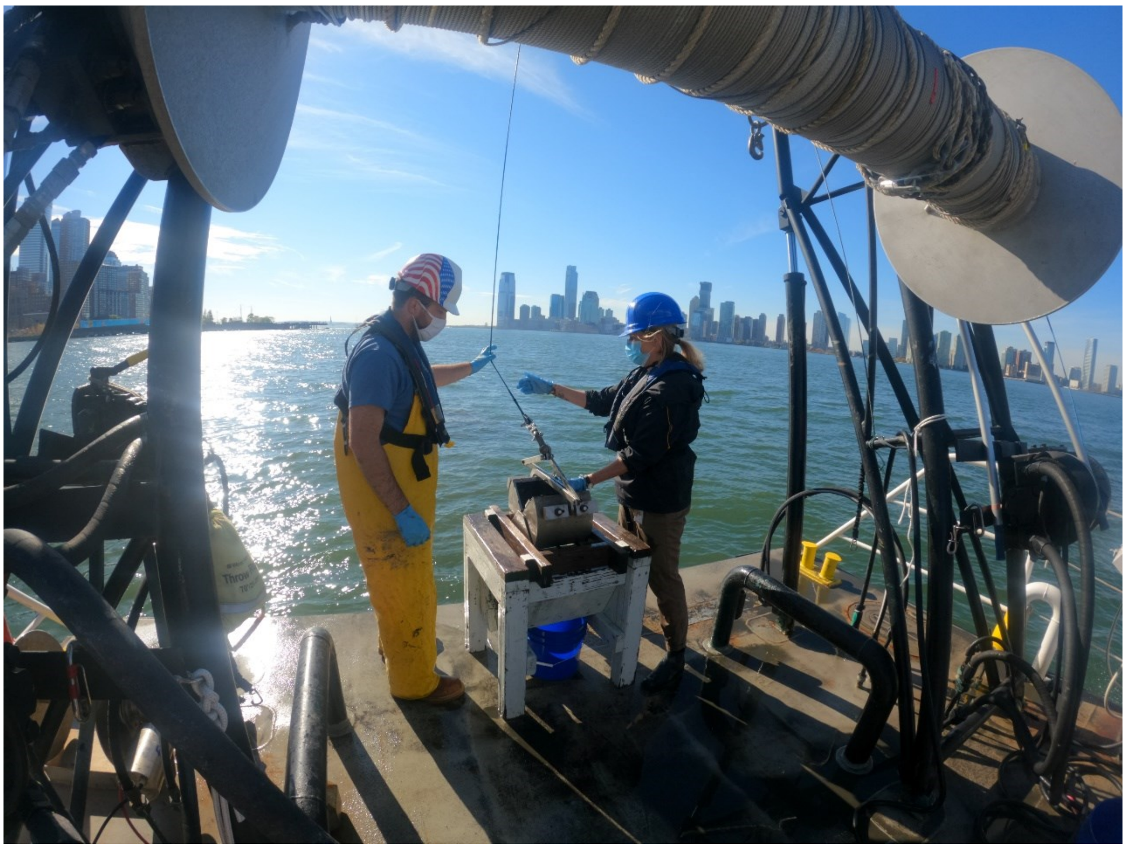
<u>Bottom type and Benthic Community Analysis for Hudson River Park</u>



Report to Hudson River Park Trust

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Background and Introduction

The Hudson River Park Estuarine Sanctuary Management Plan (ESMP) Action Agenda (2021-2030) sets forth a management framework to guide the Hudson River Park Trust (HRPT) and its partners in protecting and conserving the Hudson River Park Estuarine Sanctuary. The ESMP Action Agenda identifies research and habitat enhancement as an area of special focus over the next decade. In alignment with habitat enhancement goals, a suite of in-water habitat enhancements for oysters and other marine species are scheduled to be installed in summer 2021 in the area between Pier 26 and Pier 32 (Fig 1). Prior to that installation, HRPT and its partners are collecting critical baseline information on the existing conditions in the Sanctuary.

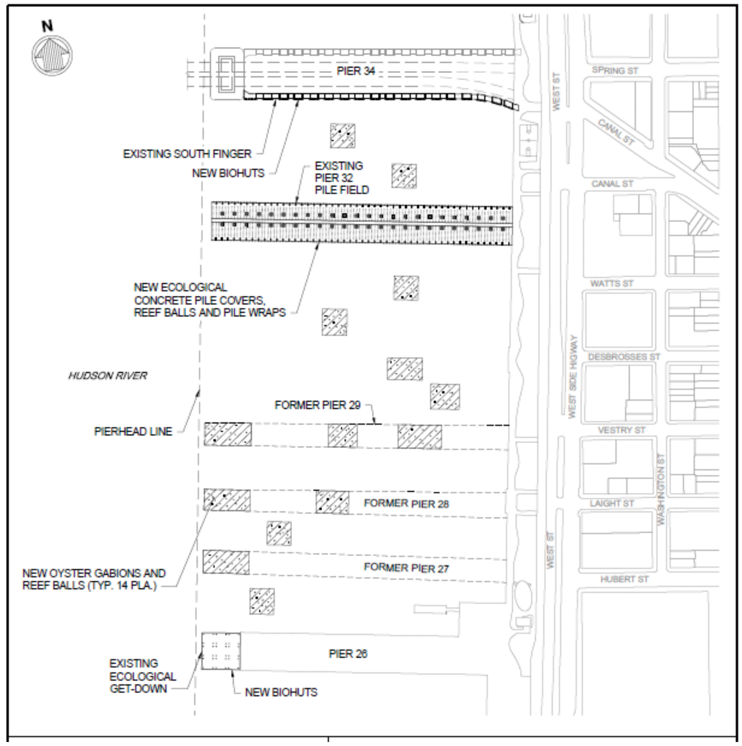
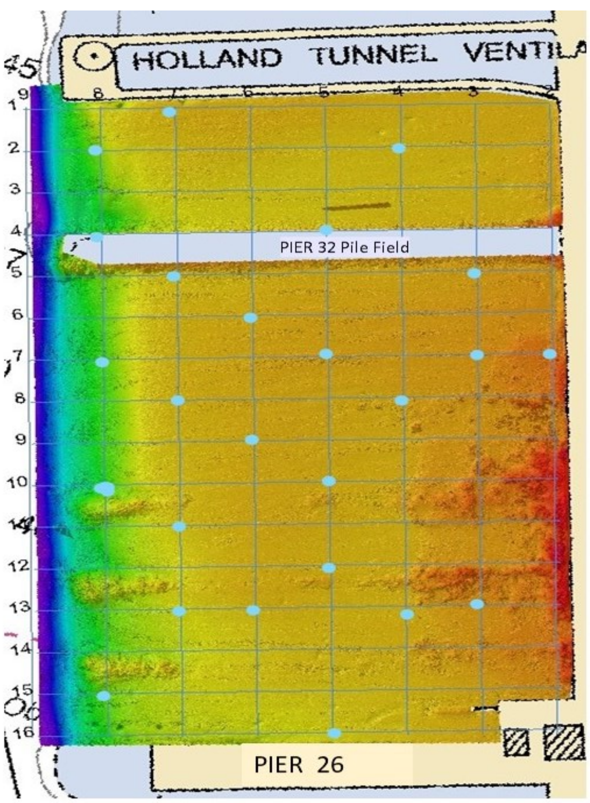


Figure 1. Habitat Enhancements to be installed in July 2021

These habitat enhancements are expected to affect the benthic, epibenthic and fish communities in the Sanctuary. Measuring the response of the sediments and the benthic community to these modifications is essential to understanding and optimizing habitat enhancement approaches and practices within Hudson River Park and throughout the Estuary. The baseline assessment and additional on-going monitoring will inform design decisions and support adaptive management that will ultimately improve restoration outcomes.



During this study, the Hudson River Foundation (HRF) and the University of New Hampshire (UNH): (1) mapped the distribution of major bottom (sediment) types; (2) quantitatively characterized the organisms living in the sediments (infaunal benthos); (3) compared the resulting data to the results of previous monitoring; and (4) obtained data that can be used after construction of habitat enhancements are completed to assess how these new features have impacted the sediments and benthic community. Under a complementary study, New Jersey City University (Fitzgerald, 2021) collected data on the epibenthic community living on the pier structures and remnant pile fields.

Figure 2. Transect lines for bottom type and benthic sampling

Pre-Construction Monitoring Methods

Field sampling activities

Field work was conducted from Monmouth University's 49-foot research vessel RV Nauvoo. Grab samples were collected in 2020 on November 5, 6, and 23 along 16 transect lines running west to east from the pierhead to the bulkhead within the project area between Pier 34 and Pier 26 (Fig 2). A single grab sample was taken from each site, yielding a total of 151 samples collected.

Bottom type mapping

Sediment grab samples were collected and analyzed in the field to characterize the major bottom types in the project area. A systematic design was followed with sampling stations located at 50-meter intervals across 16 transect lines (Fig. 2). At each sampling location, one van Veen grab (Eleftheriou and McIntyre 2005; 0.04 m^2 sample area) was taken. Sediment type was determined by visual-tactile estimation in the field of the grab contents following the methods in the Natural Resources Conservation Service field guide for describing aquatic soils (Schoeneberger et al. 2012) and classified into one of four bottom types: 1) gravel/ rock; 2) mud; 3) mud/sand and; 4) mud/wood debris. Each sample location was determined using the sampling vessel's Garmin GPS unit. A map showing the location and areal coverage of the major bottom types was produced using ArcGIS software.

Benthic community characterization

At 28 randomly selected bottom type sampling locations (blue dots in Figure 2), grab samples were collected to characterize the benthic communities. Samples were washed on a 0.5 mm mesh sieve in the field (Fig. 3), and the remaining residue was returned to the laboratory for processing. All organisms were removed from the residue under 3x magnification and identified to the lowest practical taxon (species when possible) following standard taxonomic keys (Weiss 1995; Pollack 1998). It should be noted that continuing this protocol will allow direct comparison to our previous work in the same general area of Hudson River Park's Estuarine Sanctuary (Grizzle et al. 2013; Lodge et al. 2015) and sampling conducted by Rutgers University in 2017 (Taghon et al. 2018).

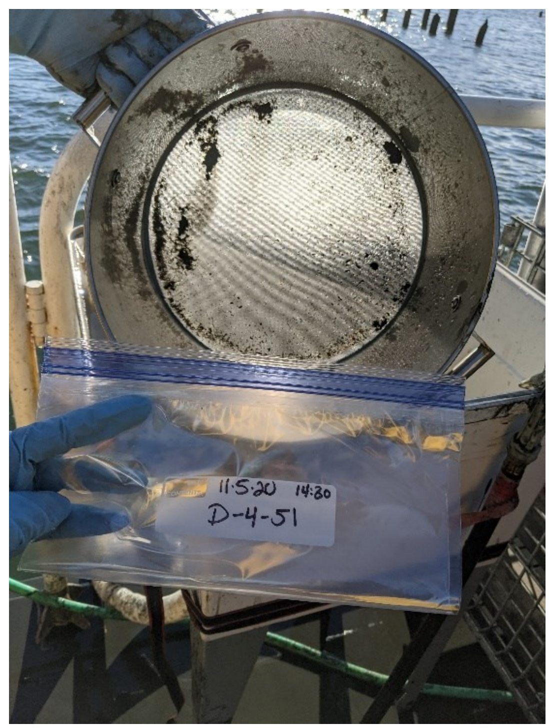


Figure 3. Benthic sample residue on 0.5mm mesh sieve

Assessing Habitat Enhancement Features

A primary objective of the sampling before deployment of the habitat enhancements was to develop baseline data needed to determine how the constructed habitat enhancement elements differ from the seafloor biotic communities they replaced. Data collected during this study will be used to compare the present resident infaunal and epifaunal soft-sediment communities to post-enhancement communities. These data will allow us to compare changes in the restoration area as well as in each of the major bottom types mapped during the pre-construction sampling. In addition, the data will be interpreted in the context of previous studies in the region (e.g., Grizzle et al. 2013; Lodge et al. 2015).

Pre-Construction Monitoring Results

Bottom type distribution

87% of the bottom samples collected were 'muddy' (mud, mud/sand, or mud/wood debris). The remainder of sites (13%) were "gravel/rock" and mainly occurred along the shoreline but also on some of the relic pile fields extending from the shore outward and visible in the bathymetric data (Fig 4)

Benthic community characterization

The 28 van Veen grab samples sieved for benthic analysis included 26 from 'mud' and two from 'gravel/rock' (Table 1). Although only two samples were taken from gravel/rock substrates, they averaged 207 individuals/0.04 m^2 compared to an average of 77 individuals/0.04 m^2 from mud sediments. Benthic communities in the two bottom types also differed substantially in taxonomic richness (a mean of 16.5 taxa/0.04 m^2 in gravel/rock compared to 10.8 taxa/0.04 m^2 from mud sediments) and composition (to be presented in future reports), as expected. These differences in large measure are expected because gravel/rock bottoms provide hard substrates that allow development of 'epibenthic' species that only live above the soft-sediment surface. A preliminary list of all taxa collected from the 28 sites indicates very diverse benthic communities in the study area (Table 2). Differences in benthic communities between the two major bottom types will be presented in an addendum to this report after the final benthic community analysis is completed (expected August 2021). Two previous studies (e4Sciences 2015 and Taghon et al. 2019) conducted sediment and benthic surveys along the western Manhattan shoreline including the waters of Hudson River Park Estuarine Sanctuary. Difference in sampling equipment, sediment and benthic analysis methods, and small variations in timing of these other surveys does not allow for a statistically valid comparison to the data collected under this study. These additional studies do however, provide a useful context to help interpret the benthic data and highlight the spatial variability of benthic community in the Sanctuary. This study's assessment of mean community density (86 individuals/0.04 m^2) is lower than Taghon et al. (396 individuals/0.04 m^2) and e4Sciences (188 individuals/0.05 m^2) but the density estimates of individual samples had overlapping ranges (Table 3.) This study's assessment of mean taxonomic richness (11 taxa/0.04 m^2) was equal to e4Sciences estimate but lower than Taghon et al. (25 taxa /0.04 m^2). As with community density, the individual estimates of species richness overlapped on all the studies.

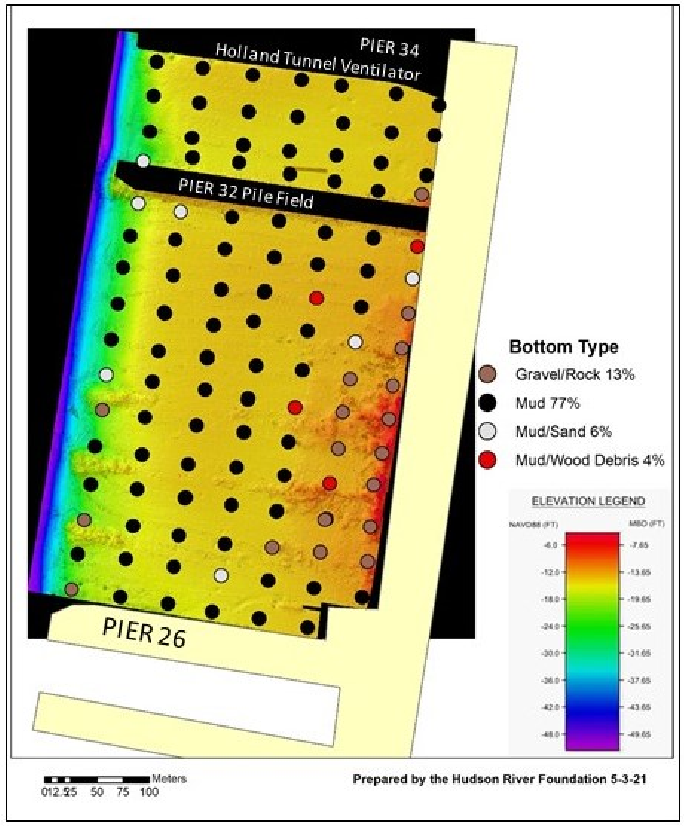


Figure 4. Major bottom types in Hudson River Park Habitat Enhancement Area (Piers 26-34) based on November 2020 sampling. Note bathymetric data shading from red (shallow) to blue (deep).

Discussion

The benthic habitats of NY Harbor have sustained historical degradation, and in many areas, the benthic communities continue to face stressors from ongoing and episodic events including sediment disturbances from dredging operations and vessel traffic and excess inputs of pathogens, nutrients, and contaminants.

Despite these stressors, the benthic habitats in the Harbor are improving. Preliminary analyses of our benthic data indicate total densities and taxonomic richness comparable to other recent studies in the area. Utilizing common indicators of estuarine benthic condition, several other studies have assessed the benthic habitats within the Hudson River Park Estuarine Sanctuary and found them to be relatively healthy. Hale et al., (2007) assessed the benthic community at numerous locations in the Estuary, including one station in the Hudson River Park Estuarine Sanctuary, and found them to be "not-stressed." E4Sciences (2015) calculated an Organic Sediment Index (OSI) at three stations within the study area (Pier 26 – Pier 34) and found the habitat stress levels to be "intermediate" or "not stressed." Taghon et al, (2018) calculated the Multivariate AZTI Marine Biotic Index (M-AMBI) and found that all the stations in Sanctuary scored as either "high" or "good," the top categories in the classification.

Conserving and enhancing these benthic habitats, especially in protected areas like Hudson River Park's Estuarine Sanctuary, is vitally important. Recently published results from the Tappan Zee oyster mitigation project, which utilized similar enhancement methods, showed early restoration success (AKRF 2021), but our scientific understanding of the efficacy and performance of these habitat enhancements (reef balls, oyster gabions, and "Biohut" wraps) is still in the very early stages. Additional data collected over longer time periods, and in additional locations in the Estuary, is needed to ensure ecosystem improvements continue to be achieved. The baseline data collected under this study, and subsequent monitoring and data assessments, will provide important new information on the effectiveness of the installed habitat enhancement techniques in the Sanctuary and advance our understanding of the environmental characteristics and factors that influence performance.

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Tables

Table 1. Densities (# individuals/grab sample [0.04 m^2]) for major phyla and bottom type at each of the 28 sites sampled for benthic communities. G/R = gravel/rock, M = mud. “OTHER” = Chordata and Cnidaria.

Site	Bottom Type	Annelida	Mollusca	Arthropoda	(OTHER)	Community Density (#/0.04 m^2)	Community Taxonomic Richness (taxa/0.04 m^2)
A-7-7	G/R	138	33	40	0	211	20
B-5-20	M	57	125	2	0	184	10
B-7-22	M	67	96	5	0	168	12
B-13-28	G/R	67	131	6	0	204	13
C-2-33	M	9	5	2	0	16	9
C-8-39	M	73	1	4	0	78	9
C-13-44	M	41	148	5	0	194	11
D-4-51	M	24	38	7	0	69	9
D-7-54	M	21	12	6	0	39	12
D-10-57	M	26	38	8	0	72	6
D-12-59	M	12	77	10	0	99	9
D-16-63	M	42	72	12	0	126	8
E-6-69	M	4	3	1	0	8	5
E-9-72	M	14	16	6	0	36	10
E-13-76	M	12	16	2	0	30	7
F-1-80	M	13	39	3	0	55	10
F-5-84	M	20	71	3	1	95	12
F-8-87	M	14	8	7	0	29	15
F-11-90	M	11	64	6	0	81	9
F-13-92	M	9	110	6	0	125	10
G-2-97	M	26	40	15	0	81	15
G-4-99	M	22	32	4	0	58	15
G-7-102	M	38	82	20	0	140	23
G-10-105	M	9	2	0	0	11	8
G-15-110	M	29	58	17	1	105	18
REF-4-115	M	14	33	3	0	50	8
REF-8-119	M	21	8	9	4	42	17
REF-9-120	M	2	2	0	0	4	3
	TOTALS:	835	1360	209	6	2410	11.2

Table 2. Preliminary list of all taxa collected in pre-construction samples from 28 sites.

Phylum Annelida
- C. Polycheata
  - Ampharetidae
  - Capitellidae
  - Cirratulidae
  - Glyceridae
  - *Lepidonotus sp.*
  - Maldanidae
  - Nephtyidae
  - Nereidae
  - Orbiniidae
  - Onuphid
  - *Pectinaria gouldii*
  - Phyllodocidae
  - Sabellidae
  - Spionidae
  - *Spiochaetopterus oculatus*
  - unidentified annelid A
  - unidentified annelid B
  - unidentified annelid C
  - unidentified annelid D

Phylum Arthropoda
- C. Crustacea
  - O. Cumacea
  - O. Amphipoda
    - Ampeliscidae
    - Caprellidae
    - Corophiidae
    - Gammaridae
    - Melitidae
    - unidentified amphipod
  - O.Decapoda
    - *Portunus gibbesii*
  - O. Isopoda
    - *Cyanthura polita*
    - *Idotea* sp.
  - O. Mysidacea
  - O. Metacopina
  - O. Ostracoda
- C. Pycnogonida

Phylulm Mollusca
- C. Bivalvia
  - unidentified bivalve
  - Cerithidae (*Bittium*?)
  - Calyptraeidae
  - *Lyonsia hyalina*
  - Melitidae
  - *Mulinia lateralis*
  - Nuculanidae
  - Pandoridae
  - Tellinidae (unident.)
  - *Tellina* sp.
- C. Gastropoda
  - *Acteocina canaliculata*
  - *Haminoea solitaria*
  - Epitoniidae
  - Hydrobiidae
  - Nassariidae
  - Pyramidellidae
  - *Rixtaxis punctostriatus*
  - *Turbonilla* sp.
  - unidentified gastropod

Phylum Chordata
- Ascidiacea

Phylum Cnidaria
- O. Actiniaria
- O. Hydroida

Phylum Echinodermata
- Holothuroidea

Table 3. Comparison of present study's assessment of species density and species richness to previous surveys

Study (Sample collection date)	Community Density Min - Max (Mean)	Taxonomic Richness Min - Max (Mean)
This study (11/23/2020)	4-211 (86)	3-20 (11)
e4Sciences (11/05/2014)	6-588 (188)	3-21 (11)
Taghon et al. (10/19/2017)	65-807 (396)	14-57 (25)