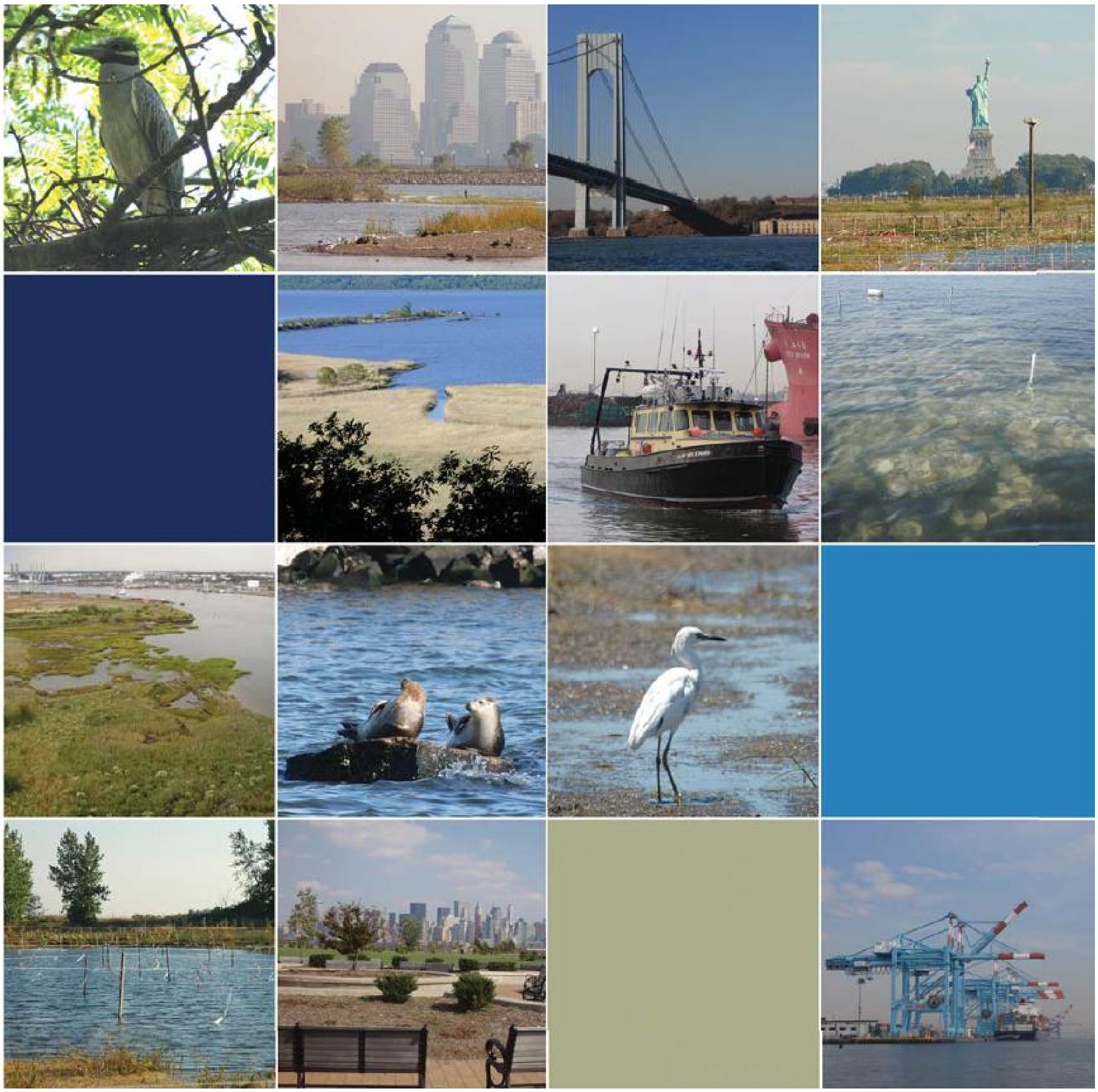
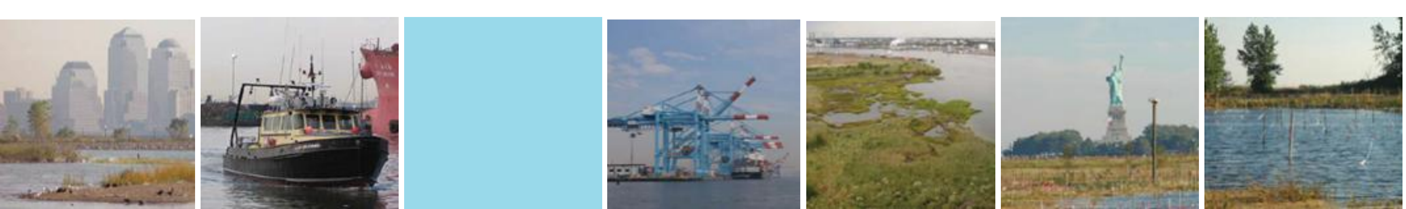
Hudson-Raritan Estuary Ecosystem Restoration Feasibility Study

Appendix O
Monitoring and Adaptive Management Plan

Draft Integrated Feasibility Report & Environmental Assessment
February 2017

Prepared by the New York District, U.S. Army Corps of Engineers





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Appendix O: Monitoring and Adaptive Management Plan

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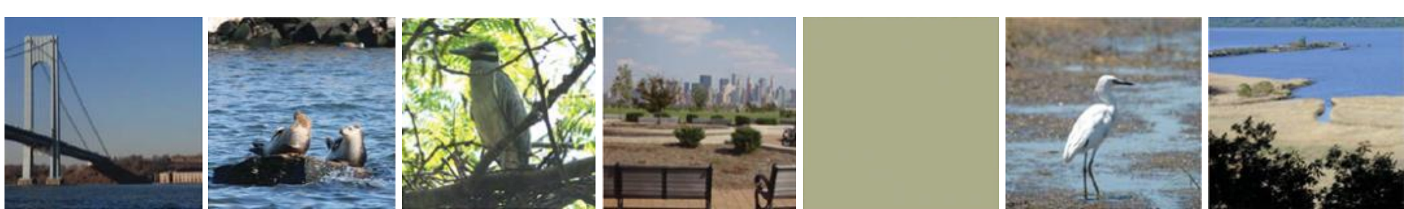


1 Introduction

This Monitoring & Adaptive Management Plan was prepared for the Hudson Raritan Estuary (HRE) Ecosystem Restoration Draft Integrated Feasibility Report and Environmental Assessment (FR/EA). Section 2039 of Water Resource Development Act (WRDA) 2007 (as amended by Section 1161 of WRDA 2016) directs the Secretary of the Army to ensure, when conducting a feasibility study for a project (or component of a project) under the U.S. Army Corps of Engineers (USACE) ecosystem restoration mission, that the decision document include a monitoring plan to measure the success of the ecosystem restoration and to dictate the direction adaptive management should proceed, if needed. The monitoring and adaptive management plan shall include a description of the monitoring activities, the criteria for success, and the estimated cost and duration of the monitoring as well as specify that monitoring will continue until such time as the Secretary determines that the success criteria have been met.

Section 2039 of WRDA 2007 also directs USACE to develop an adaptive management plan for all ecosystem restoration projects. The adaptive management plan must be appropriately scoped to the scale of the project. The information generated by the monitoring plan will be used by the New York District in consultation with the federal and state resources agencies and the USACE North Atlantic Division (NAD) to guide decisions on operational or structural changes that may be needed to ensure that the ecosystem restoration project meets the success criteria.

An effective monitoring program is necessary to assess the status and trends of ecological health and biota richness and abundance on a per project basis, as well as to report on regional program success within the United States. Assessing status and trends includes both spatial and temporal variations. Gathered information under this monitoring plan will provide insights into the effectiveness of current restoration projects and adaptive management strategies, and indicate where goals have been met, if actions should continue, and/or whether more aggressive management is warranted.

Monitoring the changes at a project site is not always a simple task. Ecosystems, by their very nature, are dynamic systems where populations of macroinvertebrates, fish, birds, and other organisms fluctuate with natural cycles. Water quality also varies, particularly as seasonal and annual weather patterns change. The task of tracking environmental changes can be difficult, and distinguishing the changes caused by human actions from natural variations can be even more difficult. This is why a focused monitoring protocol tied directly to the planning objectives needs to be followed.

This Monitoring and Adaptive Management Plan describes the existing habitats and monitoring methods that could be utilized to assess the project. By reporting on environmental changes, the results from this monitoring effort will be able to evaluate whether measurable results have been achieved and whether the intent of the Hudson Raritan Estuary Ecosystem Restoration Feasibility Study is being met.

1.1 Guidance

The following documents provide distinct USACE policy and guidance that are pertinent to developing this monitoring and adaptive management plan:

1. Section 2039 of WRDA 2007 Monitoring Ecosystem Restoration

   (a) In General - In conducting a feasibility study for a project (or a component of a project) for

ecosystem restoration, the Secretary shall ensure that the recommended project includes, as an integral part of the project, a plan for monitoring the success of the ecosystem restoration.

(b) Monitoring Plan - The monitoring plan shall--

(1) include a description of the monitoring activities to be carried out, the criteria for ecosystem restoration success, and the estimated cost and duration of the monitoring; and

(2) specify that the monitoring shall continue until such time as the Secretary determines that the criteria for ecosystem restoration success will be met.

(c) Cost Share - For a period of 10 years from completion of construction of a project (or a component of a project) for ecosystem restoration, the Secretary shall consider the cost of carrying out the monitoring as a project cost. If the monitoring plan under subsection (b) requires monitoring beyond the 10-year period, the cost of monitoring shall be a non-Federal responsibility.

2. Section 1161 of WRDA 2016. Completion of Ecosystem Restoration Projects. Section 2039 of the Water Resources Development Act of 2007 is amended by adding at the end the following:

(d) INCLUSIONS.—A monitoring plan under subsection (b) shall include a description of—

(1) the types and number of restoration activities to be conducted;

(2) the physical action to be undertaken to achieve the restoration objectives of the project;

(3) the functions and values that will result from the restoration plan; and

(4) a contingency plan for taking corrective actions in cases in which monitoring demonstrates that restoration measures are not achieving ecological success in accordance with criteria described in the monitoring plan.

(e) CONCLUSION OF OPERATION AND MAINTENANCE RESPONSIBILITY.—

The responsibility of a non-Federal interest for operation and maintenance of the nonstructural and non-mechanical elements of a project, or a component of a project, for ecosystem restoration shall cease 10 years after the date on which the Secretary makes a determination of success under subsection (b)(2).

(f) FEDERAL OBLIGATIONS.—The Secretary is not responsible for the operation or maintenance of any components of a project with respect to which a non-Federal interest is released from obligations under subsection (e).''.

3. USACE. 2009. Planning Memorandum. Implementation Guidance for Section 2039 of the Water Resources Development Act of 2007 (WRDA 2007) - Monitoring Ecosystem Restoration

4. USACE. 2000. ER 1105-2-100, Guidance for Conducting Civil Works Planning Studies.

5. USACE. 2003a. ER 1105-2-404. Planning Civil Work Projects Under the Environmental Operating Principles.

1.2 Project Area Description

Detailed description of the study area may be found in Chapters one (1) and two (2) of the Integrated Feasibility Report/Environmental Assessment (FR/EA). The study area is within the boundaries of the

Port District of New York and New Jersey, and is defined by a 25 mile radius from the Statue of Liberty. The actual borders of the HRE study area were delineated based on a combination of watershed boundaries and physical landmarks (USACE, 2004). The study area includes all tidally-influenced portions of rivers flowing into New York and New Jersey Harbor, including the Hudson, Raritan, Hackensack, Passaic, Shrewsbury, and Navesink Rivers, and the East River from the Battery to Hell Gate (USFWS, 1997). Located within the most densely populated area of the country and including the largest port on the East Coast, the HRE has tremendous ecological, historical, cultural, and recreational significance. Sites included in the plan are listed in Table 1-1.

The Jamaica Bay Planning Region is in the Atlantic Coastal Plain physiographic province. The center of the bay is dominated by subtidal open water and extensive low-lying islands with areas of salt marsh, intertidal flats, and uplands. The bay and barrier beach sediments are composed predominantly of sand and gravel derived from glacial outwash and marine sources. Surficial deposits on Long Island are glacial in origin with morainal deposits to the north and outwash deposits to the south. Extensive dredging, filling, and development have altered the landscape. Losses of upland and wetland buffers continue to threaten the estuary. Salt marsh islands that were once prevalent have subsided/eroded and are disappearing.

The Harlem River, East River, and Western Long Island Sound Planning Region lies with the Atlantic Coastal Plain physiographic province. Sediments vary depending upon location as a result of the complex flow patterns existing in the Long Island Sound, and overall HRE. Surficial sediments include both glacial and postglacial deposits, with the most recent glaciation period ending about 21,000 years ago. Surficial glacial deposits include till and stratified drift. Postglacial deposits consist of sand, marsh deposits, and estuarine silt.

The Passaic and Hackensack Rivers flow into the northern end of Newark Bay at Kearny Point. Newark Bay, the lower 14 miles of the Hackensack River, and the lower Passaic River are tidally-influenced. The upper Hackensack River is dammed north at the Oradell Dam. The Passaic River has multiple dams, the most downstream of which is Dundee Dam. Two (2) of the five (5) proposed oyster habitat restoration sites are located in Upper New York Bay. The remaining sites are at the mouth of the Bronx River, in Head of Bay within Jamaica Bay, and at Naval Weapons Station Earle in Lower New York Bay. All sites are in tidal waters of the Hudson Raritan Estuary, and border man-made structures and altered shorelines. Nearby soils on land are described, as they are potential sediment sources.

Table 1-1: List of Proposed Restorations Sites.

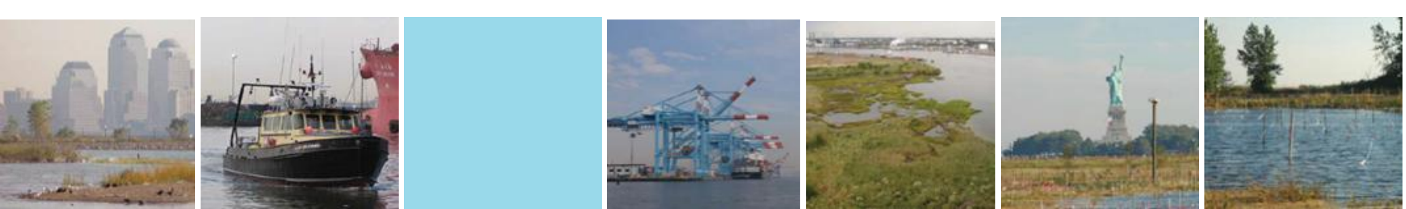
Planning Region	Primary Ecosystem Restoration Measure/Technique	Site Name
Jamaica Bay	Wetland Restoration/Creation (Invasive Species Removal, Native Plantings, Excavation, Backfilling, Grading), Breakwaters and Seawalls	Dead Horse Bay
		Fresh Creek
		Hawtree Point
		Bayswater Point State Park
		Dubos Point
		Brant Point
	Jamaica Bay Marsh Islands: Bank Stabilization – Wetland Restoration/Creation (Invasive Species Removal, Native	Stony Creek
		Duck Point
		Elders Center
		Pumpkin Patch West

Planning Region	Primary Ecosystem Restoration Measure/Technique	Site Name
Jamaica Bay	Plantings, Excavation, Backfilling, Grading)	Pumpkin Patch East
Flushing Creek	Dredging, Wetland Restoration/Creation (Invasive Species Removal, Native Plantings, Excavation, Backfilling, Grading),	Flushing Creek
Bronx River	Debris Removal, Channel Modifications, Wetland Restoration/Creation (Invasive Species Removal, Native Plantings, Excavation, Backfilling, Grading), and Aquatic Habitat Improvements	River Park / West Farm Rapids Park
		Bronx Zoo and Dam
		Stone Mill Dam
		Shoelace Park
		Muskrat Cove
		Bronxville Lake
		Crestwood Lake
		Garth Woods and Harney Road
		Westchester County Center
Lower Passaic River	Debris Removal, Invasive Species Removal, Channel Modifications, Wetland Restoration/Creation (Invasive Species Removal, Native Plantings, Excavation, Backfilling, Grading), Public Access	Essex County Branch Brook Park
		Dundee Island – Pulaski Park
		Clifton Dundee Canal Green Acres Purchase and Dundee Island Preserve
		Oak island Yards
		Kearny Point
Hackensack River	Debris Removal, Wetland Restoration/Creation (Invasive Species Removal, Native Plantings, Excavation, Backfilling, Grading), Channel Modifications/Creation, Aquatic Habitat Improvements, Public Access	Metromedia Tract
		Meadowlark Marsh

2 Monitoring Objectives, Strategy and Procedures

General Monitoring Objectives for the project include:

- To determine and prioritize needs for ecosystem restoration;
- To support adaptive management of implemented projects;
- To assess and justify adaptive management expenditures;
- To minimize costs and maximize benefits of future restoration projects;
- To determine "ecological success", document, and communicate it; and
- To advance the state of ecosystem restoration practice.



The purpose of this monitoring program is to assess the progress towards, and the success or failure of, the restoration of the respective habitats restored and the achievement of acceptable standards of salt marsh structure and function.

2.1 Monitoring Strategy by Habitat Type

This plan details the monitoring strategies for habitat types that mirror the four (4) planning objectives: 1) estuarine habitat, 2) riverine habitat, 3) Jamaica Bay marsh island habitat, and 4) oyster reefs. Since the Jamaica Bay marsh islands are estuarine habitat, the success parameters and monitoring for the two (2) habitats have been consolidated as "wetlands" for the purposes of this report. Thus, the habitat types detailed here are:

- Wetland habitat
- Riverine/Streambank Habitat
- Oyster reefs

All monitoring components of the strategies will continue to be refined and design and construction progresses for the specific habitats restored. This monitoring plan is based on feasibility level information.

2.1.1 Wetland Habitat

The purpose of the monitoring plan for wetland restoration/creation is to:

- Assess baseline conditions for water quality, vegetation, invertebrates, and other bioassessments;
- Evaluate the success of the wetland restoration/creation;
- Develop a better understanding of wetland restoration/creation opportunities and protection needs in the study area; and where applicable; and
- Involve community groups and schools, to the extent possible, in the monitoring activities.

The ecological parameters that will be monitored during pre- and post-restoration periods at wetland restoration/creation sites are:

- Water quality
- Vegetation
- Invertebrates
- Other bioassessments (birds and fish)

2.1.2 Monitoring Procedures

Pre-restoration monitoring protocols will seek to obtain baseline data for the specific site in order to establish the existing ecological conditions of the project site. This monitoring will take place within a two (2) year period prior to the start of project implementation. All ecological parameters will be monitored at least once within these two (2) years.

Post-restoration monitoring will begin four (4) to five (5) weeks after wetland restoration/creation is completed and continue each year for 10 years post restoration, or at five (5) years if restoration action

is deemed successful by Project Delivery/Monitoring Team. This initial site visit will include an assessment of the construction site and photographic documentation of the completed restoration area. After this assessment, post-restoration monitoring will occur once annually for 10 years, assessing all ecological parameters that are listed above. Post-restoration monitoring will seek to assess the success of the restored habitat using the protocols proposed in 2000 by the National Oceanic and Atmospheric Administration (NOAA) in their New York State Salt Marsh Restoration and Monitoring Guidelines Report. Protocols below have been modified from protocols used during other salt marsh and wildlife monitoring projects conducted by other resource agencies, as well as those followed by USACE. Vegetation at a local reference site, a wetland site that will remain unaltered during construction, will also be monitored pre- and post- restoration in order to better assess the establishment of wetland structure and functioning within a restored marsh. The reference site will help discern background environmental effects from the effects attributable to the restoration project. The reference site will be selected during the Pre-engineering and Design Phase (PED) of the specific site being restored.

After two (2) years post-restoration, the monitoring protocol will integrate the standard of 75 percent vegetative cover with a broad functional assessment focusing on the four (4) ecological parameters listed above. If the restored site fails to meet the requirements of 75 percent vegetation cover during the first two (2) years, the additional native vegetation will be planted to meet this goal. If, in the unlikely event, a native, sustainable ecosystem cannot be established within five (5) years at the site, changes and modifications to the project site will be initiated immediately by restoration ecologists. A redesign of the site will continue to occur on an ongoing basis in response to project failure. A new monitoring plan will be redrawn by USACE to accommodate these changes and monitor the success of the alteration.

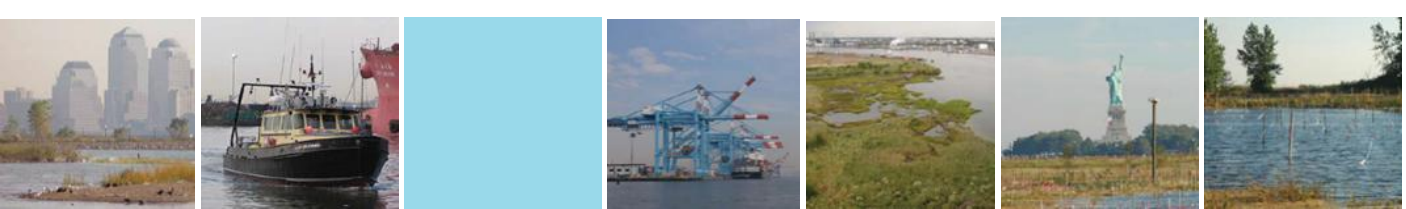
The following are monitoring procedures that will provide the information necessary to evaluate the success of the project. A number of these procedures are applicable to multiple performance measures and habitat. Further refinement of these procedures will be completed by USACE and its sponsors prior to the pre-construction monitoring period.

2.1.3 Water Quality Monitoring Methods

A Hanna Instruments Multiparameter Portable Meter (or similar device) will be used to record several aquatic parameters including salinity, temperature, pH, dissolved oxygen, total dissolved solids (TDS), and electric conductivity (EC). Water quality monitoring will occur once a month from June through September. Sampling will occur at two (2) locations within each project site. The sampling sites will be located at opposite ends of the site in order to get an accurate assessment of wetland functioning pre- and post- restoration within the project area. Water quality will be tested at approximately one (1) hour prior to high tide, during the flood tide as the water is entering the wetland system.

The location of the water quality testing sites will be recorded using a Global Positioning System (GPS) and will be marked with a stake and flagging at the nearest land point for relocation purposes. The distance and direction (using a compass) from the stake to the actual spot of water quality testing will be recorded in field notebooks for future relocation purposes as well.

The meter will be suspended at mid depth in the water column. Once at that depth the probe will be moved in slow concentric circles in order ensure fresh water flow over the meter. Once on site, the observer will also record the average wind direction and speed (measured by an anemometer), air temperature, and weather conditions such as precipitation.



Water quality will also be monitored once per year during or shortly after (≤24 hours) a major rain event (≥0.5”), and once during a dry period (≥7 days without rain). Peak flow conditions are critical to monitor, as these events show a wetland “in action,” as far as bioremediation is concerned. Pollutant levels are typically highest during periods of high flow.

Water salinity, temperature, pH, dissolved oxygen, TDS, and EC data will be compared both spatially (between observation sites) and temporally (between monitoring years) to determine changes in the aquatic habitat over the course of the monitoring period.

2.1.4 Vegetation Monitoring Methods

Vegetation will be monitored on the surface of the reference or restored area (salt marsh) using a sampling design consisting of 1.0 m^2 quadrats laid out along transects. During post restoration, additional quadrats will be placed in newly planted low and high marsh sections along the designated transects. All vegetation monitoring will occur during the last week of August and the first three (3) weeks of September.

2.1.4.1 Transect and Quadrat Design

Using aerial photography and ground surveys, transect lines will be randomly laid out across the proposed project area. The scientific literature states that monitoring transects should be a minimum of 5.0 meters long, and a maximum of 15 meters apart. For this site we will follow these set guidelines when possible in the reference site, but will alter length (extend transect to include restoration area) across the proposed project site. Prior to vegetation monitoring, observers will visit to the project site to determine the number of transect lines that will be suitable for the location.

To begin vegetation monitoring, a measuring tape marked in meters will run perpendicular to the tidal channel or open body of water that is parallel with the elevation gradient to designate the transects. At the upland region of the transect line a stake will be designated the 0 meter mark. A measuring tape will be run from the landward post to the water. The stake located at the end of the transect line at the water will be the seaward stake. This stake will record the total length of the transect line. Each end of the transect will be marked permanently with a stake and flagging at the point where the upland and wetland edges meet, or near the Mean High High water (MHHW) line, and at the water’s edge in the low marsh zone at low tide. During the placement of transect markers and vegetation monitoring, all efforts will be made to minimize trampling of vegetation along these transect line. We hope to use all transects pre- and post-restoration. The location of each transect marker will be recorded during pre-restoration monitoring using a Global Positioning System so that the transect markers can be relocated during future monitoring events.

Sampling quadrats will be 1.0 m^2 in size. Although the literature states that each transect should contain a minimum of three quadrats placed at a minimum of three different elevations between the seaward edge of the low marsh zone and the MHHW mark, transects for the pre-restoration monitoring will not contain as many quadrat samples. At each transect, one quadrat will be randomly placed within the low marsh along the transect line and the existing vegetation of the plot will be monitored. Quadrats will be placed on either side (randomly chosen) within one meter of the measuring tape. Once placed, the meter mark on the upper and lower edge of each quadrat will be marked permanently with stakes (rebar) and recorded on the measuring tape in meters. The exact location and side the quadrat will be placed on the transect line will be noted with a compass. This will facilitate relocating quadrats on subsequent monitoring visits. Locations chosen during the first monitoring cycle will be permanent locations to be revisited at each monitoring cycle that follows. Each quadrat location will also be recorded during pre-restoration monitoring using a Global Positioning System so that plots can be relocated during future monitoring events. Post-restoration monitoring will add an additional 2-3 quadrats along the transect line in order to evaluate new growth in the planted low and high marsh sections.

Conventional wetland monitoring states that the reference site should contain a minimum of one control transect including 3 quadrats and that the restored / recreated site should contain a minimum of three transects including 3 quadrats each. This maybe revised dependent on the reference site selected during the PED phase. All quadrats will be monitored for the 10 year post restoration period.

2.1.4.2 Photographic Evidence

Each transect line and 1.0 m^2 quadrat will be photographed facing channelward at the time of vegetation monitoring. Photographs will be taken once annually during the last week of August and the first three weeks of September, during vegetation monitoring.

All photographs must be taken at low tide. All transects will be photographed from the landward stake facing channelward and elevated at least fifteen feet above the wetland when possible. All transects should be identified in the photograph utilizing the code which incorporates the site information: The first two (2) letters of the site (capitalized) + the transect code (alphabetical and capitalized). Also, include the date of the photograph and the date that the site was first planted. All quadrats should be photographed facing channelward and identified in the photograph utilizing the same code system with the addition of the plot identifiers: The first two (2) letters of the site (capitalized) + The transect code (alphabetical and capitalized) + the plot code (alphabetical and lower case) + abbreviation of direction (N, S, E, or W; to indicate which side of the transect the plot is located on).

For reporting purposes, photographs (or digital images) will be 4 x 6 “prints secured to 8.5 x 11” paper or color photocopies of the original prints. All prints will be captioned with photo point code name (where applicable), direction of viewer is looking, and summary of pertinent information including date and time, tidal condition if ambiguous, and growing season. Slides are also acceptable and should be developed as 2” x 2” 35mm color slides. However, slide images must be scanned into 4” x 6” color images on 8.5” x 11” paper with captions for reporting purposes.

2.1.4.3 Vegetation

Vegetation will be monitored at least once, two (2) years prior to restoration and once annually post restoration for a minimum of 10 years. Monitoring of transects and quadrats will occur during the same time each year (during the last week of August and the first three [3] weeks of September).

2.1.5 Parameters to Monitor

2.1.5.1 Low Marsh Quadrat Sampling

2.1.5.1.1 *Plant Height*

Each 1.0 m^2 quadrat will be divided into four (4) 0.25 m^2 quadrats. One (1) 0.25 m^2 quadrat will be randomly chosen for counting Spartina alterniflora stem heights. During pre-restoration monitoring, five (5) of the tallest stems will be selected from random for height measurement within the sub-quadrat. Post-restoration, all stems within the 0.25 m^2 sub-quadrat, found inside newly planted low marsh plots,

will be measured to the nearest centimeter. The location of all sub-quadrats will be noted for each 1.0 m^2 quadrat and returned to in subsequent monitoring visits.

2.1.5.1.2 *Stem Density*

Using the same 0.25 m^2 sub-quadrat identified for measuring plant heights, stem density will be measured by counting each stem within the sub-quadrat. Once plant heights are measured during post-restoration in quadrats located in newly planted, each height measurement can be counted to give an accurate count of stems.

2.1.5.1.3 *Flowering Density*

The number of flowering stems within the same 0.25 m^2 sub-quadrat sampling area as Stem Density and Stem Heights will be counted and recorded.

2.1.5.1.4 *Percent Cover*

Throughout the entire 1.0 m^2 quadrat, the percent cover of selected indicator species (i.e. *Spartina alterniflora* in a tidal marsh) will be visually estimated. Spaces void of vegetation growth will also be taken into account when calibrating percent cover. Total percent cover will not equal greater than 100 percent. Once percent cover is visually observed, a cover class can be assigned for the indicator species in the plot:

- Cover Class I- 0-25 percent cover;
- Cover Class II- 26-50 percent cover;
- Cover Class III- 51-75 percent cover;
- Cover Class IV- 76-100 percent cover.

2.1.5.1.5 *Other Signs*

Any signs of disease, stress, herbivory or other events both in the vicinity of the length of the transect and within the quadrats will be noted during monitoring.

2.1.5.2 High Marsh Quadrat Sampling

2.1.5.2.1 *Species Composition*

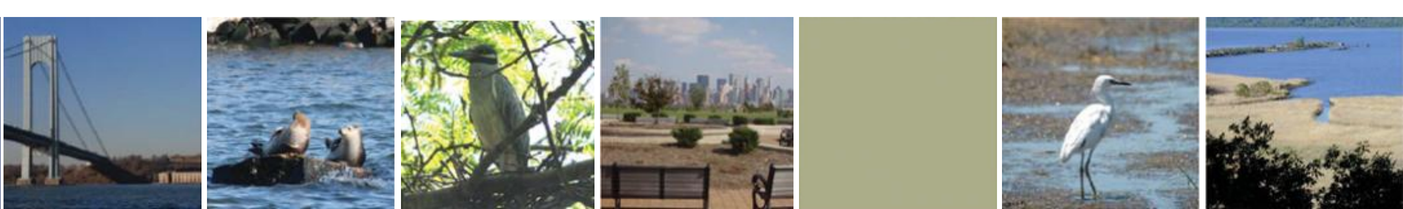
All species within a 1.0 m^2 quadrat will be identified.

2.1.5.2.2 *Plant Height*

Methods same as those listed above for Low Marsh Quadrat Sampling. This data will be recorded, when possible, for all plant species within the 1.0 m^2 quadrat.

2.1.5.2.3 *Stem Density*

Methods same as those listed above for Low Marsh Quadrat Sampling. This data will be recorded, when possible, for all plant species within the 1.0 m^2 quadrat.



2.1.5.2.4 *Flowering Density*

Methods same as those listed above for Low Marsh Quadrat Sampling. This data will be recorded, when possible, for all plant species within the 1.0 m^2 quadrat.

2.1.5.2.5 *Percent Cover*

Throughout the entire 1.0 m^2 quadrat, the percent cover of each plant species present will be visually estimated. Note that this measurement is a subset of total percent cover. When added to percent cover estimates of all other species within the plot, Total percent cover will not equal greater than 100 percent. Once percent cover is visually observed, a cover class can be assigned for each species:

- Cover Class I- 0-25 percent cover;
- Cover Class II- 26-50 percent cover;
- Cover Class III- 51-75 percent cover;
- Cover Class IV- 76-100 percent cover.

2.1.5.2.6 *Other Signs*

Any signs of disease, stress, herbivory or other events both in the vicinity of the length of the transect and within the quadrats will be recorded, when possible, for all plant species within the 1.0 m^2 quadrat.

2.1.5.3 Line Intercept Vegetation Monitoring - Total Vegetation Cover, Frequency, and Absolute Cover

While the monitoring of quadrats along intertidal marsh transects is useful for recording and tracking the success or failure of wetland plantings over time, fine-scale shifts in plant species populations are less easily ascertained using such methods. In order to monitor changes in habitat types (and / or species shifts) over time, an additional level of monitoring was added to the pre-existing protocols. The use of line-intercept surveying at the decimeter level was employed as a means of monitoring habitat (or species) shifts in vegetation zones within the reference and restored transects post-restoration. The purpose of this element of monitoring is to assess the progress of a restoration site as measured by plant survival, recurrence of invasive vegetation, and arrival of new recruits. Data for each transect will be analyzed to determine the total cover, frequency (also known as absolute cover), and relative cover of each species occurs along each full transect. Line intercept vegetation monitoring will only occur during the post-restoration period, since the project area will be severely altered during construction.

After placement of transects has been determined, each transect will be measured for the presence / absence of all species along the length of the transect line. The observer will walk the length of the transect line starting from the upland edge post (0m) and walking toward the water and the seaward post, stopping at each decimeter for plant observation. All plant species present within each decimeter interval will be noted. To determine if a species is present within a decimeter or not, one edge of the tape measure will be chosen for the survey. The interval along that edge of the line will be examined to determine if a leaf / stem / or other plant part is crossing the tape measure. If a plant is near, but not crossing, it does not count as present within that decimeter interval. The presence data collected will be recorded on field datasheets and later entered into a computer database.

The following parameters will be determined from data collected during line intercept vegetation monitoring:

Total Cover:

Total number of decimeter samples – bare ground decimeter samples
Total number of decimeter samples

*Frequency (absolute cover): **

Number of decimeters intercepting species A
Total number of decimeter samples

Relative Cover:

Number of decimeters intercepting species A
Total number of decimeter samples – bare ground decimeter samples

** Note: The sum of all individual species frequencies, when added may be greater than 100 percent. Data may be further analyzed to include measures of species richness, diversity, or other responses as appropriate.*

All vegetation characteristics recorded during monitoring will be used for spatial (between observation sites) and temporal comparisons (between monitoring years) within and between the reference and the restoration site. This data will also be used to determine changes in habitat for both sites over the course of the monitoring period.

2.1.6 Invertebrate Monitoring Methods

Macro invertebrates will be monitored on the surface of the wetland area during vegetation monitoring. Invertebrate monitoring will occur at least once a year for five (5) years during the time of vegetation monitoring. Other invertebrate organisms present within the plot will also be noted and counted (when practical).

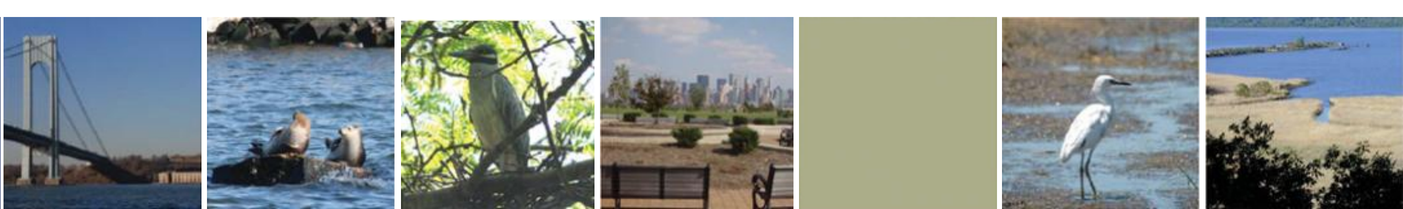
Macro invertebrates will also be monitored during fish seining activities (see ***"Fish"*** below for methods). This information will be combined with the invertebrate information collected during vegetation monitoring. Total number of organisms, species richness, and species abundance will be compared both spatially (between observation sites) and temporally (between monitoring years) to determine changes in habitat use by invertebrates over the course of the monitoring period.

2.1.7 Bioassessment Monitoring Methods

2.1.7.1 Birds

Four (4) types of avian groups will be monitored during pre- and post-restoration periods at each restoration site. The four (4) avian groups that will be monitored include: winter waterfowl, shorebirds, wading birds, and breeding birds. All observation points will be used throughout the pre- and post-restoration monitoring period. Only sites which allow full visual coverage of the water body or mudflat will be chosen for monitoring. To avoid double-counting birds, the distance at which birds are easily identifiable using binoculars and a spotting scope will be determined. Birds beyond this distance in the count from any particular observation point will not be counted. Therefore, each observation point will be independent of other observation points, and will not allow for overlap in bird observations.

All observation point(s) locations will be recorded with GPS. In addition, the location of large physical features in the landscape (large trees or rock outcroppings) will also be recorded with GPS. A written



description of the observation point(s), an explanation on how to locate them, and, if applicable, the compass directions that delineate the parts of the water body to be surveyed from each observation point will be documented along with the GPS data. All of these recordings will aid future observers in locating the observation point.

Surveys will not be conducted in rain heavier than a drizzle or in strong wind, because these conditions reduce observer visibility. If a survey cannot be conducted due to weather, or for other unforeseen event, the count will be conducted on the next possible day in which weather is suitable for bird monitoring. Once on site, the observer will record the average wind direction and speed (measured by an anemometer), temperature, weather conditions such as precipitation, and name of observers. Other environmental conditions, such as construction in progress that may affect bird numbers will be recorded at this time. The observers will remain at the observation point during the full observation period, getting up and moving around as little as possible during this time to minimize bird disturbance.

Observers will become familiar with bird species prior to field work. For breeding bird surveys, the observers should be able to identify species by sight and song. It is useful to compile a list of the birds most likely to breed on site prior to starting the survey so that observers can concentrate their learning on those species. Also, all observers will use USGS bird codes during data recording to identify bird species seen in the field. Further information about bird codes and an entire list of bird codes can be found on the USGS Laboratory for North American Bird Banding (Laurel, MD) website at http://www.pwrc.usgs.gov/bbl/manual/bandsize.htm.

Field data collected at the restoration site and at the reference site will be used to determine total number of organisms, species richness, and percent abundance of species. Total number of organisms, species richness, and species abundance will be compared both spatially (between observation sites) and temporally (between monitoring years) to determine changes in habitat use by birds over the course of the monitoring period.

2.1.7.2 Winter Waterfowl

During pre-restoration and post-restoration, the site will be visited twice per month (November through February) on pre-determined days and times. The species and number of all waterfowl present on the waterbody is recorded at each observation point. A tally-counter will be used to keep track of numbers of large, dense flocks of birds. The counting methods described on p. 164 of Bird Census Techniques (Bibby et al., 1992) can be used to increase observer counting accuracy. Waterfowl counts should be done on an incoming tide, between mid- and high tide.

2.1.7.3 Shorebirds

The ideal observation point should allow the observer unobstructed views of the entire mud or sand flat where shorebirds are expected to forage during low tide. During pre-restoration (Year 0) and post-restoration (Years 1-5) the site will be visited four (4) times during the migration season (April 1 through June 15), including at least one (1) visit at the time of the full moon in either May or June (when horseshoe crab spawning peaks, providing eggs as shorebird food). Observations will be made in increments of one (1) hour; starting a new field data sheet when each hour is up. The species and number of individuals of all shorebird observed during each time period in the study area, at each observation point, will be recorded during the site visit. Behavioral notes will also be recorded during monitoring. Shorebird counts should be done on an outgoing tide, between mid- and low tide.

2.1.7.4 Wading Birds

During pre-restoration (Year 0) and post-restoration (Years 1-5) the site will be visited once a month during wading bird breeding season from late April through mid-August. Each visit will occur during the rising tide, since wading birds do most of their hunting within salt marshes as fish swim into the salt marsh with the incoming tide. A point count and strike survey will take place each month.

For the point count, the species and number of all wading birds present on the waterbody will be recorded at each observation point. During monitoring, bird locations within the project area will be recorded on maps. Behavioral notes will also be recorded during monitoring. All bird species, including waders and non-waders that visit the site, will be noted during the monitoring period as well.

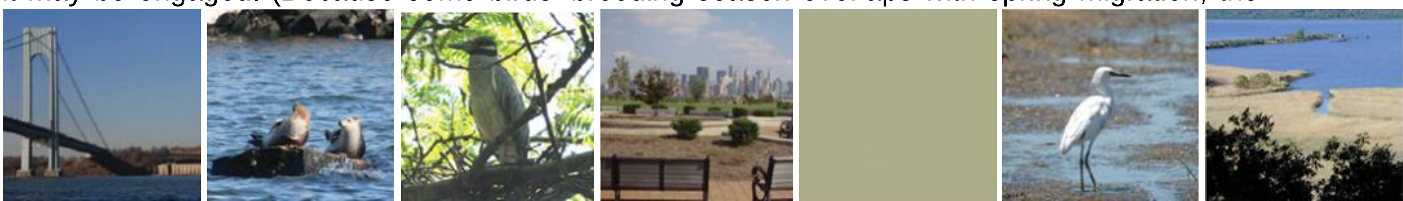
For strike surveys, one (1) observation point will be chosen. The strike survey observation period will be one (1) hour in length and randomized to tide, time of day, and phase of the breeding season. Observers will visually follow each bird that enters the observation area. The arrival and departure times of each wading bird under observation will be recorded, as well as the direction from which it arrives (North, South, East, West) and to which it departs. The observer will record, when possible, each bird's species and the number of strikes the bird makes into the water for prey during the study period, differentiating between successful and unsuccessful strikes. A site map will be marked to identify the location of the wading birds under observation. If the numbers of birds makes this impractical, observers will only follow as many birds as possible within the one (1) hour period. Post-restoration, notation will be made on a map to locate where on site (i.e. within restoration area or not) the birds are foraging. The monitoring efficiency (the percentage of strikes resulting in the capture and ingestion of prey) will be determined for each bird that is observed during the monitoring period (Kent, 1986).

2.1.7.5 Breeding Birds

During pre-restoration and post-restoration the site will be visited eight (8) times between late April and early August. Six (6) of these visits will occur during the peak-breeding season (late May through mid-July), and ideally will be as closely spaced as possible during this period. Because some birds move their territories partway through the season, more widely spaced visits may yield confusing data. At least one (1) visit will be made to the site in late April/early May. Also, at least one (1) visit will be made during the first half of August. These outlying visits are to register early and late breeders, such as black-capped chickadee (*Poecile atricapillus*) and American goldfinch (*Spinus tristis*), respectively. All visits will begin either within half an hour after sunrise or within two (2) hours of sunset, to coincide with periods of peak bird activity. Early morning is preferable for the majority of the visits, but one (1) or two (2) late afternoon visits will allow you to register species more active in the evening, like nighthawks and thrushes.

Observers will obtain a cover-type map of the project area (restoration site and areas whose vegetation is directly affected by restoration) and surrounding areas. Next, one (1) to three (3) survey points in each cover-type and one (1) survey point at each interface between cover-types will be chosen for observation at random. The survey points will be marked and numbered on a map and at least two (2) different routes will be drawn connecting these points. The routes will not have the same start and end points. These points and routes will be recorded using GPS.

During each visit the observer will walk one (1) of the routes, stopping at each survey point. For ten minutes, they will record the species of each bird seen, as well as any breeding-associated behavior in which it may be engaged. (Because some birds' breeding season overlaps with spring migration, the



behavior information may be useful for breeding bird censuses conducted at the same site). The observer will be sure to record multiple individuals of the same species singing simultaneously (call and answer) because these registrations are vital for determining numbers of territories on the site. The bird's sex and age (i.e. adult/juvenile) will be recorded when possible.

Observer field notes should include the different species observed at each point and the numbers of individuals of each species observed. The position of each bird observed will be marked on the cover-type map (one map for each visit) for that site visit.

This data will be used to create clusters (groups of registrations that correspond to the same territory/bird) and designate breeding status based on the data maps from the site visits. Breeding status is either confirmed breeding, probable breeding, or possible breeding. Approximate the locations of breeding territories using the following technique: compile all the registrations for a single species onto a separate map, using different colors for different visit dates. (In some cases, where most of the registrations do not overlap, you can compile the data for two [2] or more species onto the same map.) Create territory clusters by examining observations of different birds heard or seen simultaneously (designated by dashed line between the registrations). These birds must be included in different territories. Observations from the same visit recorded as the same bird (designated by a solid line between registrations) must be included in a single territory. Where this information is not available, delineate clusters based on spatially proximity of registrations of the same species. For a fuller account of rules for creating clusters, refer to Chapter 3 of Bird Census Techniques (Bibby et al., 1992). Classify clusters as possible, probable, or confirmed breeding territories according to the following schema:

Confirmed Breeding: The cluster contains registrations of a singing bird from at least three (3) separate visits, OR at least one (1) of the following registrations: an active nest, a bird carrying food or a fecal sac, bird performing distraction display or injury-feigning, or unfledged young within the territory cluster area. These latter observations confirm breeding regardless of the number of other observations of a conspecific with the territory on other visits.

Probable Breeding: The cluster contains registrations of a singing bird on at least two (2) separate visits, OR at least one (1) of the following registrations: a bird carrying nesting material or engaged in nest-building, pair observed in suitable habitat for breeding, or bird performing courtship and display, agitated behavior, or anxiety calls is observed within the territory area.

Possible Breeding: A single observation of a singing bird in suitable breeding habitat constitutes possible breeding.

2.1.7.6 Fish

Fish will be sampled within the open water once a month from June through September at two (2) sampling stations. The two (2) sampling stations will be determined during site visits prior to monitoring. Sampling sites will be easy to access from land and safe for volunteers and assistants. If at any time prior to or during fish sampling the site becomes dangerous to volunteers and observers the sampling event will be postponed to the next immediate available date and time.

All sampling will occur during the same tidal stage (flood tide) and water level (approximately one [1] to three [3] hours before high tide) to reduce the effects of tide on composition and relative abundance of fish caught, since tide influences fish behavior. Sampling locations will be defined at the nearest land location with stakes or flagging for future relocation. The location of sampling stations will also be

recorded using a GPS unit. Both stations will be visited each year, pre and post restoration for sampling.

Fish will be sampled at this site using a bag seine. The seine (4 ft. high, 30 ft. long, 1/8 in mesh) will contain floats for buoyancy and weights every six (6) inches along the bottom allowing the net to drag on lagoon bottom, which will ensure full range of sampling within the water column. A minimum of three (3) people will be needed to hold the seine and collect the samples. All researchers and volunteers will soak their hands in the lagoon water prior to handling fish to ensure that no body oils, soaps, or lotions will be transmitted from human hands to the scales and skin of the fish. Fish and invertebrates will be placed in buckets full of lagoon water in preparation of processing. Each fish will be identified and measured in a straight line distance, from tip of snout to the posterior end of the vertebral column, on a fish board. Fish will not be measured from tip of the snout to the end of the caudal tail because this measurement can be inaccurate if the fish has damage to these fins. Crabs will be measured with calipers in a straight line distance along the widest part of the carapace. The first 50 of any species will be measured. If over 50 of any one species are caught, the fish will simply be identified and placed back into the water. If, for whatever reason, processing is delayed or is taking an excessive amount of time, the remaining fish and crabs in the sample will not be measured and will be returned to the water as quickly as possible in order to reduce stress on the organisms.

Field data collected at the open water portion of the restoration site will be used to determine total number of species caught, species richness and species abundance. This data will be compared both spatially (between observation sites) and temporally (between monitoring years) to determine changes in habitat use by fish over the course of the monitoring period.

2.2 Riverine/Streambank Habitat

The purpose of the monitoring plan for riverine habitat is to:

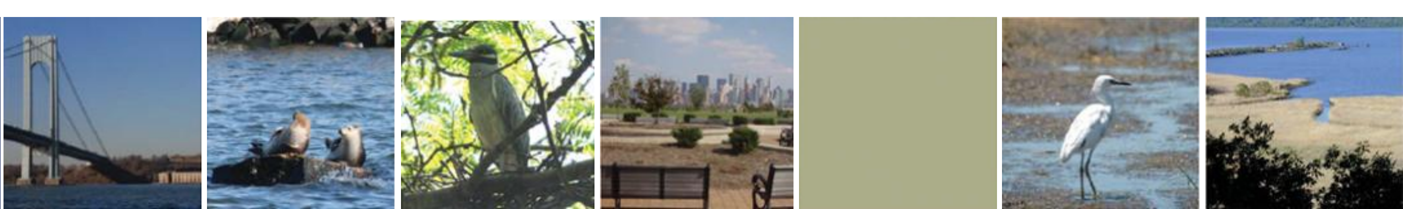
- Assess baseline conditions for water quality, vegetation, invertebrates, and other bioassessments;
- Evaluate the success of the riverine habitat restoration/creation;
- Develop a better understanding of riverine restoration/creation opportunities and protection needs in the study area; and where applicable; and
- Involve community groups and schools, to the extent possible, in the monitoring activities.

The ecological parameters that will be monitored during pre- and post-restoration periods at riverine restoration/creation sites are:

- Water quality
- Vegetation
- Invertebrates
- Other Bioassessments (birds and fish)

2.2.1 Monitoring Procedures

Because the purpose and parameters are the same for marsh habitat, the same sampling procedures and ecological parameters will be used at riverine restoration/creation sites, as applicable. Bank full discharge and stage are important parameters in the design of streambank restoration projects. Precipitation and river discharge will obtained to calculate annual mean flows and the 1.5 year



recurrence interval discharge. Sampling methods and parameters unique to fish passage are being developed in coordinating with the non-Federal sponsor. They will be included in a future version of this plan.

2.3 Oyster Reefs

The monitoring protocol describe below was taken from the Oyster Restoration Research Project (ORRP) study effort that was developed to assess the development (oyster retention, growth and survival) and performance (water filtration and habitat provision) of experimental reefs at five (5) sites within the study area.

2.3.1 Monitoring Procedures

2.3.1.1 Reef Development and Usage

Reef development will be primarily assessed by taking replicate 0.1 m2 quadrat samples.
The replicate 0.1 m2 quadrats will be placed haphazardly distributed systematically across each reef structure. All loose shell material on the surface of the reef will be removed from each quadrat and the contents will be placed in a plastic tray and returned to sampling vessel or shoreline for processing. All live and dead bivalves will be identified and measured (shell height or length to nearest mm using calipers or a ruler). Only measurements of bivalves with two (2) intact shells will be made. After processing, all samples were returned to each respective the reef.

2.3.1.2 Water Quality

Water quality data will be collected during every monitoring event with a handheld YSI meter (or similar device) measuring dissolved oxygen, water temperature, salinity and pH. Additionally, data sondes (with sensors for chlorophyll a, turbidity, temperature, salinity, dissolved oxygen, and depth) will be placed at each site from May to October to replicate prior collected data.

Whole-reef water filtration will be measured on the larger reefs using in situ fluorometers and following methods in Grizzle et al. (2006, 2008). This would consist of placing one (1) fluorometer immediately upstream and another downstream of the reef and recording data at frequent intervals. The fluorometer readings are directly related to the concentration of chlorophyll a in the water column, and are sometimes reported as relative fluorescence units, or simply as millivolts (mV) in the present study. If several simplifying assumptions (e.g. well-mixed water column; see Grizzle et al. 2008 for details) are made, a simple calculation of the difference between the two (2) readings provides a direct measure of how much chlorophyll is being removed and how much of the overall water column is being filtered. Fluorometer data will be recorded at 5-second intervals for up 1.5 hours at the selected study reef.

2.4 Monitoring Responsibilities

The responsible parties for the ten year standard monitoring will be USACE and the implementing non-federal sponsor. Any standards presented in this plan are to be used as guidelines for evaluation. Closer investigation will be performed by the monitoring and adaptive management team which shall consist of at least one (1) representative of the following agencies: USACE, NOAA Fisheries, United Stated Fish and Wildlife Service (USFWS), New York State Department of Environmental Conservation (NYSDEC), New York State Department of State (NYSDOS), and New York City Department of Environmental Protection (NYCDEP). The regulatory agencies responsible for approving the restoration designs, monitoring protocols, and any required permitting for restoration activities are the NYSDEC and New Jersey Department of Environmental Protection (NJDEP), depending on the location of the site.

2.4.1 Reporting Results

A yearly monitoring summary report would be drafted by the USACE that briefly summarizes the data collected and determines if adaptive management is needed. A final monitoring report would be drafted that details the outcomes of each constructed restoration project. Included in each report shall be the monitoring data, photographs, a brief summary of the collected data, and a discussion of the data collected.

3 Adaptive Management

Adaptive management in the context of this project is an approach to resource management in which management goals remain the same, but management objectives and techniques may be modified in response to feedback (such as monitoring results) from the system being managed. Adaptive management recognizes that human knowledge regarding biological and physical systems are limited and that these systems may not always respond as expected. When a management or restoration project is to be implemented but there is some uncertainty regarding the response of the system to particular actions, adaptive management provides a way for management actions to respond to feedback from the system being managed.

Adaptive management will be implemented if specific restoration standards are not met or if it appears that actual conditions will diverge sufficiently far from the intended conditions to threaten the achievement of overall project goals. Funding for adaptive management will be included in the project cost estimates so that this option will be available in the future if needed.

3.1 Wetland Habitat

The focus of specific parameters for adaptive management for wetland restoration/creation is vegetation density, and health and vigor. After two (2) years post-restoration, the monitoring protocol will integrate the standard of 75 percent vegetative cover with a broad functional assessment focusing on the four (4) ecological parameters listed above. If the restored site fails to meet the requirements of 75 percent vegetation cover during the first two (2) years, the additional native vegetation will be planted to meet this goal. If, in the unlikely event, a native, sustainable ecosystem cannot be established within five (5) years at the site, changes and modifications to the project site will be initiated immediately by restoration ecologists. A redesign of the site will continue to occur on an ongoing basis in response to project failure. A new monitoring plan will be redrawn by the PDT to accommodate these changes and monitor the success of the alteration.

3.2 Riverine/Streambank Habitat

The focus of specific parameters for adaptive management for riverine habitat restoration/creation is the same as those for wetland restoration/creation. Therefore, the adaptive management approach is the same. Parameters unique to fish passage are being developed in coordinating with the non-federal sponsor. They will be included in a future version of this plan.

3.2.1 Oyster Reefs

For oyster reef creation, adaptive management will primarily consist of monitoring the substrate in years after initial planting and decide whether it is necessary to add more shell to provide additional clean settlement sites and monitoring recruitment and decide if the site is recruitment-limited and provide justification for brood stock enhancement.

4 References

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