

Oyster Restoration Feasibility Study

Project Summary

2010

Hudson River Foundation, NY/NJ Baykeeper, U.S Army Corps of Engineers, Port Authority of New York/New Jersey, The Urban Assembly New York Harbor School, The Harbor Foundation, Governors Island Preservation and Education Corporation, Hudson River Park Trust, NY/NJ Harbor Estuary Program, NY City Parks Department, NY City Department of Environmental Protection, U.S Environmental Protection Agency, New York State Department of Environmental Conservation - Hudson River Program, Bart Chezar

A collaborative partnership to determine the feasibility restoring oysters to the NY/NJ Harbor Estuary

1. Introduction:

Oysters were once a very abundant and cherished resource of the Harbor estuary. An account from Ingersoll, published in 1887, describes oyster beds and reefs covering a large fraction of the Harbor area. *“Oysters once grew naturally all along the Brooklyn shore, and in the East River; all around Manhattan Island ; up the Hudson as far as Sing Sing; Out to the Jersey shore from that point to Keyport, N. J., and in Keyport, Raritan, Newark, and Hackensack Rivers; all around Staten Island, and on many reefs and wide areas of bottom between Robyn's Reef and Jersey City.”* By the early 20th century, sediment and water pollution and over harvesting had all but eliminated these once dominant features. While no known reefs and only a handful of individuals remain today, water and sediment quality has improved dramatically and the restoration of the Eastern oyster (*Crassostrea virginica*) to the Harbor Estuary may now be possible. The promise of their restoration has captured the interest of scientists, policy makers, and the general public, all recognizing the importance of the oyster as a symbol of environmental improvements, and as a means of further connecting people to the estuary.

Restoring oysters and oyster reefs is one of the eleven restoration targets making up the regionally developed and supported Comprehensive Restoration Plan (USACE, 2009). The Comprehensive Restoration Plan (CRP) sets a goal of restoring 500 acres of oyster reef by 2015 and 5,000 acres by 2050. Historically, the primary interest in the oyster was as a food product and little attention was paid to their contribution to the ecosystem. While the historical importance of the oyster fishery to the NY/NJ Harbor is clear, our region’s restoration efforts are not aimed at reviving the lost commercial fishery but instead are focused on achieving ecosystem benefits. Our oyster restoration efforts are expected to result in enhanced ecological services, primarily through the addition of unique three-dimensional habitats for fish and invertebrates. Oyster reefs may also contribute other ecological benefits such as water filtration, nutrient cycling, and shoreline stabilization.

Oyster Restoration Feasibility Study Partnership

A partnership¹ of not-for-profit organizations, federal, state and city agencies, citizens, and scientists have come together to advance oyster restoration research in the NY/NJ Harbor Estuary. The partnership is a collaborative effort designed to maximize the use of the available resources and the partners’ expertise. The Partners will contribute a combination of funds, equipment, and personnel and have agreed to fulfill specific obligations, which together make up the complete project proposed here. The partners have also agreed to meet regularly as part of the NY/NJ Harbor Estuary Program’s (HEP) Oyster Workgroup, a sub-group of the HEP Comprehensive Restoration Plan workgroup.

¹ Hudson River Foundation, NY/NJ Baykeeper, U.S Army Corps of Engineers, Port Authority of New York/New Jersey, The Urban Assembly New York Harbor School, The Harbor Foundation, Governors Island Preservation and Education Corporation, Hudson River Park Trust, U.S Environmental Protection Agency, NY/NJ Harbor Estuary Program, NY City Department of Environmental Protection, NY City Parks Department, New York State Department of Conservation - Hudson River Program, NOAA Restoration Center, Bronx River Alliance, Rocking the Boat, Bart Chezar-Bay Ridge Flats Oyster Project

2. Main Objectives and Project Background

The goal of the project is to further scientific understanding of oysters reintroduced into the NY/NJ Harbor Estuary. This project is a necessary next step to determine the feasibility of achieving the oyster restoration targets of the Comprehensive Restoration Plan for the Hudson-Raritan Estuary (see www.thewatersweshare.org) By constructing several experimental reefs, monitoring their development, and researching how oysters are affected by natural forces and how the surrounding environment is affected by oysters, the project will provide important new information from which larger scale restoration decisions can be made.

Over the past few years, several organizations have been involved in oyster-related activities, including oyster gardening, pilot reef construction, and scientific research. These activities have helped to cultivate the public's interest in oysters, promoted education and stewardship of the estuary and developed new scientific insights about the potential survivability of reintroduced oysters. The release of the draft CRP and its endorsement by the Harbor Estuary Program's Policy Committee last year has added impetus and focus to ecosystem restoration of the Harbor Estuary, especially with regard to oysters.

In August 2009 the Hudson River Foundation convened a panel of expert oyster scientists to review the local ongoing efforts and to make recommendations for further scientific investigation that would be necessary to determine the feasibility of large-scale oyster restoration, consistent with the targets outlined in the CRP.

The outcome of the panel's deliberations produced several important conclusions. The panel found that while the ongoing scientific research, involving the deployment of oysters in small caged environments, is providing valuable insights into the growth and survival of reintroduced oysters, additional study is necessary to evaluate a fuller range of natural factors that affect the development of oyster reefs. These include the influence of predators, and other biological and physical interactions that cannot be addressed in the ongoing caged experiments. The panel recommended that the best way to address these issues was to build several experimental small-scale reefs throughout the lower estuary and observe their development. In addition, the experimental reefs provide an opportunity to conduct experiments to evaluate how oysters also affect their surroundings (e.g., changes in aquatic communities and new ecological services provided the reefs.)

Another major conclusion was that the ongoing efforts of the various entities working with oysters should be coordinated and consolidated into a cohesive partnership. With the groups working together, greater efficiencies could be realized and a consistent, integrated scientific effort could be achieved at many sites within the estuary.

This project will also serve as a new platform for numerous education and outreach opportunities. Partners will have ready access to the data collected and are expected to develop their own related programming to further engage the public in the oyster restoration effort and the overall ecosystem restoration agenda.

3. Study Design

The project will construct and monitor small experimental reefs sites at 5 locations² throughout the Estuary (Figure 1). The experimental reefs will be designed to mimic natural oyster reefs and be large enough to allow for sufficient sampling during monitoring and research activities. Monitoring and research experiments will be conducted to characterize the development of the oysters and assess the ecosystem services they provide (or affect). Base environmental variables will also be monitored to track changes in conditions relevant to reef development and performance.

The Hudson River Foundation is responsible for the overall coordination of the project. Dr. Ray Grizzle of the University of New Hampshire is the principal investigator (PI) for the research project. Dr. Grizzle oversee the *reef assessment* portion of the project, beginning with the construction of the experimental reefs through to the analysis of reef development and performance. The experimental reefs are designed to serve as platforms for oyster research so in addition to the data being collected and analyzed by the project team, in the fall of 2010 the project will release a call for proposals primarily directed at assessing the ecosystem services provided by and affected by the reefs. Responding investigators will have access to all monitoring and reef development data to be collected by ORRP partners. ORRP partners have facilities, equipment and vessel support that may be shared with responding investigators. It will be incumbent on prospective investigators to explore cooperative arrangements with the ORRP members. An outside peer review panel will review the proposals and make recommendations to the project. The PI will coordinate with the outside researchers to ensure their activities do not impact the reef development or reef performance assessment. All the data collected under the project will be shared and accessible.

Figure 1. Proposed Experimental Reef Locations



²Dubos Point in Jamaica Bay, NY will be permitted, constructed and monitored by the NYCDEP.

Monitoring to Assess Reef Development

The objective of this monitoring effort is to document the timing of important changes such as time of reproduction, significant die-offs and influxes of predators. We will also monitor the location and amounts of sediment accumulation, occurrence of fouling organisms, and other changes relevant to reef development. Reef monitoring will start six weeks following spat-on-shell installation in 2010 and occur every six weeks between April and November of 2011.

- On all sampling occasions we will:
 - (1) Collect an excavated sample from the reef (six randomly placed quadrants) and identify, count and measure all live mollusks. We will report:
 - a. Oyster density - number of live oysters of all sizes per unit area
 - b. Number of dead oysters
 - c. Oyster size and size-frequency of all live oysters in a sample
 - d. Oyster growth - change in size attribute(s) of marked individuals
 - (2) Measure accumulated sediment on the surface of the reef
 - (3) Record observations of relative abundances of all potential predators (crabs, sea stars, drills) and occurrence of fouling organisms

- In fall 2010 we will sacrifice 20 oysters from each reef for disease (MSX and dermo) testing

Base Environmental Data

Data on environmental conditions such as temperature, salinity and dissolved oxygen are needed to interpret the reef development and reef performance measurements. These data are particularly important in assessing major events such as die offs or predator influxes. Because water quality conditions can change dramatically over short time periods, our project will utilize continuous recording sensors where possible. Several datasondes are currently deployed throughout the Harbor and several of our partners have instruments available for use during the project. The final collection of deployed datasondes and the data download webstie will be available after November 2010. In addition to these deployed datasondes a a handheld YSI water quality monitoring device will be used to measure pH, dissolved oxygen (DO), temperature, salinity, and conductivity at all sites during monitoring events.

- Using a combination of existing instruments, project deployed instruments and measurements taken during reef monitoring events, we will collect data representative of the site conditions at all the experimental sites. The following variable will be measured:
 - Salinity
 - Temperature
 - Dissolved Oxygen
 - Turbidity
 - Chlorophyll

- On at least one neap tide and one spring tide, we will measure mid-depth water current speed over as much of a tidal cycle as possible upstream and downstream of each reef

Reef Performance Assessment (Ecosystem Services and Habitat Change)

In general, three major ecosystem services are provided by oyster reefs: 1) provision of habitat for other species, 2) augmented fish production, and 3) water quality improvements. Measuring these ecosystem services is a difficult and evolving scientific exercise and there are no widely used approaches that might be considered “standard methods”. For this reason our project will request proposals from the academic community to seek innovative, effective and efficient means to assess the ecosystem benefits provided by the reefs. Throughout the two-year experiment period, we will collect and share basic environmental data and oyster development data with award recipients.

In addition to the monitoring and research measurement being undertaken by responding investigators under the RFP process, we will collect information on resident plant and animals present on the reef.

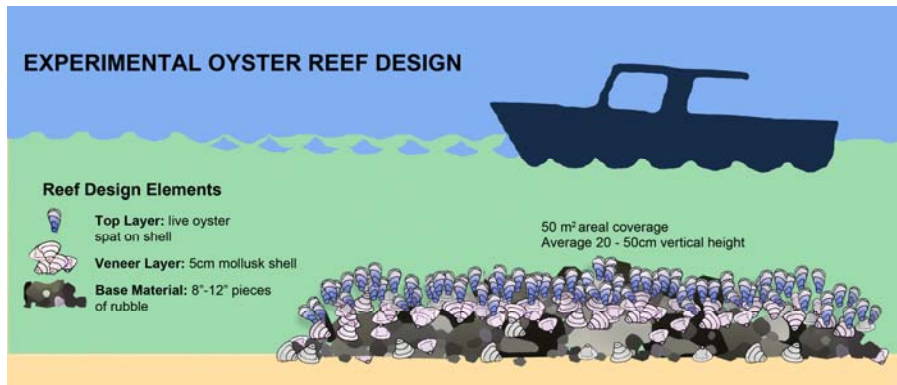
It is recognized that constructing a reef will alter the character of the existing environment. To help interpret the effects of this change, the ORRP has characterized the bottom type and benthic community prior to reef installation and also at representative sites (reference sites) as close as possible to the experimental reef sites. This data is being analyzed by Dr. Grizzle and will be available in November, 2010.

An additional project goal is to increase the interest and involvement of the academic research community in the NY/NJ Harbor oyster restoration efforts. By fostering a collaborative scientific dialogue and reducing the logistical hurdles to conducting research in the Harbor we aim to encourage researchers to seek additional funding to use these reefs to conduct additional experiments.

4. Experimental Reef Design and Construction

The experimental reefs will be constructed using a combination of rock and mollusk shell (Figure 2). The aim is to use materials that provide: (1) a stable base for reef development, (2) surface features that promote spat survival and larval settlement, and (3) live oyster spat-on-shell that can grow and sustain the reef until the reef can be self-sustaining through natural recruitment. For newly constructed experimental reefs, the following techniques will be employed.

Figure 2



Base Materials

The base rock material will meet the NYSDOT 6" D50 specification (50% of stones will pass through a 6" sieve; the largest stone will be no larger than 9"). The method(s) used for placement will vary from hand deployment of bagged shell to mechanical deployment off a barge. Shell will be placed above the rock base in a thin veneer. Blount Fine Foods in Warren Rhode Island will supply clamshell for the project. One ton bags of shell will be deployed from a crane through a funnel on the bottom of the bag to allow uniform placement of the shell material over the rock base.

Figure 3. Oyster Shell Deployment



Spat-on-shell

To complete the experimental reef structure, oyster spat settled onto clamshell will be added to the rock and shell base. Mr. Peter Malinowski at The Urban Assembly New York Harbor School (UANYHS) will perform remote setting on Governors Island using eyed larvae from Milford Lab in Connecticut. Approximately 5,000 shells set with spat will be required for each site. Test-sets using eyed-larvae from Fishers Island will be initiated in February to confirm the viability of waters around Governors Island for remote setting. Setting will begin in early April and will be conducted over approximately six weeks until target numbers have been produced, at which time all bagged shell will be placed in the nursery area off of Pier 101. Spat-on-shell in bags will be held in the FLUPSY bays and suspended from the sides of the FLUPSY. Oysters will remain at this location until ready for placement at study sites in October of 2010 when predation rates will likely be decreased and the spat will have grown to a size (20-40mm shell height) less vulnerable to predators. All aquaculture permits will be held by UANYHS. The live spat-on-shell should be put out late in the fall.

Shape and Dimensions

Natural oyster reefs have shapes and sizes that appear in most cases to be largely controlled by water flow patterns, food fluxes, and other environmental factors. Thus, size and shape are site specific ranging from small circular patches covering several m² to elongated irregularly shaped reefs that extend for kilometers along tidal channels. The size and shape of our constructed reef experiments will also depend on site characteristics and will range from roughly circular to rectangular with coverage of approximately 50 m² (5m x 10m). Height on natural reefs is also variable ranging from several centimeters on actively harvested areas to perhaps a few meters on old pristine reefs (none of which still exist). The height of the experimental reefs will range from approximately thirty to 50cm. This vertical relief will allow an empirical assessment of sedimentation rates at each site while also providing some protection against complete burial and loss. Individual site characteristics and material placement methods will also cause variation in relief and oyster density.