Hudson River Park Trust's Tribeca Habitat Enhancement Monitoring Program

Year 2 Annual Report - Executive Summary

Prepared for

The Hudson River Park Trust

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March 2024

EXECUTIVE SUMMARY

In the summer of 2021, Hudson River Park Trust installed over 200 habitat enhancement structures between Piers 26 and 34 in the Hudson River. The types of structures deployed included biohuts, textured concrete pile encasements, pile wraps, reef balls, and gabions. An additional 48 habitat enhancement structures, 24 reef balls and 24 gabions, were deployed in August 2023 as part of Phase 2 of the project. The purpose of this enhancement effort was to increase the Lower Hudson River Estuary oyster population and provide habitat for benthic, epibenthic, and mobile organisms. By the permit conditions issued for the project, three monitoring areas must be assessed yearly over five years post-installation: oyster health and performance, estuarine community utilization (including benthic, epibenthic, and mobile organisms), and water and sediment properties.

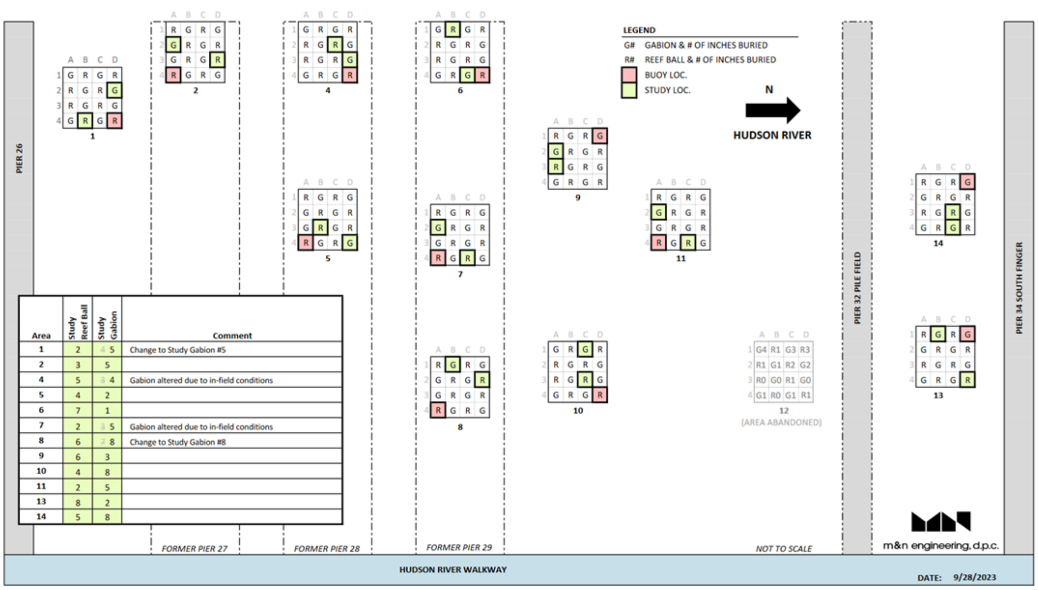

Figure 1. Location of enhancement structure clusters and marking buoys. Clusters 9, 13, 14 are part of Phase 2.

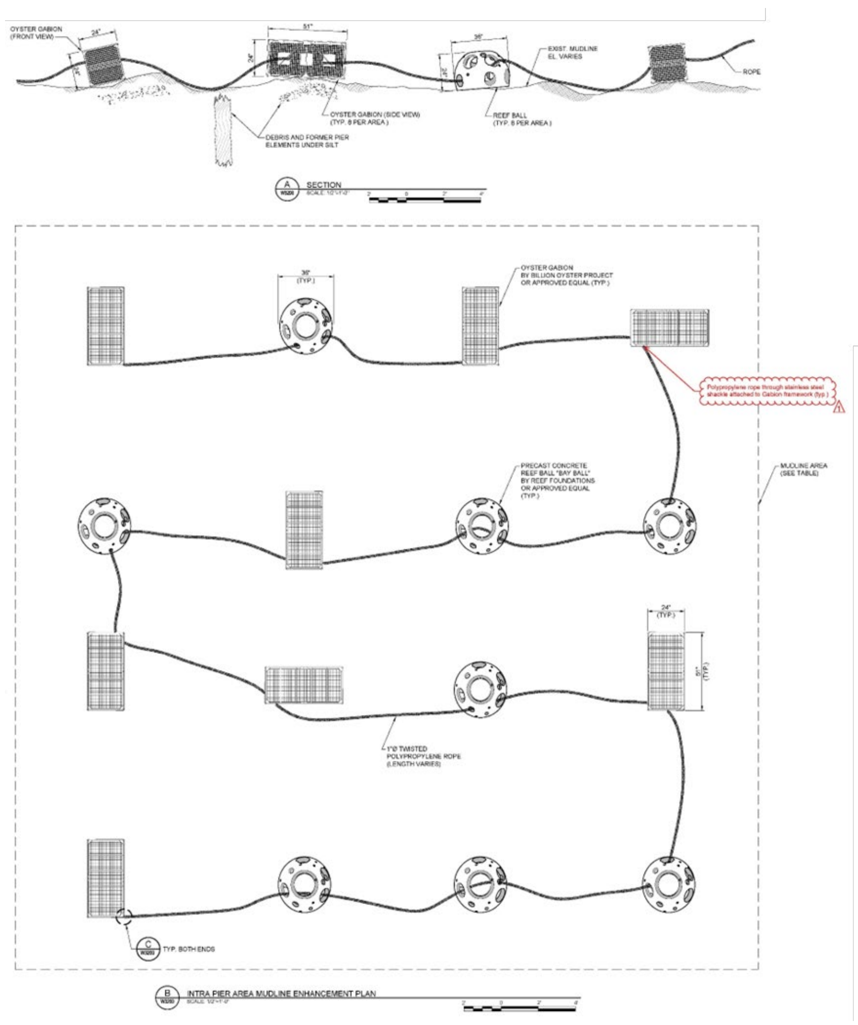

Figure 2. Layout of a representative individual enhancement structure cluster. A) profile view; B) top-down view.

Oyster Health and Performance

The oyster health and performance monitoring plan employs a repeated measures statistical design, which requires the same reef balls and gabions to be monitored at each sampling event over the five-year project period. Sampled reef balls and gabions were randomly chosen before the commencement of the monitoring efforts in Year 1. In Year 2, quadrats with calipersand photographic assessments were used to assess oyster growth and performance on the selected reef balls and gabions during sampling events on June 29th & 30th and November 20th, 2023. Issues with the research vessel's hydraulic winch caused fall sampling, which would normally occur in September, to be delayed until November. Status of the epibenthic community was also assessed during these June and November sampling events.

Figure 3. Representative 0.05 m^2 quadrat placed at randomly selected locations on reef balls

Phase 1 reef balls and gabions were set in remote tanks in June 2021, therefore, the oyster health and performance sampling conducted in June 2023 represents approximately two years of oyster population development for clusters 1-8, 10 and 11 and only a few months for Phase 2 clusters 9, 13 and 14. This sampling indicated widely variable oyster densities among the clusters and the two substrate types (i.e., reef balls and gabions). Mean oyster sizes were similar for the two substrates, whereas mean oyster densities were substantially greater on the gabions. Both mean oyster density and individual oyster size on reef balls in November 2023 were comparable to June 2023.

Due to sampling delays impacting the integrity of the lift lines, only two Phase 1 gabions were sampled in November 2023. During November 2023 sampling, individual size data proved similar to June 2023 while density data showed a substantial decrease. During both the June and November sampling periods, weathering of the gabions obscured oyster shells within the structures, therefore, photographic analysis of live oyster shell percent coverage in gabion quadrat samples was not possible. Live oyster shell coverage on the sampled reef balls ranged from 0% to

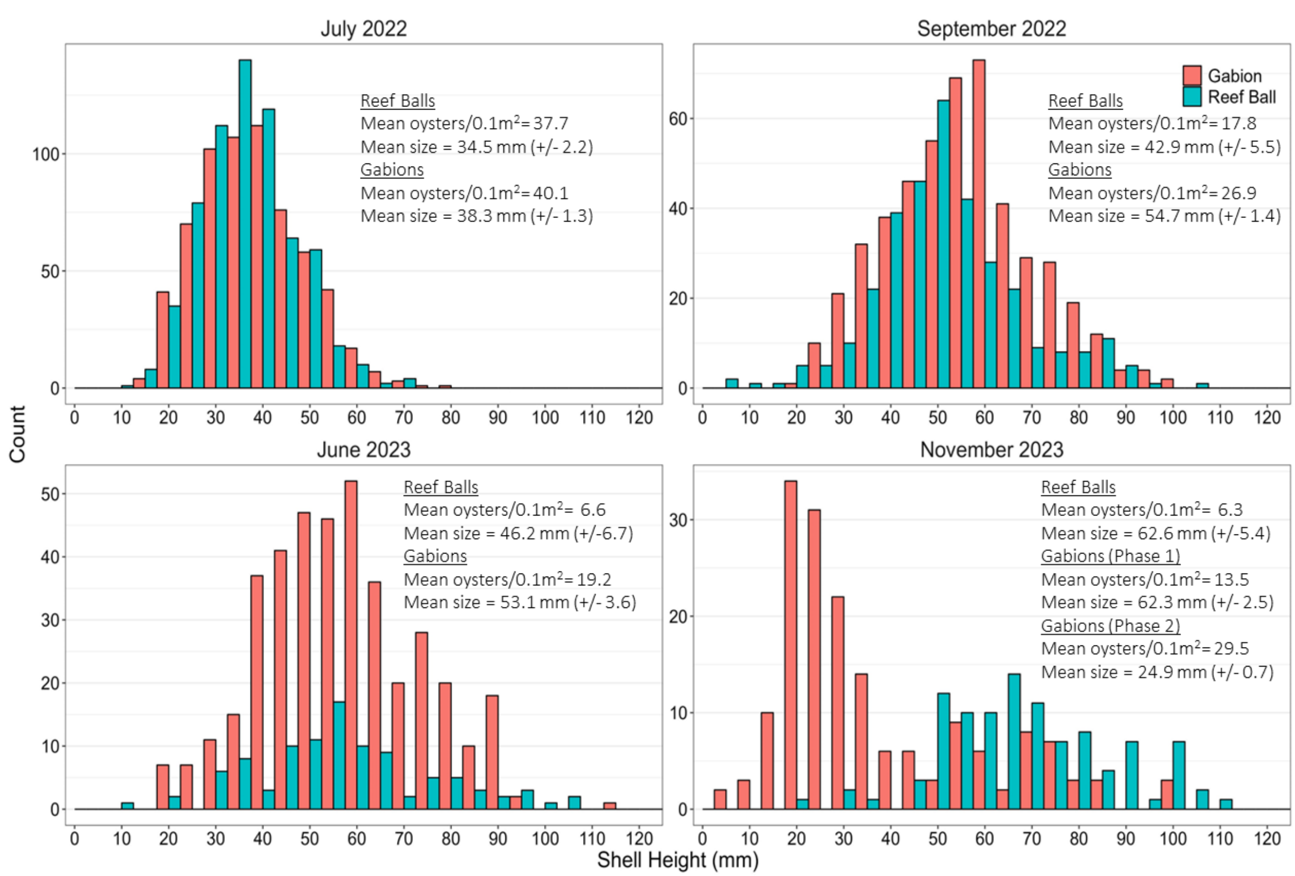

Figure 4. Size-frequency plots for combined (all clusters) data by substrate type for all four sampling dates. NOTE: November 2023 gabion data includes monitoring data from Phase 2 clusters 9, 13 and 14 which were set with oysters prior to deployment in summer 2023. There was only one likely natural recruit (< 25 mm) observed on the other gabions.

44% during June and November sampling, reflecting a decline from the previous year (0% to 95% in Year 1). Dead oyster shells were present in many of the quadrats with coverage ranging from 11% to 47%. Many of these dead oyster shells appear to have recently died over the previous winter. Additionally, there was evidence of predation by crabs and oyster drills.

Phase 2 reef balls and gabions were remotely set in July 2023, therefore, the November 2023 sampling represented approximately four months post-remote setting and approximately three months post-deployment of Phase 2 substrates. Spat were observed on all three Phase 2 gabions that were examined. The mean density and individual size of the oysters suggest successful setting occurred, and the mean oyster densities are comparable to initial setting data from the Phase 1 deployment (average setting density of 30.5 spat per shell).

Considering all four sampling datasets, the oyster populations on both substrate types have shown a decrease since sampling was initiated in July 2022, with the lowest mean densities observed in November 2023. Mean size over the two and half years has increased overall but also varied widely among clusters and substrate types. Recruitment in this area of the Hudson is known to be highly variable, and to date, observed recruitment on the Phase 1 deployed substrates has been limited.

During Year 2, diver video surveys were conducted to qualitatively assess oyster coverage on unsampled structures throughout the project area. At randomly selected unsampled reef balls, divers with Moffat and Nichol visually estimated the percentage of surface area covered by oyster growth. The percent coverage was then compared to the oyster growth observed on the study reef ball within the same enhancement cluster. The diver oyster growth observation results confirmed that the randomly selected reef balls are, in fact, representative of the entire project area (Table 1). We will continue to assess the monitoring techniques for the gabions and consider any future refinements as the structures age.

Table 1. Reef ball oyster % coverage results from dive survey

Enhancement Cluster	Oyster Percent Coverage		
	Study Reef Ball	Random Reef Ball #1	Random Reef Ball #2
#1	25%	5%	5%
#2	<5%	<5%	10%
#4	5%	<5%	<5%
#5	30%	20%	10%
#6	<5%	<5%	<5%
#7	40%	75%	90%
#8	30%	40%	35%
#10	5%	10%	40%
#11	60%	75%	75%

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Epibenthic Community Monitoring

The epibenthic community monitoring plan employs a repeated measures statistical design to sample invertebrates on the substrates aligned with oyster performance monitoring outlined above. During both June and November sampling periods, the weathering of gabions prevented accurate photographic analysis of epibenthos. While several species were noted in the field, including oyster drills and slipper snails, no percent coverage analysis was completed. On sampled reef balls, epibenthic and shell coverage ranged from 0% to 30% in June and ranged from 0% to 100% coverage in November. While some quadrats were bare or covered only in mud, others were thick with Loosanoff's Halicona sponge (*Haliclona loosanoffi*), *Campanularia* hydroids, algae, and red beard sponge (*Microciona prolifera*). A total of ten different epibenthic species were observed in the quadrat samples of reef balls. Species observed on the enhancement structures included sessile, encrusting species as well as mobile species and both individuals and colonial species. All observed epibenthic species are taxa that are common in the Hudson Raritan Estuary.

Table 2. Epibenthic species observed on reef balls, June, and November 2023.

Growth Form	Scientific Name	Common Name
Sessile Colony	*Campanularia* spp.	Hydroid
	Haliclona loosanoffi	Loosanoffi sponge
	Hydroides dianthus	Serpulid worms
	Microciona prolifera	Red beard sponge
Sessile Individual	*Mogula manhattensis*	Sea grape
	Crepidula fornicata	Common slipper snail
Mobile Individual	*Palaemonetes* spp.	Grass shrimp
	Panopeidae	Mud crabs
	Stylochus ellipticus	Oyster flatworm
	Urosalpinx cincerea	Oyster drill

Mobile Community Monitoring and Water Quality

Species composition and relative abundance of fishes and large invertebrates within the study area were assessed weekly from mid-July through September using two types of unbaited traps (larger "pots" and small "wire mesh traps"). The two types of traps were deployed in strings of eight traps (four pots and four wire mesh) each. Three trap strings totaling twelve pots and twelve wire mesh traps were deployed in the Enhancement area and two strings totaling eight pots and eight wire mesh traps were deployed in the Control area north of Pier 46. After a soak time of approximately one week, all traps were retrieved and all fish and invertebrates in the traps were identified, counted, measured, and released. Traps were then cleaned and redeployed for the next week-long sampling period. Water quality (dissolved oxygen [DO], salinity, temperature, pH, and turbidity) was measured at the surface and bottom of each trap string during weekly sampling events in both the Enhancement and Control areas.

Table 3. Abundance (uncorrected for sample effort differences) of species abundance collected in pot traps only.

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Species	Year		
	2022	**2023**	**Grand Total**
American eel (*Anguilla rostrata*)		2	2
Silver perch (*Bairdiella chrysoura*)		1	1
Blue crab (*Callinectes sapidus*)	99	82	181
Black sea bass *(Centropristis striata)*	118	106	224
Smallmouth flounder *(Etropus microstomus)*		1	1
Skilletfish (*Gobiesox strumosus*)	2	1	3
Naked goby *(Gobiosoma bosc)*	9		9
Seaboard goby *(Gobiosoma ginsburgi)*	4	44	48
Unidentified goby *(Gobiosoma sp.)*	1	2	3
Pinfish *(Lagodon rhomboids)*	1		1
Longnose spider crab *(Libinia dubia)*	3		3
Portly spider crab *(Libinia emarginata)*	17	4	21
Unidentified spider crab *(Libinia sp.)*	30	1	31
Tom cod *(Microgadus tomcod)*	2		2
Striped bass *(Morone saxatilis)*	1	2	3
Unidentified Moronid bass *(Morone sp.)*		1	1
Oyster toadfish (*Opsanus tau*)	98	131	229
Summer founder *(Paralichthys dentatus)*	2	6	8
Northern sea robin *(Prionotus carolinus)*	6		6
Striped sea robin *(Prionotus evolans)*	1		1
Winter flounder (*Pseudopleuronectes americanus*)	4		4
Windowpane (flounder) *(Scophthalmus aquosus)*		1	1
Tautog *(Tautoga onitis)*	7		7
Cunner *(Tautogolabrus adspersus)*	1	2	3
Grand Total	**406**	**387**	**793**

During Year 2 monitoring, a total of 160 mobile community traps were fished successfully in the Control area and 237 traps were fished successfully in the Enhancement area. A total of 505 fish and crabs (over 17 taxa [Libinia species combined]) were collected over ten weekly trap recoveries between July and September, representing a decrease in catch from year 1 (712 fish and crabs over 23 taxa). Year 2's most abundantly fished species were black sea bass (*Centropristis striata*), oyster toadfish (*Opsanus tau*) and blue crab (*Callinectes sapidus*). When standardized to unit effort, with both trap types combined, assemblage structure and abundance were very similar between the Enhancement and Control areas in 2023. These three abundant species were generally captured at a rate of one individual per two or three traps per week. Wire mesh traps collected fewer species and individuals than rectangular pot traps in 2023. Small black sea bass followed by oyster toadfish dominated both wire mesh trap and pot trap catches, but blue crabs were few in wire mesh traps in comparison to pot traps. When separated by trap type, a difference among treatment locations became apparent for wire mesh trap collections. Oyster toadfish catch per unit effort (CPUE) was much higher in the Control area wire mesh traps than in the Enhancement area. Additional fish and invertebrates collected from enhancement structures during oyster health and performance sampling on the vessel deck included 13 nominal taxa, of which two (Blenny sp. and Goby sp.) may have represented either multiple species each or unidentifiable specimens of species already noted. Species found amongst the enhancement structures were the same as those collected in traps, except for rock gunnel (*Pholis gunnellus*), which was only observed in the structures.

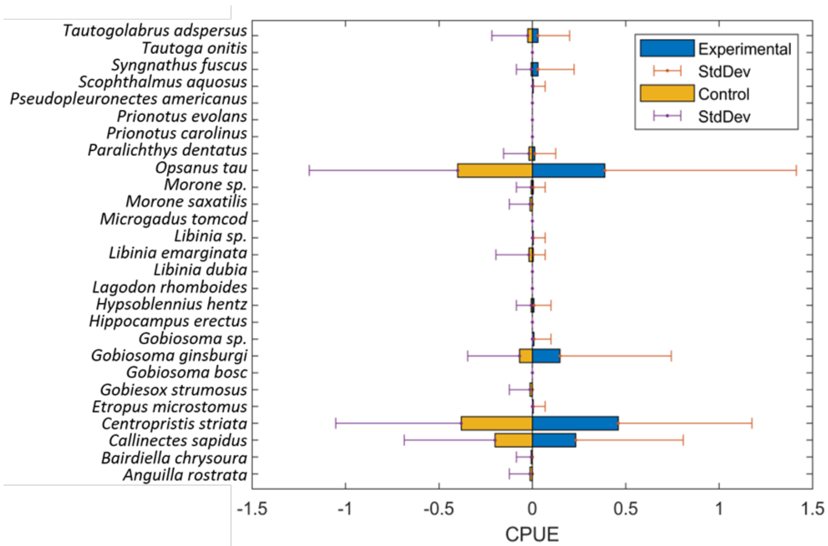

Figure 5. Bar graph of relative CPUE in the Control and Enhancement areas by species (All trap types combined) in 2023.

Water quality was typical of a healthy oligo-mesohaline estuarine location, with bottom salinity ranging between 7.9 and 22.39 psu, which was considerably fresher in 2023 (mean 15.04 psu) than in 2022 (mean 23.42 psu). Bottom temperature was also very similar among years, with only 4 samples being cooler in 2022 (mean 23.80°C) than in 2023 (mean 23.73°C). Bottom dissolved oxygen in the project site did not fall below the 4.0 mg/L stress threshold, reaching a minimum of 4.07 mg/L in the Enhancement area, and was similar among sites and years (2022 mean 4.68 mg/L; 2023 mean 5.17 mg/L).

Current Perspective and Looking Ahead

During Year 2 monitoring, we observed changes in the oyster population, epibenthic community, fish, and mobile invertebrate abundance. While communities in natural and restored habitats may vary in population parameters annually, our goal is to foster robust, diverse, and healthy communities that demonstrate stability over extended periods. Continued monitoring of the Tribeca Habitat Enhancement Project is essential for understanding the site's longevity and health, and to inform HRPT’s future habitat enhancement projects.

Moreover, in Year 3 (2024), we plan to expand the Tribeca monitoring program to include additional study elements such as oyster reproduction, oyster disease, benthic invertebrate community composition, and epiphytic monitoring of piling enhancement structures. This expanded monitoring, alongside potential supplemental monitoring methods and increased statistical analyses as our datasets mature, will provide deeper insights into the enhancements' impacts on local biota.

The impending monitoring program at the newly refurbished Gansevoort Peninsula, which will employ innovative monitoring methods, will further enable researchers and resource managers to assess the success of these habitat enhancement programs more comprehensively across a variety of methodologies.

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