengthen community resiliency in the face of rising waters and to capture the environmental and economic benefits of a fully restored Hudson River Estuary.

Thank you,

Nava Tabak

Scenic Hudson
Director of Science, Climate, & Stewardship

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15 March 2019

Heather Gierloff and Colleagues
Hudson River National Estuarine Research Reserve
PO Box 315
Staatsburg NY 12580

Dear Heather and Colleagues:

Thank you for sending me the draft HRNERR Management Plan. In my comments below I've highlighted a few things that concern me as a longtime researcher and observer at the HRNERR sites, Tivoli Bays in particular. I've been studying Tivoli Bays since 1971, and the rest of the estuary progressively through the 1970s. With students, colleagues, and collaborators I've worked on lichens, bryophytes, vascular plants, fishes, the herpetofauna, birds, muskrat, and beaver – and how people use the wetlands. Many of my findings have been presented in scientific and nontechnical publications and in reports (some prepared for HRNERR).

Page 6- Coastal development. The 500-year flood zone is a very conservative (small) zone of concern. All steep slopes, bluff rims, lower reaches of tributaries, and the rest of the state-designated coastal zone are important for protection of water quality, a buffer zone for sensitive wildlife such as the bald eagle, and other ecological elements. This is stated, to some extent, in the passage about buffer zones at the top of page 7. Some states protect or regulate much more extensive upland buffers adjoining key estuaries.

Figure 8 is confusing because there seem to be four different blue-purple tones and only two in the key.

P. 9, "Columbia-Green" is missing an e.

P. 11- The Tivoli Bays Natural Heritage Area list of rarities omits goldenseal (*Hydrastis canadensis*) which I believe was reported by Barbour in the rare plant survey he conducted for HRNERR some time ago. It occurs outside the strictly estuarine habitats but is potentially vulnerable to management of the uplands. Goldenseal is a Threatened species in NY (probably mostly because of collecting for the medicinal herb trade).

Figure 6. Three areas of former (and residual) Phragmites patches in Tivoli North Bay are mapped as Freshwater Tidal Mudflat. This may have been correct when the mapping was done, but I am 99% sure these areas are now dominated by intertidal marsh vegetation. Dan Miller should know.

The little finger of red pointing soutward in the north end of North Bay is not all tidal swamp; it is partly or mostly a spoil bank from channelizing the tributary that debouches there. Also, just west of that, in the corner at the north end of the marsh and next to the railroad, is a small dump dating from the 1970s. It is

not capped. When I first saw this dump it contained herbicide containers. This dump needs to be investigated for toxic contamination (not necessarily shown on map). As I recall from soil analyses we did in 1982, there was an anomalously high level of arsenic in the marsh at the location which could have been from herbicides.

P. 16- Iona Island explosion site. The explanation of what is a COPC vs a COPEC is confusing. In 1980 when I analyzed oblique color airphotos for muskrat lodges at Tivoli North Bay, Constitution Marsh, and Iona, there were almost no lodges at Iona. The reason for this surprising result is unclear and the toxic contamination could be a factor (or it could have been a small marsh with lots of potential bank burrow sites).

P. 17- Piermont. The northern parts of the marsh are not bordered (on the west) by cliffs and talus. There is a substantial area of forest, with some steep slopes that are not cliff or talus, and there is an area northwards with a paved road and other park facilities.

P. 17-19 – Piermont. The dump at the north end, on the north side of the tidal channel of Sparkill Creek, should be mentioned. I believe it has never been capped. It needs study because leachate could be affecting flora and vegetation.

I haven't checked all the vegetation mapping. The legends for these maps should state the dates of remote imagery on which the mapping was based and whether everything was ground-truthed.

P. 23-24. The division of responsibilities for Tivoli Bays between HRNERR and the WMA administration (Nate Ermer) should be clarified. This is confusing to researchers and others who use the area.

P. 26- The names of individuals currently holding these positions (perhaps except the interns) should be shown.

P. 28- Reconvene the Reserve Steering Committee. I don't see what this is. In the original FEIS or other 1982 document, a committee was created to advise regarding management of the Tivoli Bays (at least), and this committee, as I recall, never met after the reserve was officially designated. Was this the Steering Committee? Perhaps the plan should explain the prospective composition of the Steering Committee in terms of organizations to be represented.

P. 33, Objective 2- I'm not aware that a rare plant expert has surveyed the proposed new location (a few meters south of the old one) for the paddlecraft dock at Tivoli North Bay. There could be important rare plants in the intertidal zone or near Mean High Water, including the elusive Nuttall's micranthemum which was last found in the mouth of Stony Creek in the 1930s (the only known site in New York) and may be globally extinct. I surveyed for this species with a State Museum botanist prior to the construction of the original dock, in communication with the DEC, but then the dock was installed at a different location.

P. 37- Wildlife Management Area regulations. One-fourth of the funding for the purchase of land from Central Hudson came from the Unique Area funds associated with the State Nature and Historical Preserve Trust, indicating that the site should also be subject to the appropriate Unique Area regulations. DEC made an administrative decision (Herb Doig, as far as I know) to call the area a WMA instead of a Unique Area – a bias.

Camping by a single private family group has traditionally been allowed once each year on Magdalen Island, and I have been informed that a trashy mess is left by this group. I can put you in contact with the observer.

P. 44- Horseback riding should be listed as either an Allowed, Permitted, or Not Permitted activity at Tivoli Bays (I don't think it's a good idea, but inevitably someone will want to ride there). The trails should be monitored for damage from bicycling.

P. 58, etc.- Amtrak's proposal to gate and fence the East Shore railroad against public access would make it much harder for researchers to get to important parts of the marshes (and to the railroad itself, which is very interesting biologically and has been a site of bird and other studies).

P. 59- You have stated that the Saw Kill and Stony Creek automatic water quality monitoring equipment will definitely be removed and installed elsewhere. This should be stated clearly in the plan. The plan should also state how HRNERR, Bard, and other entities will work together to facilitate the replacement of equipment at those two locations in order that there will be a continuous data record for those streams. Those data may not be used much, but there are clear uses for the data now. I believe these are the only Hudson River tributaries with continuous data collection, underlining its importance for local management as well as larger scale monitoring.

P. 60- Table 2 is very helpful. (However, I suggest that all the tables in the plan be numbered and numbered continuously (e.g., the table on p. 55 and many others are not called Tables and given table numbers), and that a List of Tables and a List of Figure be added after the Table of Contents.)

P. 66- SAV should be identified to species in the monitoring program, at least in selected areas. There are various pondweeds, naiads, etc. that are lumped into a single category (as far as I know). We need to know if native and nonnative species are increasing or decreasing, and what is happening to an important wildlife food species such as Sago pondweed.

P. 69- If HRNERR is to continue using herbicides to manage Phragmites, research should be initiated to determine if rare biota, resource species (e.g., muskrat), etc., are adversely affected by toxicity of glyphosate, adjuvants, or other compounds. The literature on glyphosate toxicity is voluminous and it is clear that glyphosate at environmentally relevant levels has many nontarget effects on plants, animals, and other organisms as well as humans.

P. 69, 71- Young Forest Initiative. I have explained in an article in News from Hudsonia why clearcutting to create sapling wood or shrubland at Tivoli North Bay is inappropriate and in contravention of DEC guidelines for the YFI. A superior alternative would be to manage the shrubland that is already developing on the oldfields at this site, by altering the mowing-brushhogging regime. Nature is not a one-size-fits-all system, and an across-the-board policy of clearcutting a percentage of forest on WMAs and other state lands doesn't make ecological sense. Thirty acres of clearcutting would be a recipe for nonnative pest plant invasions, some of which has already occurred at that site following the 1979 Central Hudson logging. It should also be noted that no reserve (e.g., Tivoli Bays) can support all types of habitats or all species; managers need to start from what's there before trying management that will have to be invested in perennially and may not have all the desired effects.

P. 69-70. See my remarks about herbicides, above. Also, the long term development of vegetation on patches where Phragmites has been herbicided at Stockport, Tivoli, and Iona may be different from the short-term development that is reported in the plan. I would like to see the monitoring data associated with the Phragmites management at those three sites analyzed and made public; all too few results of

Phragmites management projects in the U.S. have been disseminated. Finally, HRNERR could play a leadership role in helping to develop non-chemical methods for managing Phragmites, something that is very badly needed. The plan should mention that a classical biocontrol program is being developed for nonnative *Phragmites australis australis*, and discuss how this might affect the reserve marshes. I don't think classical biocontrol as currently proposed is a good idea (I've published on this subject), but I think HRNERR should understand that it might have a large effect on the marshes at Iona and Piermont.

HRNERR should practice early detection – rapid response (EDRR), a management approach that is widely agreed on, instead of, or perhaps in addition to, investing heavily in management of species that are already abundant. One such example is cutleaf blackberry (*Rubus laciniatus*, also considered a component of *Rubus fruticosus* agg.) on Iona Island east of the railroad. In 2011 there was may have been only one or two plants; current status is unknown to me. *R. fruticosus* agg. ("Himalayan blackberry") is considered very troublesome in the Pacific Northwest.

P. 70. Solarization has been used successfully to manage Phragmites at Constitution Marsh. However, any management of invasive plants requires a long-term commitment, whether non-chemical or chemical.

It should be noted that the central area of Piermont Marsh that, last I saw, was proposed for a forty-acre herbicide application to manage Phragmites, abuts shoreline stands of *Spartina cynosuroides, S. alterniflora,* and a sterile bulrush that could very well be the endangered New England bulrush.

Regarding invasive plants, are the HRNERR sites being monitored for hydrilla? Although apparently limited to the Croton system, the estuarine circulation and high propensity of this species to disperse make it very likely that it has, or will, reach other Hudson River localities.

P. 71, etc. -General comments about marshes and sea level rise. Study is needed of the railroads, Phragmites, beavers, and nitrogen influences on marsh accretion, persistence, and migration. Thin-layer augmentation is a good concept but the easier or extant mechanisms should generally be given priority.

Innovative projects should include testing modification of Phragmites stand architecture rather than chemical control. Phragmites provides many important ecosystem services, including biodiversity support, and it should be possible to have the desired diversity (including salt meadows at Piermont) and the non-habitat ecosystem services such as sediment building and stabilization and carbon sequestration. See papers by Kiviat, J Weis, and others on Phragmites.

P. 72, etc. -Mention should be made of the importance of obtaining a conservation easement from Bard College around Tivoli South Bay (consonant with the Callendar House, Kaatsbaan, and Montgomery Place easements). The college refused in the 1980s and now is the time to re-open the discussion.

P. 74- This is a very short list of references. A complete list of interpretive and research publications and reports pertaining to the HRNERR sites should be provided, or linked to. HRNERR itself has trouble keeping track of research that has been conducted at the sites (not to mention other researchers), underlining the importance of maintaining at least a virtual archive of reports, publications, and of course data. All data collected by HRNERR, and HRNERR-sanctioned researchers, should be made explicitly public except in cases where, for example, there are law enforcement implications. Making everything readily available is necessary to fulfill the Research and Monitoring Objectives stated earlier. Possibly the Marist College Library Hudson River collection could be a partner in archiving Hudson River research reports and publications.

Moreover, the plan should reference research that supports the goals and objectives. Professionals and the general public need to understand where the ideas come from, and that there is evidence that the proposed actions are needed and will work as suggested. It's also important to show the reader that the preparers of the plan have consulted, and processed, the existing knowledge about the estuary, the four sites, and their biota and abiotic environment.

Appendices- Where are they?

Sincerely,

Erik Kiviat PhD
Executive Director

Appendix 10

Response to Comments

RESPONSE TO COMMENTS

The Draft *Hudson River National Research Reserve Management Plan,* dated January 2019, was published for public review and comment in the Environmental Notice Bulletin (ENB) and a press release on February 6, 2019. The Draft Management plan was available on the DEC and HRNERR websites and advertised on several digital newsletters. A copy of the ENB publication and press release are included following the responses to comments.

The comments received were carefully reviewed and analyzed. Paraphrased comments are listed below followed by the responses. All comments were addressed, apart from those dealing with editorial or formatting changes.

INTRODUCTION TO HUDSON RIVER RESERVE SITES

Comment:
The 500-year flood zone is a very conservative (small) zone of concern. All steep slopes, bluff rims, lower reaches of tributaries, and the rest of the state-designated coastal zone are important for protection of water quality, a buffer zone for sensitive wildlife such as the bald eagle, and other ecological elements. This is stated, to some extent, in the passage about buffer zones at the top of page 7. Some states protect or regulate much more extensive upland buffers adjoining key estuaries.

Response:
Reserve staff will review upland buffer areas at the four component sites to ensure ecological resource protection and prioritize future land acquisition and management.

Comment:
The Tivoli Bays Natural Heritage Area list of rarities omits goldenseal (*Hydrastis canadensis*) which was reported in the Tivoli Bay Wildlife Management Area Biodiversity Inventory Final Report by the New York Natural Heritage Program dated January 1996.

Response:
The list of rarities referenced in the comment are the species that were used to meet the criteria for Natural Heritage Area Designation in 2007. The list is not intended to note all rare intertidal and upland species in the Tivoli Bays Wildlife Management Area.

Comment:
Three areas of former (and residual) Phragmites patches in Tivoli North Bay are mapped as Freshwater Tidal Mudflat. This may have been correct when the mapping was done, but I am 99% sure these areas are now dominated by intertidal marsh vegetation.

Response:
This map was a result of a 2007 mapping effort and has since changed. The map has been updated to show the three areas as Freshwater Tidal Marsh.

Comment:
There is a historic cemetery at Tivoli Bays that was part of Ward Manor and used from the 1920s to 1950s. Until recently it was thought to be small, but a Bard team has now documented 177 graves. Hudson River NERR may have a trust responsibility to care for this site.

Response:
Reserve staff and the DEC Bureau of Wildlife will investigate the management needs for this site.

Comment:
The little finger of red pointing southward in the north end of North Bay is not all tidal swamp; it is partly or mostly a spoil bank from channelizing the tributary. Also, just west of that, in the corner at the north end of the marsh and next to the railroad, is a small dump dating from the 1970s. Soil analyses done in 1982, showed an anomalously high level of arsenic in the marsh at this location.

Response:
The future tidal wetland mapping will address plant community classification inaccuracies at these locations.

Comment:
Iona Island explosion site. The explanation of what is a contaminant of potential concern (COPC) vs a contaminant of potential ecological concern (COPEC) is confusing. In 1980 when I analyzed oblique color airphotos for muskrat lodges at Tivoli North Bay, Constitution Marsh, and Iona, there were almost no lodges at Iona. The reason for this surprising result is unclear and the toxic contamination could be a factor (or it could have been a small marsh with lots of potential bank burrow sites).

Response:
The definition of COPEC was added to the management plan. Reserve staff notes the concern for contaminants at Iona marsh.

Comment:
A section of the Iona narrative is missing.

Response:
The management plan has been updated to include the missing narrative for Iona Island.

Comment:
The northern parts of Piermont Marsh are bordered on the west cliffs, talus and a substantial area of forest, with steep slopes.

Response:
The site description for Piermont Marsh has been edited to note the presence of forested slopes along the western border of the marsh.

Comment:
The dump at the north end of Piermont Marsh, on the north side of the tidal channel of Sparkill Creek, should be mentioned. I believe it has never been capped. It needs study because leachate could be affecting flora and vegetation.

Response:
The management plan has been edited to include reference to the landfill at the Piermont Marsh component site.

Comment:
The legends for the land cover maps should state the dates of remote imagery on which the mapping was based and whether it was ground-truthed.

Response:
The figure legends have been updated to include the source of the land cover data.

ADMINISTRATIVE PLAN

Comment:
The division of responsibilities for Tivoli Bays between HRNERR and the WMA administration should be clarified. This is confusing to researchers and others who use the area.

Response:
The Management plan has been updated to state that the multiple divisions within the DEC co-manage the component sites.

Comment:
The names of individuals currently holding the indicate staff positions (perhaps except the interns) should be shown.

Response:
The organizational framework focuses on staff titles and roles rather than the names of individuals to allow the plan to be relevant through staff changes.

Comment:
Reconvene the Reserve Steering Committee. Perhaps the plan should explain the prospective composition of the Steering Committee in terms of organizations to be represented.

Response:
The Advisory Committee section of the plan has been edited to state that Reserve Site Management Partnership meetings will be convened. The meetings will include land managers

from the State Agencies that own lands in each component site. In addition, separate Estuary Training, Education, and Research Program meetings will be convened periodically.

FACILITIES AND CONSTRUCTION

Comment:
Objective 2- Has a rare plant expert surveyed the proposed new location (a few meters south of the old one) for the paddle craft dock at Tivoli North Bay? There could be important rare plants in the intertidal zone or near Mean High Water, including the elusive Nuttall's micranthemum which was last found in the mouth of Stony Creek in the 1930s (the only known site in New York) and may be globally extinct

Response:
A plant expert was not consulted during the design of the boat launch. Staff utilize this area frequently and have not seen a plant that looks similar to the Nuttall's micranthemum.

PUBLIC ACCESS AND VISITOR USE

Comment:
Wildlife Management Area regulations. One-fourth of the funding for the purchase of land from Central Hudson came from the Unique Area funds associated with the State Nature and Historical Preserve Trust, indicating that the site should also be subject to the appropriate Unique Area regulations. DEC made an administrative decision to call the area a WMA instead of a Unique Area – a bias.

Response:
Although it is designated as a Wildlife Management Area, DEC generally manages Tivoli Bays in a way that is consistent with the statewide Unique Area regulations (6 NYCRR Chapter 2 Part 190). Tivoli Bays has special area-specific regulations (6 NYCRR Chapter 1 Subchapter G Part 106) that provide additional protections beyond the general statewide WMA regulations (6 NYCRR Chapter 1 Subchapter G Part 51). DEC is revising Part 51 to address additional types of public use that were not previously included when these regulations were last updated more than 20 years ago.

Wildlife Management Areas are managed for two primary purposes – 1) to provide habitat for wildlife and 2) to provide opportunities for public, wildlife-dependent recreation. Unique Areas are managed to protect the unique resource(s) for which they were acquired. At Tivoli Bays, the tidal freshwater wetlands are the defining features of the property from both a wildlife habitat and unique natural resource perspective. Thus, the protection of these important wetlands is the overarching goal of any management that is undertaken at the area, irrespective of the area's designation.

Comment:
Horseback riding should be listed as either an Allowed, Permitted, or Not Permitted activity at Tivoli Bays (I don't think it's a good idea, but inevitably someone will want to ride there). The trails should be monitored for damage from bicycling.

Response:
DEC is revising Part 51 to address additional types of public use that were not previously included when the regulations were last updated more than 20 years ago. Among the public uses of WMAs that will be addressed in the Part 51 revision are equestrian and off-road bicycle use. In the updated Part 51, it is likely that these activities will be confined to roads and designated trails. The Department will have the discretion to allow or restrict these uses on specific trails through a trail designation process.

EDUCATION

Comment:
Scenic Hudson is concerned about an emerging deficiency that has been noted by many organizations focused on environmental education and fostering environmental stewardship in younger generations. In many parts of the Hudson Valley region there is an urgent need for a dedicated outreach effort to schools/communities that do not traditionally work with or are unable to access programs from natural resource managers like the HRNERR programmatic staff and facilities. This includes environmental justice areas-as defined by New York State-and schools that serve low-income communities.

Response:
We appreciate and recognize the challenges you bring up. In many cases, we actively reach out to schools in environmental justice communities, such as with schools and community groups involved with our citizen-science eel project in Poughkeepsie, Kingston, Newburgh, Yonkers, and Troy. We also promote visits to Norrie Point with transportation resources provided by the NYSDEC's "Connect Kids" program which is designed to serve environmental justice communities. But, we can and will do more to make our education resources available to everyone in the Hudson Valley.

Comment:
Because of the emphasis placed on the HRNERR programmatic staff's limited resources to table at different community events it might be advantageous and a better use of staff time to find new events that reach diverse populations that might not currently be served or exposed to environmental programming.

Response:
It is true that our main limiting factor for community events is staff time. If you have recommendations of community events, we will be happy to consider attendance. In the meantime, we will reach out to a broader array of community events and offer our outreach services as staffing allows.

RESEARCH AND MONITORING

Comment:
Amtrak's proposal to gate and fence the East Shore railroad against public access would make it much harder for researchers to get to important parts of the marshes at Tivoli Bays.

Response:
Reserve staff have been working with Amtrak/Metro North to make sure researchers and staff still have access across the railroad.

Comment:
Continuation of the long-term data sets that stretch back to the 1990's will be critical in future assessments of long-term (multi-decade) trends.

Response:
Reserve staff will be working with partners to continue long-term monitoring at the Saw Kill and Stony Creek as well as increasing monitoring in the main stem of the river.

Comment:
Research Staff have stated that the Saw Kill and Stony Creek automatic water quality monitoring equipment will be removed and installed elsewhere. This should be stated clearly in the plan. The plan should also state how HRNERR, Bard, and other entities will work together to facilitate the replacement of equipment at those two locations in order that there will be a continuous data record for those streams. Those data may not be used much, but there are clear uses for the data now. I believe these are the only Hudson River tributaries with continuous data collection, underlining its importance for local management as well as larger scale monitoring.

Response:
Reserve staff, through a needs assessment, determined that the data from the SWMP stations in Saw Kill and Stony Creek, tributaries to the Hudson, are only being used by one researcher. There are data gaps in the main stem of the Hudson River that, if filled, would be very useful for several researchers both in New York State and nationally.

Strategies under Objective 2 has been updated to state that Research Reserve staff will be working with Bard and other entities to facilitate the replacement of the equipment at Saw Kill and Stony Creek.

Comment:
The Hudson River Environmental Conditions Observations System (HRECOS) would benefit from the addition of more continuous monitoring of the mainstem Hudson River. NERRS already partners with HRECOS to continuously monitor Tivoli Bays and Norrie Point. Adding stations at Stockport Flats and Iona Island would fill in longitudinal gaps in the HRECOS network.

Response:
Reserve staff will be working with Partners to increase the monitoring in the main stem of the Hudson within the data gap areas mentioned.

Comment:
Table 2 is very helpful. I suggest that all the tables in the plan be numbered and numbered continuously and that a List of Tables and a List of Figure be added after the Table of Contents.

Response:
The Management Plan has been updated to correctly number the tables and include a list of tables and figures below the Table of Contents.

Comment:
Horizontal migration is key to adaptation of the Hudson River tidal wetlands to sea level rise. Thus, we encourage Hudson River NERR scientists to work with partners to research a diversity of sites, including areas will were not historically wetlands but are projected to be in wetland migration pathways.

Response:
Horizontal tidal wetland migration is stated in Stewardship and Restoration Objective 3: "Reserve tidal wetlands are resilient and, where feasible and appropriate, migration pathways are conserved or created by improving tidal connectivity". Changes in tidal wetland area of cover, including horizontal migration, will be monitored using tidal wetland mapping and change analysis. The specific inclusion of monitoring horizontal migration was added to the description of Tidal Wetland Inventories. This mapping to will allow migration sites to be identified and targeted for future intensive research.

Comment:
Submerged aquatic vegetation (SAV) should be identified to species in the monitoring program, at least in selected areas. There are various pondweeds, naiads, etc. that are lumped into a single category (as far as I know). We need to know if native and nonnative species are increasing or decreasing, and what is happening to an important wildlife food species such as Sago pondweed.

Response:
In previous SAV mapping efforts, specific species of SAV could not be determined due to the quality of the aerial photographs. The single mapping category of "SAV" was used interchangeably with "*Vallisneria americana*", the dominant species. Starting in 2014, digital photography has greatly increased the resolution of the photos. The inventory obtained in 2018 has particularly good resolution in the upper estuary. There is ongoing work to determine if specific SAV species can be accurately identified and mapped.

Comment:
Continued regular monitoring and mapping of SAV beds by professional scientists, in conjunction with citizen science efforts, provide local decisionmakers and conservation managers with critical information on the health and location of this resource. SAV change maps have proven useful to resource managers along the Hudson.

Response:
Reserve staff are working with partners to continue the SAV mapping in the future.

Comment:
Hudsonia sampled vegetation and soils in 15 Hudson River fresh-tidal and oligohaline marshes ca 20 years ago for the Hudson River NERR-sponsored hydro-geomorphic model (HGM) project. This included sampling vegetation at the upper, landward, edges of the marshes, in the belts where sea level rise should be having a relatively strong effect. I highly recommend that this sampling be repeated to further understanding of sea level rise (SLR) effects on the marshes, considerable thought and money will be spent on protecting or restoring the marshes. That vegetation belt (landward edge) is, I believe, not represented in HRNERR's current monitoring of vegetation. Moreover, the lower elevation data from the HGM project, and my intensive 1984 study of vegetation and soil in Tivoli North Bay, are useful adjuncts to the current sediment elevation table (SET) and vegetation monitoring efforts.

Response:
With the need for this data to inform the protection and restoration of marshes, the proposal mentioned above may be valuable as a NERRS Science Collaborative project. Research Reserve needs are identified and prioritized in collaboration with partners, stakeholders, and end-users of the information. These topics are distributed annually by the NERRS Science Collaborative with the announcement of each year's request for proposals (RFP).

Comment:
There are a number of relevant water quality monitoring/research questions that could have a real nexus with management. Such as, how safe is the Hudson River for swimming. Could the Research Reserve have a role in measuring bacteria to better understand the relative contribution of tribs vs. wastewater plants of pollutants in the Estuary, whether that is bacteria or another micro-pollutant?

Response:
The Research Reserve does not currently have the capacity to monitor bacteria to determine swimmability of the Hudson River. We will explore the possibility of working with partners to measure bacteria at our current water quality monitoring stations.

Comment:
Understanding the ramifications of dam removal in Hudson River tributaries, gained through the research such as the Dams and Sediment in the Hudson (DaSH) project, will be extremely useful.

Response:
Research Reserve staff agree with the benefits of the DaSH project and hope to continue collaborative research on this topic.

Comment:
Given the recent development of a feasibility study (NY & NJ Harbor & Tributaries Focus Area Feasibility Study, HATS) from the Army Corps of Engineers (ACOE) to build storm surge barriers to manage damage from high-impact storm events, we urge the NERR'S program to prioritize involvement in the identified "Communities at Risk" threat. The habitats and shorelines of the estuary could be significantly impacted by physical barriers being proposed by the ACOE. We note that NERR'S scientific expertise and its significant knowledge of the estuary's unique and irreplaceable ecosystems and knowledge of the relationship between local, state and federal programs tasked with managing the resource could be an incredible asset to the broader estuarine community as it labors to understand the ACOE's complicated proposals. We encourage NERRS to participate in the on-going public process as the HATS advances.

Response:
Research Reserve agrees that the storm surge barriers in the HATS feasibility study may have an impact to the Hudson Estuary. Research Staff are currently working on a NRRS Science Collaborative project to inform the decision making related to the storm surge barriers in the metropolitan area. The project can be found in the Management plan in the Reserve Research Focus Areas, Climate Adaptation Impacts.

STEWARDSHIP AND RESTORATION

Comment:
If HRNERR is to continue using herbicides to manage Phragmites, research should be initiated to determine if rare biota, resource species (e.g., muskrat), etc., are adversely affected by toxicity of glyphosate, adjuvants, or other compounds. The literature on glyphosate toxicity is voluminous and it is clear that glyphosate at environmentally relevant levels has many nontarget effects on plants, animals, and other organisms as well as humans.

Response:
HRNERR is committed to applying best management practices to prioritize and address invasive species infestations while minimizing adverse non-target impacts. We will continue to evaluate existing and novel treatment options (chemical and non-chemical) and apply the best available science, management information, control techniques, and technologies to adaptively manage invasive species.

Comment:
We recommend careful consideration of the biological and social implications of applying glyphosate and other pesticides to wetlands and other natural areas to control Phragmites. We strongly support efforts at controlling Phragmites physically though methods such as inundation, solarizing, and mowing where feasible. We encourage further research into methods to control Phragmites and other invasive species without the use of pesticides.

Hudsonia's Phragmites Management Sourcebook for the Tidal Hudson River (https://hudsonia.org/wpcontent/files/Sourcebook%20for%20Reed%20Management%20April07.pdf) provides additional information and resources.

Response:
As indicated above, HRNERR is committed to applying best management practices to prioritize and address invasive species infestations while minimizing adverse non-target impacts. We will continue to evaluate existing and novel treatment options (chemical and non-chemical) and apply the best available science, management information, control techniques, and technologies to adaptively manage invasive species.

Comment:
Tivoli Bays, Young Forest Initiative, rather than clearcutting to create sapling wood or shrubland at Tivoli North Bay, a superior alternative would be to manage the shrubland that is already developing on the old fields at this site, by altering the mowing-brushhogging regime. Thirty acres of clearcutting would be a recipe for nonnative pest plant invasions.

Response:
DEC has not finalized the Habitat Management Plan (HMP) for Tivoli Bays. The HMP document will provide the basis for future habitat management actions at the WMA. DEC readily acknowledges that invasive plant species can negatively impact the outcomes of forest management activities. For any forest management activity that is proposed in the HMP, DEC will develop a detailed prescription that addresses, among other things, the management of competing vegetation including invasive plant species. This prescription will include specific management actions that will be undertaken before, during, and after the timber harvest to prevent invasive species from interfering with the objectives of the harvest.

DEC acknowledges that allowing the continued succession of the existing old fields at Tivoli Bays would create shrubland habitat that is similar in structure and function to the young forest habitat created through timber harvesting. However, the premise of the Young Forest Initiative is to create young forest/early successional habitat through forest management. Any significant deviations from this approach will be addressed in the forthcoming HMP.

Comment:
The fields at Ward Manor (east of North Bay) have been mowed in several years and at least two of them are well on their way to shrub dominance. Formerly I believe the fields were mowed in rotation for grassland birds. However, I think these fields are too small for most grassland breeding species to nest. I suggest that the fields be allowed to continue developing into shrubland which can then be managed by brushhogging in rotation, for shrubland wildlife.

Response:
As previously stated, DEC has not finalized the Habitat Management Plan for Tivoli Bays. The HMP document will provide the basis for future habitat management actions at the WMA. DEC generally concurs with the assessment that the old fields at Tivoli Bays are too small to support

breeding grassland bird species. However, the maintenance of some field acreage dominated by herbaceous vegetation contributes to the WMA's overall habitat diversity. Many generalist wildlife species utilize field habitats to fulfill specific life history requirements and species such as eastern bluebird and American kestrel rely on meadow habitats for breeding. Allowing shrub cover to continue to develop in some areas through a longer mowing rotation while maintaining other areas in herbaceous cover with a shorter mowing rotation will create a mosaic of early successional habitats that should benefit a variety of wildlife species.

Comment:
The long-term development of vegetation on patches where Phragmites has been herbicided at Stockport, Tivoli, and Iona may be different from the short-term development that is reported in the plan. I would like to see the monitoring data associated with the Phragmites management at those three sites analyzed and made public. HRNERR could play a leadership role in helping to develop non-chemical methods for managing Phragmites, something that is very badly needed. The plan should mention that a classical biocontrol program is being developed for nonnative *Phragmites australis australis* and discuss how this might affect the reserve marshes. Hudsonia has published that classical biocontrol, as currently proposed, is not a good idea.

Response:
HRNERR will continue to evaluate existing and treatment options (chemical and non-chemical) and apply the best available science, management information, control techniques, and technologies to adaptively manage invasive species. Research Reserve staff will continue to closely monitor the ongoing development of a classical biocontrol program for *Phragmites australis australis*.

Comment:
HRNERR should practice early detection – rapid response (EDRR), to detect cutleaf blackberry, *Rubus laciniatus*, also considered a component of *Rubus fruticosus* agg, on Iona Island east of the railroad. In 2011 there may have been only one or two plants. *R. fruticosus* agg. ("Himalayan blackberry") is considered very troublesome in the Pacific Northwest.

Response:
Reserve staff will work with New York State Parks to assess the status of *Rubus laciniatus* at Iona Island and develop appropriate management strategies.

Comment:
Solarization has been used successfully to manage Phragmites at Constitution Marsh. However, any management of invasive plants requires a long-term commitment, whether non-chemical or chemical.

Response:
HRNERR staff will be evaluating the feasibility, efficacy, and impacts of solarization at targeted locations within the Reserve. We acknowledge that invasive species management requires a long-term commitment, regardless of the control method.

Comment:
It should be noted that the central area of Piermont Marsh that, last I saw, was proposed for a forty-acre herbicide application to manage Phragmites, abuts shoreline stands of *Spartina cynosuroides, S. alterniflora,* and a sterile bulrush that could very well be the endangered New England bulrush.

Response:
Prior to initiating any specific management actions, vegetation surveys would be conducted to identify any rare or uncommon species. Protecting and enhancing native vegetation, including *Spartina cynosuroides*, *S. alterniflora*, and *Bolboschoenus novae-angliae*, is one of our primary management goals at Piermont Marsh.

Comments:
Regarding invasive plants, are the HRNERR sites being monitored for hydrilla? Although apparently limited to the Croton system, the estuarine circulation and high propensity of this species to disperse make it very likely that it has, or will, reach other Hudson River localities.

Response:
Reserve staff is working with DEC Bureau of Invasive Species and Ecosystem Health to monitor and treat Hydrilla in the Croton River.

Comments:
General comments about marshes and sea level rise. Study is needed of the railroads, Phragmites, beavers, and nitrogen influences on marsh accretion, persistence, and migration. Thin-layer augmentation is a good concept but the easier or extant mechanisms should generally be given priority.

Response:
Reserve staff will be considering feasible options to encourage the persistence of tidal wetlands during higher water levels in the Hudson River.

Comments:
Innovative projects should include testing modification of Phragmites stand architecture rather than chemical control. Phragmites provides many important ecosystem services, including biodiversity support, and it should be possible to have the desired diversity (including salt meadows at Piermont) and the non-habitat ecosystem services such as sediment building and stabilization and carbon sequestration. See papers by Kiviat, J Weis, and others on Phragmites.

Response:
Reserve staff are aware that Phragmites has value in the landscape and will be using that knowledge when managing the sites in the future.

Comment:
Knotweed is colonizing at Piermont, Tivoli, and Stockport, and I believe it's also present at Iona. It will be important for HRNERR to help address this incursion before knotweed becomes abundant in the Reserve and the rest of the estuary.

Response:
Reserve staff will assess the status of knotweed at Reserve sites and develop appropriate management strategies.

Comment:
Mention should be made of the importance of obtaining a conservation easement from Bard College around Tivoli South Bay (consonant with the Callendar House, Kaatsbaan, and Montgomery Place easements). The college refused in the 1980s and now is the time to re-open the discussion.

Response:
Reserve staff will work with Bard College to explore conservation easement options around Tivoli Bay South.

Comment:
There is a very short list of references at the end of the Management Plan. A complete list of interpretive and research publications and reports pertaining to the HRNERR sites should be provided or linked to. All data collected by HRNERR, and HRNERR-sanctioned researchers, should be made explicitly public. Making everything readily available is necessary to fulfill the Research and Monitoring Objectives stated earlier. Possibly the Marist College Library Hudson River collection could be a partner in archiving Hudson River research reports and publications.

Response:
The Reserve will be working in the near future to better document the research publications and reports that pertain to the Reserve sites.

Comment:
The plan should reference research that supports the goals and objectives. Professionals and the general public need to understand where the ideas come from, and that there is evidence that the proposed actions are needed and will work as suggested. It’s also important to show the reader that the preparers of the plan have consulted, and processed, the existing knowledge about the estuary, the four sites, and their biota and abiotic environment.

Response:
Reserve staff consult with key research partners and advisory committees to make sure the proposed work is relevant and feasible.

LAND ACQUISITION

Comment:
We encourage HRNERR to consider areas outside of current boundaries with regard to pathways for marsh migration in the face of sea level rise and *advocacy* for the transfer of OGS owned lands to other state agencies who may better steward them.

Response:
Reserve staff will continue to work with State Agencies and partners to find ways to protect tidal wetlands migration pathways.

OVERALL PLAN COMMENTS

Comment:
The second draft management plan for Piermont Marsh could be greatly improved by explicit attention to the following: 1. Reviewing previous research at Piermont 2. An even-handed and broad review of Phragmites ecology, habitat functions, and other ecosystem services 3. Noting the significance of the proposed Phragmites classical biocontrol project for the marsh, what effects it has on Phragmites and the rest of the ecosystem; 4. Addressing the confirmation of identification and, if correct, the protection of New England bulrush, which occurs at the western edge of the proposed 40 acres of herbicide application, as well as the associated big cordgrass and smooth cordgrass, and at the eastern (river) edge the lilaeopsis; 5. Intensively surveying the birds, mammals, and terrestrial insects of the marsh and if appropriate managing their habitats accordingly. For example, it is apparently assumed that there are no short-grass, high marsh animals at Piermont, but to my knowledge there has been no survey work in the short grass meadows at the appropriate seasons and times of day.

Response:
The Draft Piermont Marsh Reserve Management Plan (2017) is included as an appendix in the HRNERR Management Plan. Comments specifically on the Piermont Marsh Reserve plan will be addressed in future revisions of the document.

Comment:
We urge HRNERR to continue its collaboration between the state's natural resource agencies and the region's land trust community to identify strategic priorities for land acquisition in order to identify and implement the HRNERR's Management Plan's coastal and underwater land management objectives that strengthen climate resiliency, estuarine habitat connectivity and public access goals

Response:
Reserve staff is working with partners to move the management plan forward and look forward to new partners along the way.

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