<u>Identification of epibenthic colonizing organisms near proposed oyster restoration site</u>

Final Report to HRPT

Addendum to 2019 Project 'Colonization of Piles within Hudson River Park'

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Background and Significance

A previous study (Fitzgerald et al., 2020 used novel underwater photography and video to look at presence of encrusting organisms on pier pilings throughout Hudson River Park. The results showed that while age and material did not significantly impact which organisms were found, there were several species living on pier pilings including bivalves, encrusting sponges and bryozoans, and sessile crustaceans. These organisms help to increase diversity in the estuary, provide adequate filtration of the water, and attract mobile organisms (e.g., fish, crabs) to the area. Smaller fish and crabs in turn help to attract larger migratory fishes such as striped bass and tautog.

Recently, a large oyster restoration project was proposed between Piers 26 and 34 in lower Manhattan. The discovery of large live oysters underneath piers several years ago has shown that oysters can survive in the area. Fitzgerald et al., 2020, found over 100 oysters amongst the pier pilings (including a large cluster at Pier 84) as well as on the degraded pile fields (Pier 32). An intensive underwater hydrographic survey has shown that in addition to the pile field at Pier 32, there are 3 'rubble fields' between Pier 26 and 34 (very degraded old timber piles, concrete and accumulated sediment). These rubble fields may also be home to epibenthic invertebrates.

Learning what organisms are encrusted on pilings underneath Pier 34, as well as on the rubble field timber, would help complete a pre-installation epibenthic survey that began with the underwater surveys in Fitzgerald et al., 2020. This data would add to the knowledge inventory Hudson River Park Trust (HRPT) has compiled to make scientifically informed management decisions regarding the oyster restoration project in the Park's Tribeca neighborhood. The presence of live native oysters on pier pilings and pile fields (including rubble field debris) as well as other associated fauna could help to bolster a restored population and add genetic diversity to the stock. It is highly likely native oysters have phenotypic adaptations to help them survive in the Hudson River Estuary (HRE) (McFarland & Hare, 2018). Additionally, observations of potential species of concern to the restoration activities (such as predators) can help practitioners with design and management decisions for future restoration projects.

It is predicted that the steel pilings underneath Pier 34 will be home to several species of encrusting organisms (e.g., sponges, tunicates, and bryozoans) as well as sessile bivalves (e.g., oysters and mussels). Furthermore, comparing the assemblage of these pilings to those made of other materials like concrete and wood found in the Park will provide interesting evidence for future reconstruction projects. Due to the proximity to proposed restoration activities, and the abundance of organisms found on Pier 32 (species richness= 8; Fitzgerald et al., 2020), it is recommended to survey Pier 34 and the adjacent rubble fields along with Pier 26 Biohuts, to form a complete picture of the pre-survey data. This will complement pre-installation surveys of infaunal and benthic mudflat organisms (via Van Veen grabs and traditional organismal analysis; HRPT pers. comm.), as well as provide another test of quality control for the novel video techniques. Previous video of steel piles (Pier 66) did not have high quantities of oysters due to epoxy coating on the piles; however, Pier 34 piles are encased in rubber which has been found to attract oyster and other epifaunal encrusting organisms (pers. obsv., at other sites in the HRE as well as in Hudson River Park). This study will provide the Park with a baseline epibenthic survey for the proposed habitat enhancement site likely to be installed in summer 2021.

Methods:

Location: Pier 34 has a unique design with north and south narrow pier fingers separated by open water and capped off at the western end by the Holland Tunnel air ventilation shaft. This survey only focused on HRPT's 'south finger' of Pier 34. On the south finger there are 18 clusters of piles with 6 piles per each cluster. For the previous study (Fitzgerald et al., 2020), approximately 1/3 of the piles were sampled. It was proposed to randomly choose 9 clusters, and 3 piles within each, yielding analysis of 27/108 piles or approximately 1/4 of the total piles.

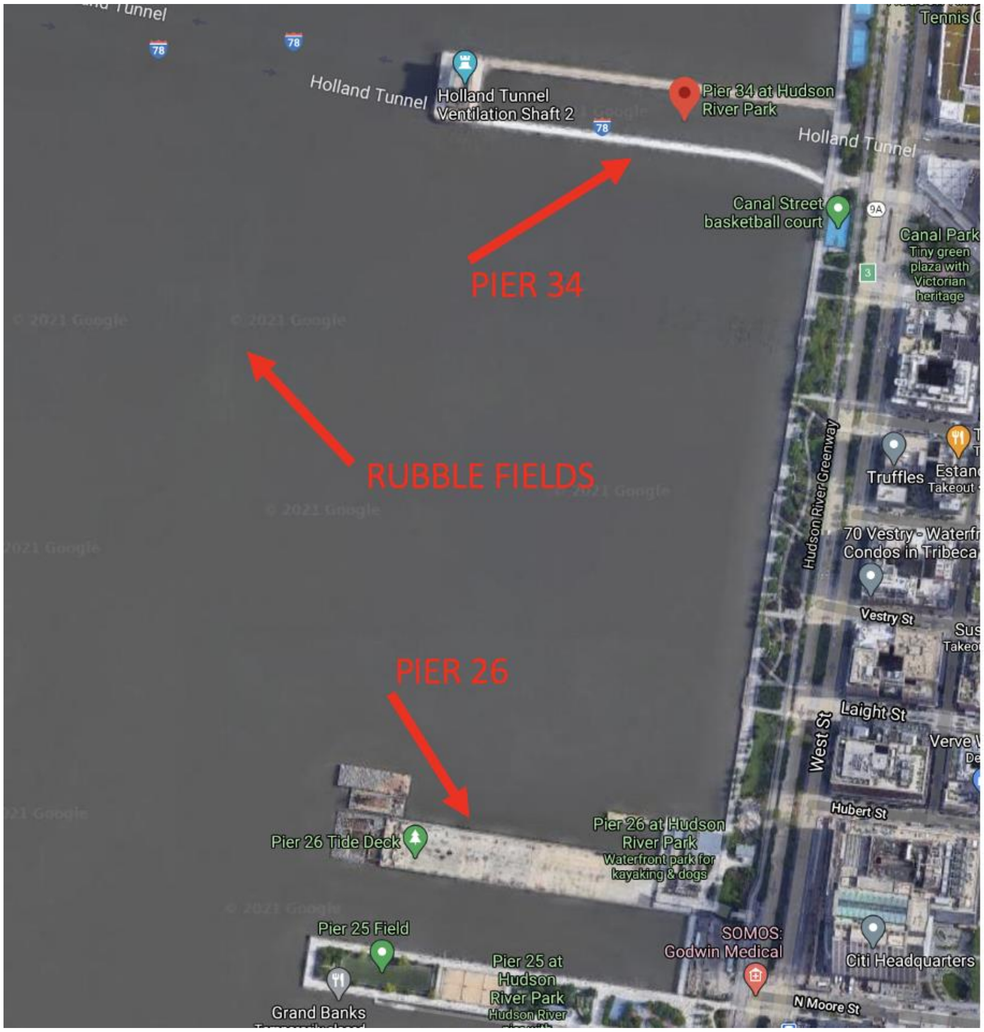

Figure 1: Map of study sites. Pier 34, located above the Holland Tunnel, has two "fingers"; only the South finger is surveyed during this study. Pier 26 Biohuts are located at the Pier 26 Tide Deck. The rubble fields are remnants of Piers 27, 28, and 29; approximate location shown on map.

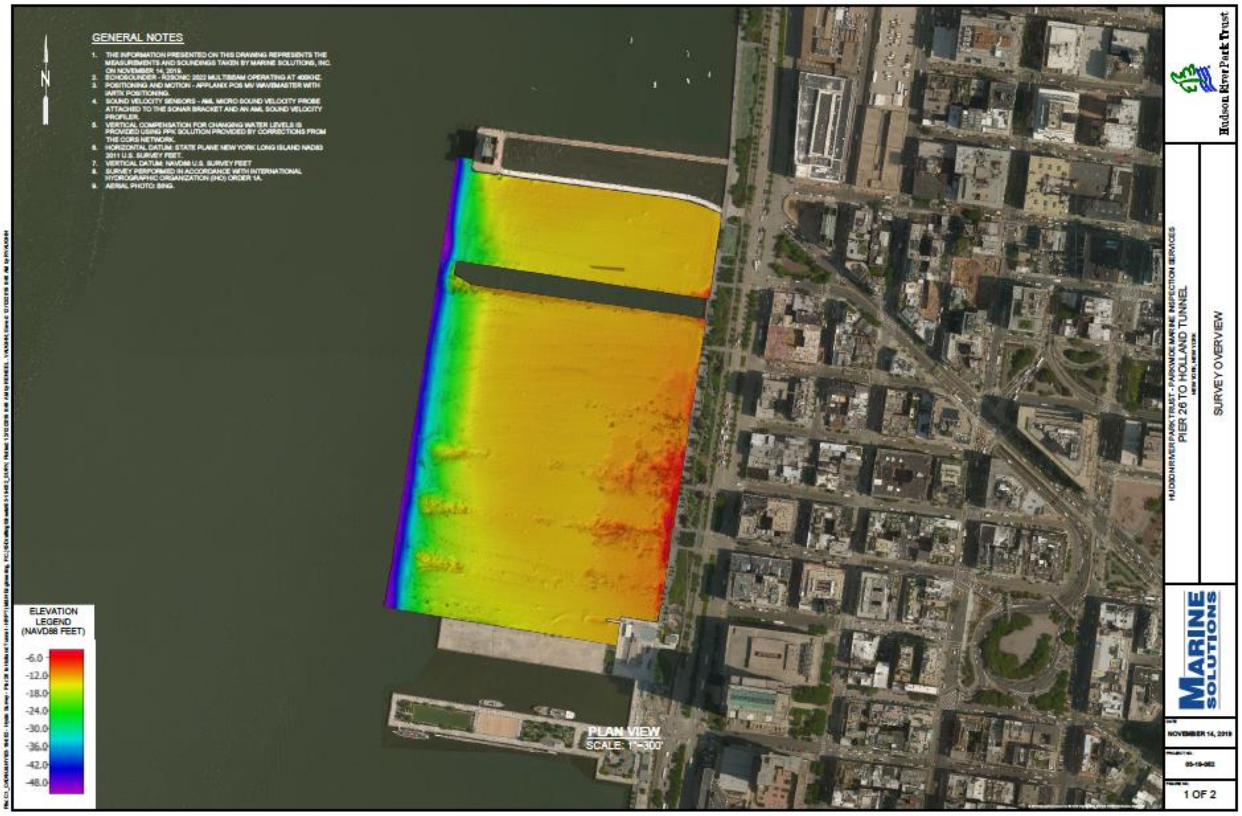

Figure 2: Hydrographic survey map of rubble fields (previously Piers 27, 28, & 29) performed by Moffat & Nichols for HRPT (2020).

In addition to surveying the piles at Pier 34, six piles of Pier 26, which are surrounded by Biohut wraps, were recorded on video using a submersible Clearwater Box and Go-Pro camera. Lastly, a diver was sent down with the video camera to survey the rubble fields to see if any life was visible on the extremely degraded substrate or if it was all buried in soft sediment. Video surveys were conducted as in Fitzgerald et al., 2020; a diver held the Clearwater Box with Go-Pro camera and slowly descended and ascended around the piles.

Piles chosen: Cluster names based off map from HRPT (Figure 3)- S0 was not chosen as it was not a full cluster with 6 pilings. Piles are numbered ABC along the Northern side (West to East) and DEF along the Southern side. Random pilings within each cluster were chosen (Table 1).

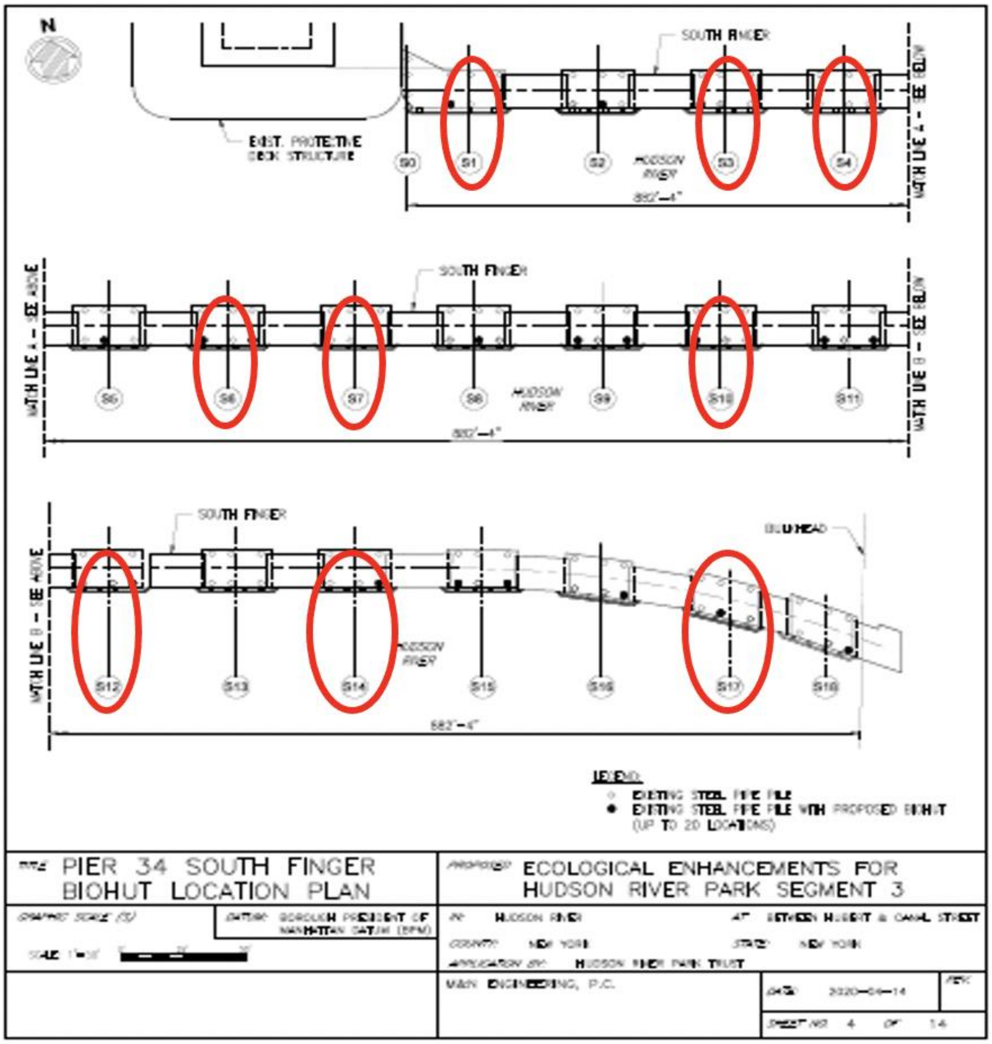

Figure 3: Plans for Pier 34 pilings. The encircled pilings clusters were chosen for surveys, with random pilings within each cluster picked.

Cluster	Pile		
1	A	B	E
3	B	D	F
4	D	E	F
6	A	E	F
7	A	B	E
10	B	E	F
12	C	D	E
14	A	C	D
17	A	B	E

Table 1: Piles to be surveyed from Pier 34. Additionally, all six Biohuts were chosen off Pier 26, and a diver recorded footage along the rubble fields in between the two piers.

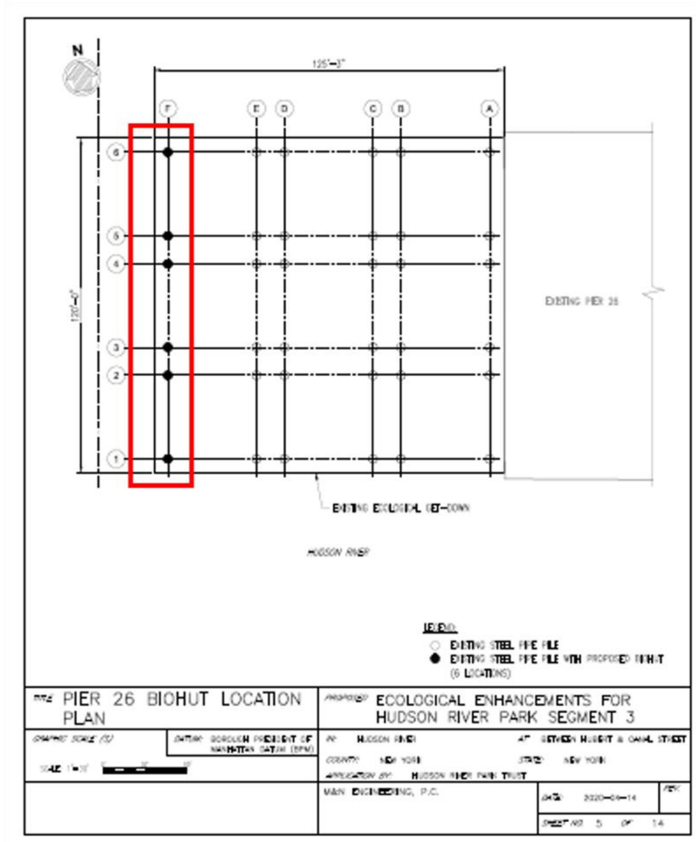

Figure 4: Pier 26 Biohuts plans (via HRPT). Biohuts are wrapped around the pilings enclosed in the red box.

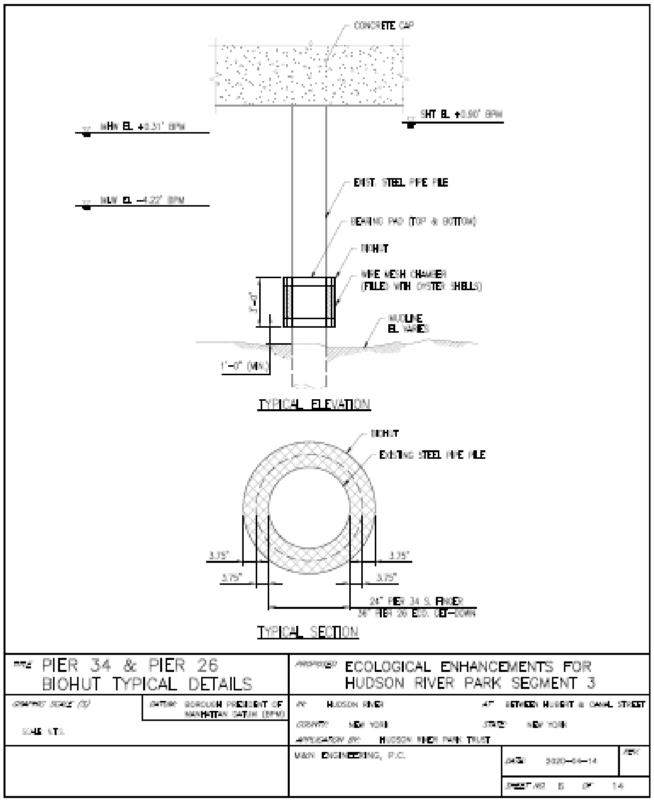

Figure 5: Biohuts. This shows how the cages are placed around the pilings on Pier 26. Video surveys around the Biohuts complimented monitoring data from HRPT (performed annually).

For the rubble fields, side-scan hydrographic surveys revealed very old, broken down timber pile fields in between Pier 26 and 34 (Moffat & Nichols and HRPT, Figure 2). These rubble fields are the remnants of Piers 27, 28, and 29, where the timber piles are cut to right above the sediment surface. Divers from Moffat & Nichols used the Clearwater Box and Go-Pro camera to capture footage along the timber rubble, with the diver slowly descending and swimming along the timber rubble.

Results & Discussion

Species observed:

Twenty-three species were observed across Piers 26, 34, and the mud-line rubble fields (Table 2). Most of these were found across all three locations, or at a minimum on both Piers (pilings and Biohuts). The communities on both Pier 34 and Pier 26 were very similar; however, the differences in substrate (cages with shells versus smooth steel piling) may have led to differences in composition in each one. Pilings achieved almost 100% coverage below the tide line, but the composition changed with depth; at the top of the pilings hardier species (e.g., barnacles, slipper snails) were found while more gelatinous species (e.g., tunicates, sponges) were found below the tide line.

Regarding the species observed, several are of note for future restoration activities. The eastern oyster, *Crassostrea virginica*, was observed minimally at both Pier 34 and Pier 26. On the Pier 26 Biohuts, two live oysters (small size, approx. 10-20mm) were seen cemented to the cages surrounding the pile. The Biohuts are filled with loose shell, but due to how packed they were and the limitations of the video footage, there was no way to see inside the shell to determine if more spat were present. However, on six Biohuts, only two small spat were observed. On the Pier 34 piles, five live oysters were observed (spread across three piles). The oysters ranged in size from small spat to market-size oysters (70-80mm). These oysters were rubbed clean by the diver and ensured they were closed and not dead oysters (a 'box', or a dead oyster with both valves attached) In total, oysters were found on less than 20% of the piles, which is not indicative of a large natural spat set. Natural spat have been observed on cages in the area (HRPT staff, pers. comm.), and previous projects have identified large live oysters on the piles (Fitzgerald et al., 2020; The River Project and HRPT, pers. comm), though densities are always low. Spat settlement and recruitment in the Hudson River are a topic of research and recent debate; some years have large spat sets and other years show very minimal recruitment (McFarland & Hare, 2018; Medley 2010). The upper reaches of the salinity wedge in the Hudson River (North of the Tappan Zee/Mario Cuomo Bridge) show higher rates of spat recruitment, which lessens downriver towards Battery Park (Starke et al., 2011). Twenty scars of *C. virginica* (bottom valve still cemented to pile, but no tissue/top shell left) were found on Pier 34, with an additional four (in one clump) found along the mud line.

Another species of interest is *Urosalpinx cinerea*, the Atlantic oyster drill. Oyster drills were observed on all pilings at Pier 34, with an average of 37.78 ± 22.39 drills per pile (a very wide distribution). Oyster drills prefer hard substrate (Zarnoch & Schreibman, 2012), which is why they were ubiquitous on pilings, and not seen on the mud line (one was observed, on a piece of rubble which extended up out of the mud). Only a small number of drills were seen at Pier 26 (seventeen in total); however, due to the size of the mesh openings on the Biohuts, it is very possible that more oyster drills were inside the cages and obscured by the shell during the video footage. Oyster drills are a predator of *C. virginica*, and smaller (spat) oysters are particularly vulnerable to drill predation (Carriker, 1955). Oyster drills have been observed at several sites within the lower HRE, including Soundview Park (NY/NJ Baykeeper, pers. comm.) and Brooklyn Bridge Park (Billion Oyster Project) (McCann, 2018). Lower salinity periods, such as when spring discharge and precipitation lowers salinity in the river, can help to reduce *U. cinerea* populations and help oyster survival rates (Levinton et al., 2011); however, average salinity at the piers is high enough to support active predation by the oyster drill population. This may represent a mortality threat to any new restoration project with small spat being added to the lower Hudson River.

There were also several species of encrusting sponge observed, but the one with the most impact on future oyster restoration is *Cliona* spp., the boring sponge. Boring sponges are able to infiltrate shells through their cell growth and weaken the shell of the oyster. This may lead to increased vulnerability to predators (such as oyster drills and blue crabs) as the shell will not be strong enough to withstand pressure from predators. Infiltration by *Cliona* sponges can cause bioerosion of shells and underlying substrates (though, steel piles were not able to be infiltrated); if rock or rubble are used in future restorations, *Cliona* could compromise the integrity of the structures over time (Dunn et al., 2014).

In addition to encrusting sponges, several species of colonial tunicates were found covering the piles. The golden star tunicate *Botryllus schlosseri* as well as the Pacific colonial tunicate *Botrylloides diegensis* were found in mats overlying the pilings and biohut cages. Mixed in with these encrusting tunicates were thick clumps of sea grapes *Mogula manhattensis* as well as several species of sponge (Organ pipe sponge *Leucosolenia botryoides,* Red beard sponge *Microciona prolifera* and Deadman's fingers sponge *Haliclona oculata*). In total, these encrusting species made an intricate, intermingled cover for the substate. In most areas of the pile, the organisms achieved 100% coverage of the pile. In other areas, small breaks in the species composition showed where a species was recently removed (i.e., around the Slipper snails *Crepidula fornicata* one could observe a small circle where they had removed all algae/sponge with their radula). Barnacles *Semibalanus balanoides* were present along the top half of the piles, but in lower depths were overgrown by sponge and tunicate. The species were fighting for space in a competition for the least abundant resource, and this led to a unique community composition on each pile. Though the species present were the same, the abundance and manner in which they were spread out across each pile differed greatly. The density of the colonizing organisms may be the cause of low oyster recruitment on piles. Previous studies have shown inhibition of oyster spat settlement with presence of *Cliona;* interestingly, presence of live barnacles was shown to increase spat recruitment (Barnes et al., 2010). It has been shown that infestation by boring sponges can reduce oyster condition and survivorship (Carroll et al., 2015), but inhibition of spat settlement is variable (Dunn et al., 2014b).

The species richness on any given pile was between 9-11 species. This is higher than the observed species richness at Pier 32 (Fitzgerald et al., 2020). One reason for the difference in species composition and richness could be the temporal change- the 2019 videos were taken in May, while the 2020 videos were done in November. Seasonal changes in fouling communities are well documented; as the water warms up, different species will have a more dominant period and become better competitors for space on the pile. As summer turned to fall and water temperatures cooled, many species saw increased mortality allowing other fouling organisms to come in and take over. Rheinhardt & Mann, 1990, noted a seasonal pattern to fouling communities in estuarine oyster reefs where highest diversity and density was achieved in late summer (maximum water temperature). During future projects, it is suggested to perform more video analysis of pilings in August/September to show an accurate picture of the piling community over time in the Hudson River.

Species Present: HRPT Addendum 2020					
Taxon	**Common Name**	**Species Name**	**Pier 34**	**Pier 26 Biohuts**	**Rubble Fields (Mud Line)**
Mollusca	Eastern Oyster	*Crassostrea virginica* (live)	X	X	
		Crassostrea virginica (scars/boxes)	X		X
	Oyster Drill	*Urosalpinx cinerea*	X	X	X
	Slipper snail	*Crepidula fornicata*	X	X	
		Crepidula plana	X		
Crustacea	Northern rock barnacle	*Semibalanus balanoides*	X		
Urochordata	Golden star tunicate	*Botryllus schlosseri*	X	X	X
	Pacific colonical tunicate	*Botrylloides diegensis*		X	X
	Sea grape	*Mogula manhattensis*	X	X	X
Porifera	Boring sponge	*Cliona* spp	X	X	X
	Organ pipe sponge	*Leucosolenia botryoides*	X	X	X
	Bread-crumb sponge	*Halichondria bowerbanki*	X	X	
	Red beard sponge	*Microciona prolifera*	X	X	
	Deadman's fingers sponge	*Haliclona oculata*			X
Cnidaria	Hydroid	*Stylactaria* Spp.	X	X	
	Anemone	*Fagesia lineata*	X		
Plantae	Red algae	*Porphyra* spp.	X	X	X
	Green algae	*Spongomorpha* spp.			
	Green filamentous algae	*Ulva intestinalis*	X		
Osteichthyes	Tautog	*Tautoga onitis*	X		
	Skillletfish	*Gobiesox strumosus*	X		
	Atlantic silverside	*Menidia menidia*	X		
	Unidentified fish				X
Crustacea	Blue crab	*Callinectes sapidus* (juvenile)	X		
Polychaeta	Polychaete tubes (observed, empty)		X	X	X

Table 2: Species diversity of surveyed piles, Biohuts and rubble field.

	OYSTERS- LIVE	OYSTER DRLLS	FISH	SLIPPER SNAILS
PIER 26	2	17	0	0
PIER 34	6	1020	7	619
MUD LINE	0	1	1	0

Table 3: Species of interest with total abundance (across all piles at the site). Pier 34 shows the most abundance but also had the most piles sampled. The average abundance, per pile, was not different between Pier 26 and Pier 34.

In conclusion, taking into account the findings from Fitzgerald et al., 2020, HRPT pre-installation surveys (Van Veen grabs and hydrographic surveys), and this study we can achieve a greater view of the biodiversity in the lower Hudson River (between Piers 34 and 26). Using novel videography surveys, it was noted that species richness is higher in the fall season (this study) rather than early spring (Fitzgerald et al., 2020); community composition shifts during the season with new species coming to dominance with changing abiotic conditions. During each survey, presence of live oysters was noted, though abundances and densities were low on each pier surveyed. However, the presence of live oysters indicates that a wild larvae population does exists and may continue to help populate restoration activities in the lower HRE in the future. Differences between piling materials may have led to differences in species composition, as season did.

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