HUDSON RIVER PK®

# Community Oyster Project Report: Hudson River Park's Pier 32

# Abstract

Beginning in 2017, Hudson River Park has led an ongoing oyster monitoring field study called the Pier 32 Community Oyster Project. The goal of the Pier 32 Community Oyster Project is to gain a greater understanding of how pile fields, which are the wooden structural remains of former shipping piers can be repurposed as habitat for oyster restoration and recruitment. In this study, the oysters are suspended from piles in mesh structures called oyster wraps. The oyster monitoring is completed by Hudson River Park staff and volunteers. Volunteers were primarily recruited at Community Eco-Paddle events, and overall found the program to be informative and beneficial according to surveys collected following the program. The adult oysters monitored in the field seasons (May-October) of 2018 and 2019 increased significantly in both mass and length each summer. Hudson River Park staff qualitatively observed that the oyster wraps served as habitat for a variety of fish and invertebrates, and may provide suitable substrate for spat recruitment.

# Introduction

## I. Background/Purpose

New York City has a robust and well-recorded history of wild oyster populations thriving in the Hudson River. The Eastern oyster (*Crassostrea virginica*) is endemic to the Hudson River and historically grew with great abundance. Yet, in 2018, the oyster population was less than 0.01% of what it once was (TNC BOP Oyster Monitoring Report). Hudson River Park launched the Pier 32 Community Oyster Project in 2017 with the goal of trialing methods that could both increase the lower Hudson River's oyster population and to teach the public about oysters and their ecological role in the estuary. The Eastern oyster has many qualities that are valuable to preserving and improving the health of the River. An individual oyster can filter up to 50 gallons of water on a given day, and this filter feeding serves as a cleaning mechanism for the River by removing excess plankton and certain toxins from the water column. Through this process, oysters contribute to improving water quality by maintaining stable nutrient concentrations, managing turbidity, and preventing plankton overgrowths. The ecosystem services that oyster reefs provide, including improving water quality, increasing shoreline resilience, preventing storm surge, and serving as a foundational habitat for estuarine biota, have made oyster restoration an ecosystem-health goal for many environmental researchers and organizations.

The field site for this project is located in Hudson River Park's Pier 32 pile field (Map 1). These piles were once the structural support for a shipping pier, and today a potentially underutilized location for habitat enhancements with the potential to support a diverse ecosystem of fish and invertebrates. The Pier 32 Community Oyster Project reclaims piling structures as a trial zone for installing oyster restoration treatments to study oyster growth and reproduction. Piles have successfully served as habitat for wild oysters, and for this reason, our research aims to determine conclusively if abandoned pile fields are viable sites for oyster recruitment and growth. Typically, in order to achieve successful recruitment, oysters must colonize a reef composed of rocks or oyster shells (Starke, Levinton, & Doall 2011). Yet research in other urban estuaries has found that anthropogenic structures (such as piles) can support similar assemblages of life as rocky reef habitat (Connell 2000). Life forms that have been shown to successfully recruit onto piles in other studies include mussels, oysters, bryozoans, ascidians, sponges, barnacles, tubeworms, and algae (Connell 2000). Gaining a better understanding of oyster growth on various hard substrates remains increasingly important as manmade marine infrastructure defines urban coastline environments.

The Community Oyster Project will further our understanding of oyster survival in manmade structures, and could be successful in cultivating the oyster population in the lower Hudson River area. In the past, Hudson River Park researchers have found large, wild oysters up to 9 inches long growing on piles at Pier 40, beneath floating docks at Pier 26, and at other locations. In addition to oysters, piles have also been observed to support a variety of other biota: in a recent survey of pile structures in the Hudson River, researchers have found shipworms, sponges, snails, barnacles, mussels, and a variety of algae (Fitzgerald *et al.*, 2020). A 2018 study of Hudson River Park's pile fields also determined that the sediment in pile fields

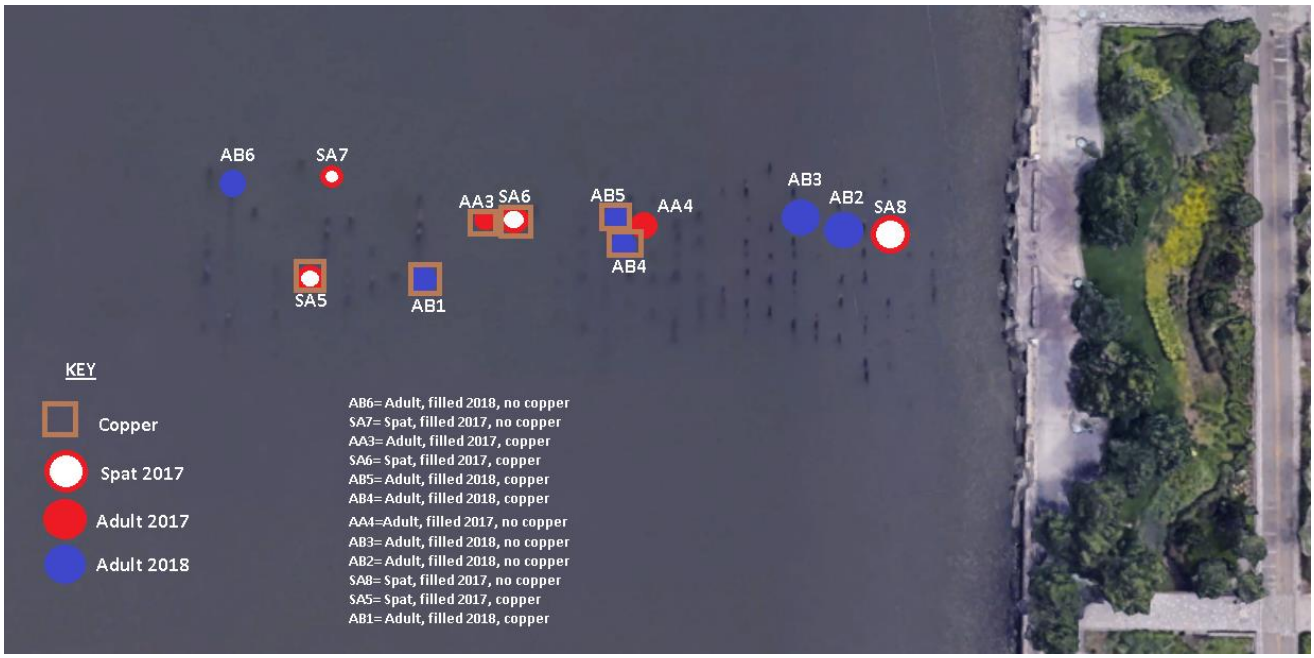
had good environmental properties, including higher nutrient sequestration than non-pile field sites, and a high diversity of benthic infauna (Taghon, Petrecca, & Fuller 2018). The success of wild oysters and invertebrates in the pile fields has hinted that these locations could be viable restoration zones for oyster populations and other epibionts.

Hudson River Park's science team began monitoring oysters in the Pier 32 pile field in 2017 with the assistance of community volunteers and intends to continue recording oyster growth patterns in the pile fields until at least 2020 in accordance with current permitting. For this project, oysters are suspended in marine-grade mesh wraps, designed by Park staff, that are secured in a C-shape around the existing pilings and monitored to record their growth and survival over time. In the first summer of the Community Oyster Project, average oyster shell length increased in all monitored wraps (Pier 32 Oyster Report 2017). With the exception of one wrap, which experienced a mortality event in September, average weight of oysters increased over the course of the monitoring period as well. Despite the success of the wraps during the June-October 2017 period, there was a near-100% mortality rate in the oyster wraps when they were retrieved for monitoring in June 2018. Hudson River Park's science staff determined a number of factors that may have contributed to the high mortality rate and adjusted the structure of the wraps in an attempt to remedy this problem for the following year (see *Methods*). As a result of the high mortality rate in the 2017 cohort of oysters, the wraps were refilled entirely with adult Fisher's Island oysters in 2018.

# II. Key Research Questions

This project has two primary aims. The first is to monitor and study oyster growth and recruitment on wooden piles at Pier 32 in Hudson River Park. The Park aims to determine if oysters survive, show growth, and provide space for juvenile oysters to settle over time in a pile field habitat. The second key goal of this project is to encourage community science in New York and increase public engagement in oyster monitoring. As the community takes part in oyster monitoring events, we strive to meaningfully educate program participants about the ecology of the Hudson River and the role that oysters play in the local estuarine system.

# III. Methodology




**Map 1.** This map shows an aerial view of Hudson River Park's Pier 32 pile field with the locations of all oyster wraps. Oyster wraps are suspended from piles using wire rope and carabineers (Fig.1, Fig. 3). All wraps with spat remain undisturbed from 2017, and all 2018 oysters are adults.

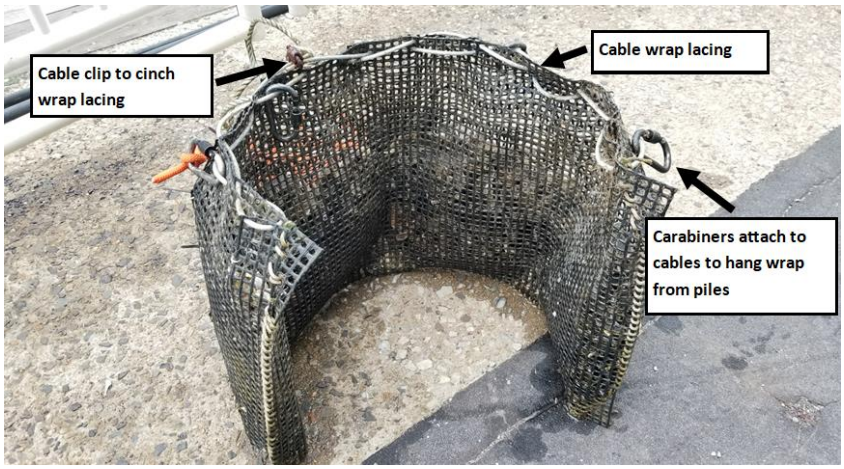



**Fig 1.** Exterior of an oyster wrap with oysters inside. Pictured wrap is laced closed and prepared for deployment with cables attached and all bio-fouling cleaned.

**Fig 2.** Oysters inside a wrap that has been modified with shelves to reduce crowding. Carabineers are attaching shelves to wrap exterior in order to provide increased support.

**Fig. 3.** Deployment process for an oyster wrap. Cables are attached to the wrap and the pile. The oyster wrap sits about 7 feet below mean low water.

The oyster wraps used in this project are containers made of marine-grade mesh that allow for flow-through of water and plankton but prevent access to most predators (Fig.1). The wraps are laced closed on the top and bottom using cable wire and sealed with steel rope clips. In June 2017, twelve oyster wraps were filled with oysters. Half of the wraps were retrieved monthly during the field season (June – October), while the other half was attached firmly to the piles with bolts (Fig. 3), not to be monitored until 2020, in order to study if the disturbance that occurs during monitoring has any effect on the survival of oysters. The six oyster wraps that were being used for monthly monitoring were completely emptied and refilled in July 2018, due to a near-100% mortality rate during the overwintering period. In July 2018, these six oyster wraps were each filled with 150 tagged, living, adult oysters that were donated by Fisher's

Island Oyster Farm. Each month between July and October 2018, all six of the wraps were monitored. To monitor the oysters, 75 random oysters were selected from each wrap to measure. The length of the oysters is measured using calipers or rulers to the nearest millimeter, and the weight of the oysters was measured to the nearest .01 gram using digital pocket scales. The same methodology was employed in 2019; however, in 2019 monitoring took place monthly between May and October. Hudson River Park's science team completed the monthly oyster monitoring with the assistance of volunteers and staff. Volunteers joined Park staff in programs called "Community Eco-Paddle" that were hosted in collaboration with non-motorized boathouses in Hudson River Park. Volunteers ranged in age from small children to adults. In addition to "Eco-Paddle" events, oysters were also monitored by corporate volunteers and student classes from local colleges and high schools.

The mortality event that occurred in the Winter 2017/2018 season caused a reassessment of methods, and preventative measures were taken in hopes of reducing mortality in future seasons. One theory is that the interiors of the wraps were overcrowded, causing competition and disturbing flow-through of water and plankton. To treat this, we built shelves to separate the oysters into three tiers and create a more spacious distribution inside the wraps (Fig. 2). The shelves are supported with carabineers as a measure to avoid overcrowding during the winter season, when the wraps receive minimal maintenance. Another theory is that the oysters were affected by cold temperatures and ice scour close to the water's surface. As a solution for this problem, we extended the length of the cables suspending the wraps from the piles; the wraps now sit seven feet below mean low water, rather than three feet below mean low water as they did during the Winter 2017/2018 season. As previously mentioned, the widespread die-off of oysters in New York City between November 2017 and May 2018 may have been caused by another larger unidentified environmental factor. Nevertheless, the adult oysters placed into the wraps in July 2018 survived overwintering, and the Park science team remains hopeful that the second overwintering until May 2020 has an equally high survival rate. For wrap maintenance throughout the summer, oysters were also cleaned as needed to remove algae, sea squirts, and other bio-fouling organisms that accumulated on the exterior of the wraps in order to allow for consistent flow-through of water and plankton.

# IV. Results

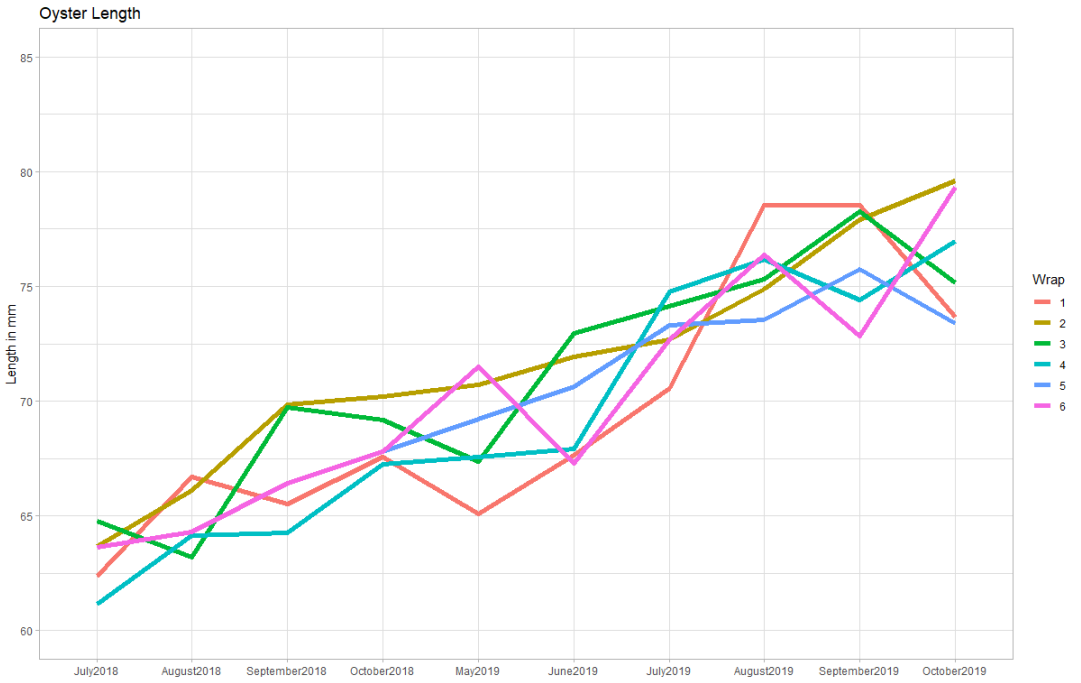



**Fig 4 |** Average oyster length in mm by month from July 2018 to October 2019. For all wraps monitored, length increased significantly over the course of the monitoring period (see Table 1).

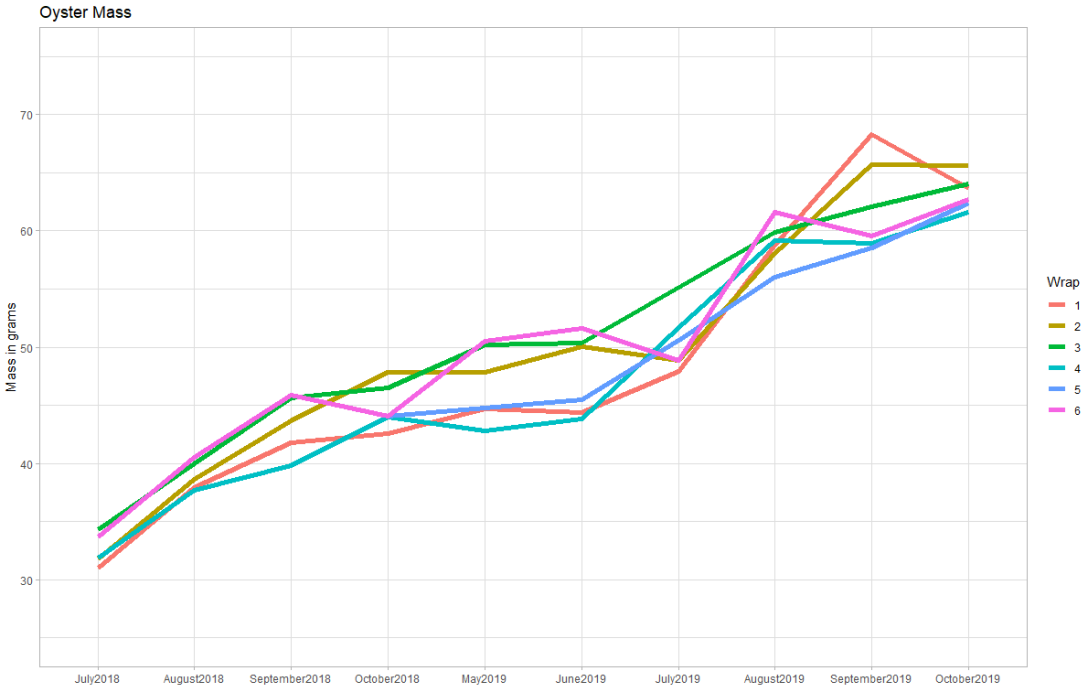



**Fig. 5 |** Average oyster mass in grams by month from July 2018 to October 2019. For all wraps monitored, mass increased significantly over the course of the monitoring period (see Table 1).

| Wrap # | Oyster Mass (g) July 2018-October 2019 | | | Oyster Length (mm) July 2018-October 2019 | | |
|---|---|---|---|---|---|---|
| | Average Difference | T-test P-value | Average Growth Rate (%) | Average Difference | T-test P-Value | Average Growth Rate (%) |
| **W1** | 32.7153 | 1.42E-27 | 105.66 | 11.3134 | 5.57E-10 | 18.14 |
| **W2** | 33.8553 | 2.69E-30 | 106.64 | 15.9532 | 4.64E-09 | 25.06 |
| **W3** | 29.7489 | 3.11E-25 | 86.80 | 10.3829 | 3.26E-08 | 16.03 |
| **W4** | 29.7536 | 1.66E-42 | 93.32 | 15.8092 | 2.78E-28 | 25.85 |
| **W5** | 28.6836 | 4.33E-39 | 85.14 | 9.7874 | 3.69E-14 | 15.38 |
| **W6** | 29.0556 | 6.38E-36 | 86.2485 | 15.7157 | 1.45E-25 | 24.70 |

**Table 1. Oyster Growth**. Two-sample t-tests compare average baseline mass or length to average mass or length at the end of the monitoring time frame.

All oyster wraps showed a statistically significant increase in both length and mass over the course of the monitoring period (Table 1). In the first season of monitoring, between July 2018 and October 2019, oysters increased in length by 5.5 mm and in mass by 11.9 g, on average. Between July 2018 and October 2019, the full length of the monitoring period, average oyster length increased by 13.1603 mm and average oyster mass increased by 30.63538 g. Wrap 2 had the greatest increase in both length and mass overall, and Wrap 2 was also the wrap with the greatest growth in the first monitoring season between July and October 2018.

It does not appear that the placement of the wraps, with regard to proximity to the bulkhead, has any effect on the growth rate of the oysters or the composition of the wraps. An ANOVA and post-hoc analysis Tukey test were run in order to determine if there was significant difference between wraps' growth. There was significant difference between some wraps, but there was no noticeable pattern to indicate that difference in wrap composition was related to any specific factor of placement.

The wraps were also qualitatively found to be popular habitat location for many species. Estuarine fish and invertebrates, particularly species known to prefer benthic, protected habitat were discovered inside of oyster wraps when they were opened for monitoring. Amongst the most commonly discovered animals were oyster toadfish (*Opsanus tau*), skilletfish (*Gobiesox strumosus*), blue crabs (*Callinectes sapidus*), mud crabs (*Panopeidae*) and grass shrimp (*Palaemonetes pugio*). Additionally, sea squirts (*Molgula manhattensis)* settled on the surface of the wraps throughout the majority of the warmer monitoring season (July-September). Sea squirts settled so densely that the wraps needed to be regularly cleaned in order to maintain the

flow-through capacity and allow for water and plankton to reach the oysters. Various algae also grew on the surface of the wraps and were removed during these regular cleanings as well. While it was not a formally measured factor, we also found noticeable spat recruitment on oysters between July and October of 2019. The oysters did not have any spat presence during the 2018 monitoring season; therefore, all spat recorded in 2019 was indicative of new recruitment.

The results of the Community Eco-Paddle participant surveys indicate that the Community Oyster Project was also able to help boost perceptions of New York City's natural environment. The post-program survey was comprised of four statements, and the respondents indicated how strongly they agreed or disagreed with each statement. This helped Park staff to understand how firsthand experience in monitoring oysters and learning about the history of oysters in the Hudson River helped individuals to feel more connected with their environment, care more about the health of the Hudson River, and feel more confident in their knowledge of oysters' ecosystem services. For all questions, a larger percentage of individuals responded that they "Strongly Agree" with the statement following participation in the program, indicating that the program was successful in educating about oysters and improving perceptions of the River (Fig. 6). Notably, prior to the program, about 10% of participants felt that they did not understand the role of oysters in the Hudson River, and after the program, that number decreased to almost zero (Fig. 6).

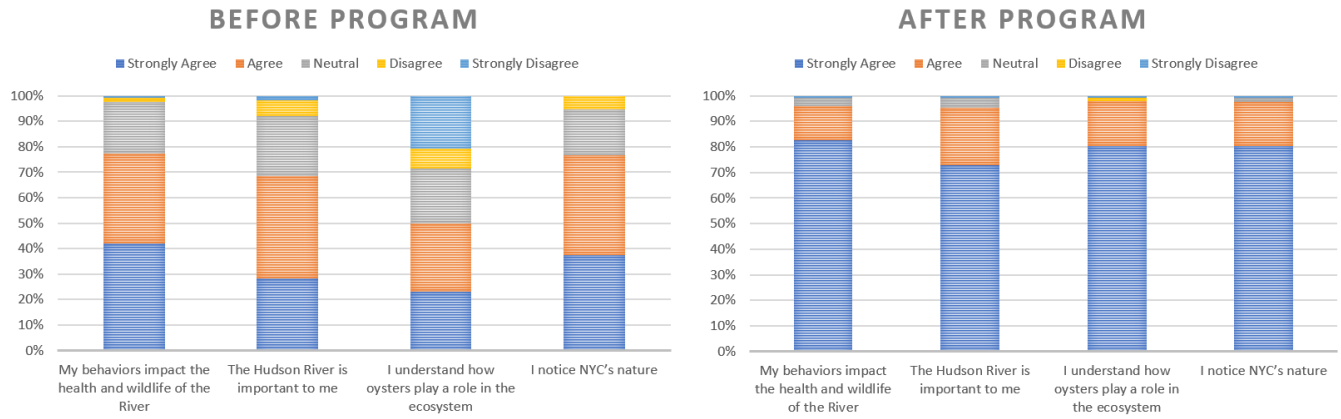



**Fig. 6 |** Results of Community Eco-Paddle participant surveys from 2018 and 2019 combined (n=127).

# V. Discussion & Future Directions

The results of this study suggest that the Pier 32 pile field is a viable habitat for adult oyster survival, growth, and spat recruitment. Due to the oysters' significant growth during each monitoring season and throughout the project, we predict continued growth and spat recruitment in future monitoring seasons. It is not clear whether the overwintering success of the oysters was a result of the new, adult cohort of oysters, the environmental conditions, or the alterations made to the wrap structures; however, the oyster growth was such that we are optimistic that future overwintering seasons will be equally successful in this oyster restoration project.
The oyster wraps also appear to be good habitat for juvenile fishes and small invertebrates. While the animals found inside of the oyster wraps were not recorded in a quantitative manner for this study, mud crabs and grass shrimp were found inside of every wrap that was opened for monitoring, and the majority contained at least one juvenile oyster toadfish or blue crab. Two of the most valuable ecosystem services provided by oysters are water filtration and the creation of habitat reefs for fish and invertebrates, such as those that have been observed during the Pier 32 Community Oyster Project wrap monitoring. Therefore, increased water quality and fish abundance may be indicators of successful oyster restoration in the Hudson River Estuary. Historic data indicate that fish abundance is decreasing in the long term, and this is likely a result of overfishing, pollution, and habitat loss (State of the Estuary Report 2018). While current data is too preliminary to interpret the effect that oyster wraps may have on local fish and wildlife, oyster reproduction, and recruitment of wild oyster reefs onto the piles is a long-term goal of this project that could be beneficial to the health of the River and its fish populations.

Hudson River Park will also continue to host Eco-Paddle programs in future seasons. The program is beneficial to the public, as people enjoy the interactions with the environment and the exposure to oyster populations. A similar, New York City based study also looked at the effect of place-based environmental education in oyster-focused lessons (Caref & Lawrence 2018). Students and teachers monitored oysters, learned about the Hudson River, and reported on their overall experience. Reports showed that on-site oyster restoration field science lessons for individuals who are not typically exposed to environmental science education have been found to improve perceptions of the Hudson River and foster positive attitudes toward science and the environment (Caref & Lawrence 2018). These results are consistent with the findings of Hudson River Park's Eco-Paddle participant surveys; individuals who are exposed to hands-on opportunities to interact with their environment and handle wildlife respond positively to the experience and feel more connected to the natural world. Hudson River Park prioritizes creating high-impact learning experiences, and Eco-Paddle is an opportunity to foster a connection between individuals and their environment.

Hudson River Park will also continue to monitor oyster growth in future seasons. In the upcoming years of this research project, it will also become important to monitor the growth and survival of spat present on the adult oysters to better understand if oyster wraps are a strong method of introducing new, wild oysters into the Hudson River. An ultimate goal of many oyster research projects at this time is to restore a strong, self-sustaining population of oysters in the

Hudson River, and studying spat survival will be a valuable tool in reaching that goal. McFarland & Hare (2018) studied the survival of spat-on-shell at a number of sites in the Hudson River estuary, and found that sites in the New York harbor, such as Governor's Island, experienced high mortality of spat, with as low as 57% survival within one month of deployment. New York Harbor sites had the lowest survival rate of all the sites in the study, which included sites as far north as Yonkers, NY, and some locations in the East River and Jamaica Bay (McFarland & Hare, 2018). Because the oyster restoration sites in this study are in the Lower Hudson, these sites bear a particularly high mortality risk for spat, especially during over-wintering, when survival is significantly lower than summer seasons (McFarland & Hare, 2018). Further research in this area will be required to fully understand the reestablishment of a wild oyster population within the Lower Hudson estuary. It is not clear at this time if the pile field habitat yields significantly better growth than other potential oyster habitat available in the Lower Hudson, such as benthic reef balls or traditional oyster restoration cages. However, it is clear that adult oysters are able to successfully thrive and grow over the course of multiple seasons in this habitat. While the presence of spat has not been analyzed statistically at this time, there is evidence to indicate that the oyster population in the wraps are reproducing, due to the presence of spat that was observed in the 2019 monitoring season. The data collected to date suggests that oysters will continue to grow in this environment in coming seasons, and Hudson River Park is moving forward with increasing the area of designated oyster restoration habitat within the estuarine sanctuary. Hudson River Park is hopeful that continued efforts from multiple organizations and community science volunteers will slowly help to reach goals set forth for the health of the Hudson River.

# Works cited:

Caref, E., & Lawrence, S. (2018). If You Give a Kid an Oyster: Reflections on Collaborations in PlaceBased STEM Education Through Oyster Restoration Science in New York City. Journal of STEM outreach, 1(2).

Connell SD (2001) Urban structures as marine habitats: an experimental comparison of the composition and abundance of subtidal epibiota among pilings, pontoons and rocky reefs. Mar Environ Res 52:115–125

Fitzgerald, A.M., C. Roble, M. Krupitsky, M. Ramirez, and C. Giraldo. 2020. Invertebrate colonization of pier pilings in the Hudson River. Final Report to Hudson River Park Trust.

McCann, Mike. 2018. New York City Oyster Monitoring Report: 2016 -2017. The Nature Conservancy, New York, NY.

McFarland, K., & Hare, M. P. (2018). Restoring oysters to urban estuaries: Redefining habitat quality for eastern oyster performance near New York City. *PloS one*, *13*(11).

Starke A, Levinton JS, Doall M (2011) Restoration of *Crassostrea virginica* (Gmelin) to the Hudson River. USA: A spatiotemporal modeling approach. J Shellfish Res 30(3): 671–684.

Stinnette, I., Taylor, M., Kerr, L., Pirani, R., Lipuma, S., Lodge, J. State of the Estuary 2018. Hudson River Foundation. New York, NY.

Taghon, G. L., Petrecca, R. F., & Fuller, C. M. (2018). Benthic Infaunal Communities and Sediment Properties in Pile Fields within the Hudson River Park Estuarine Sanctuary.

Weaver, R. J., Hunsucker, K., Sweat, H., Lieberman, K., Meyers, A., Bethurum, A., ... & Bethurum, S. (2018). The Living Dock: A Study of Benthic Recruitment to Oyster Substrates Affixed to a Dock in the Indian River Lagoon. *Marine Technology Society Journal*, *52*(4), 7-18.