YEAR 1 ANNUAL REPORT: HUDSON RIVER PARK TRUST'S GANSEVOORT HABITAT ENHANCEMENT MONITORING PROGRAM

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EXECUTIVE SUMMARY

The Hudson River Park Trust (the "Trust") is committed to increasing the oyster population of the Lower Hudson River Estuary and creating valuable habitat for benthic, epibenthic, and mobile organisms within the Estuarine Sanctuary waters of Hudson River Park (the "Park"). Building on its Tribeca Habitat Enhancement Project, the Trust installed a salt marsh and 300 reef enhancement structures, consisting of gabions and reef balls, some seeded with oyster spat, on the northern edge of the Park's Gansevoort Peninsula in 2022. During the summer of 2023, baseline studies were conducted on the Gansevoort Habitat Enhancement area to assess the structure and functioning of the salt marsh as well as nekton abundance. Later that year, the Trust secured funding from the National Oceanic and Atmospheric Administration (NOAA) to support four years of seasonal, post-construction monitoring, beginning in the summer of 2024. This monitoring aims to evaluate the effects of the enhancement structures, the health of the salt marsh, and changes over time in estuarine communities and conditions. The monitoring plan focuses on three key research areas to be assessed over the four-year project period from 2024 to 2027: 1) oyster health and performance, 2) estuarine community utilization and water chemistry, and 3) salt marsh condition. The plan incorporates innovative and non-invasive technologies and methodologies, such as remote vehicles and baited cameras, which are not currently employed at the Tribeca Habitat Enhancement area. These tools will improve the understanding of restoration efforts while preserving the integrity of the enhancement structures. This report summarizes the findings from Year 1 monitoring of the habitat enhancements at the Gansevoort Habitat Enhancement area.

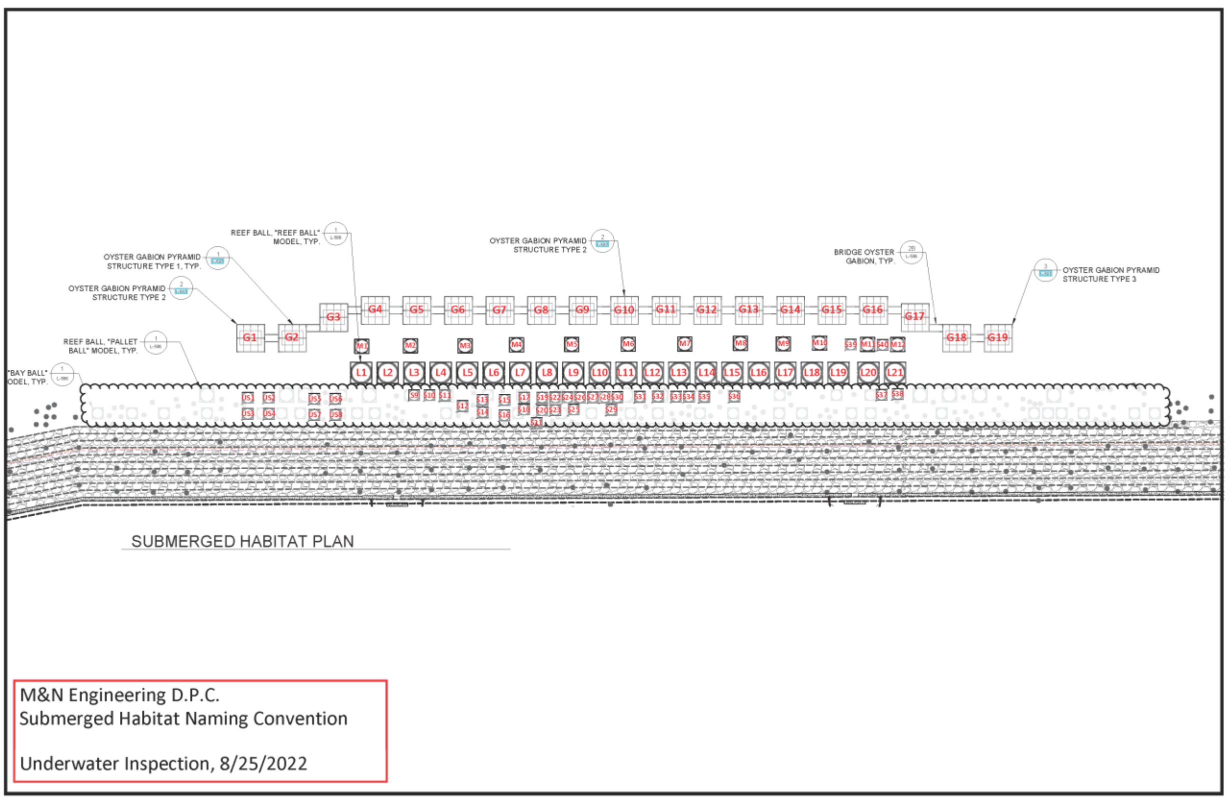

Figure 1. Gansevoort Habitat Enhancement Project layout

Oyster Health and Performance

Oyster coverage and growth were assessed on a representative selection of gabions and reef balls using underwater video and ARIS sonar imagery obtained in coordination with divers on August 1 and 2, 2024. The highest percent coverage of oysters and oyster habitat scores were observed on small, seeded reef balls, followed by gabions, with no coverage on the large, unseeded reef balls. These results indicate that oysters that were seeded on small reef balls and gabions are surviving and growing, with growth extending at least the height of an adult oyster from off the structures. Over 70% of reef ball images and 18% of gabion images received a habitat score of 3, which is associated with greater abundance and diversity of other organisms compared with locations that have low oyster percent coverage and minimal vertical structure. Despite the turbid environment, underwater video proved to be an effective method for observing oysters on reef balls and oysters growing out of the metal frames on gabions. ARIS sonar imaging also successfully estimated oyster survival and growth based on percent coverage, with results comparable to underwater video. For future sampling, underwater video will be collected during low tide, while ARIS sonar imagery will be collected at high tide.

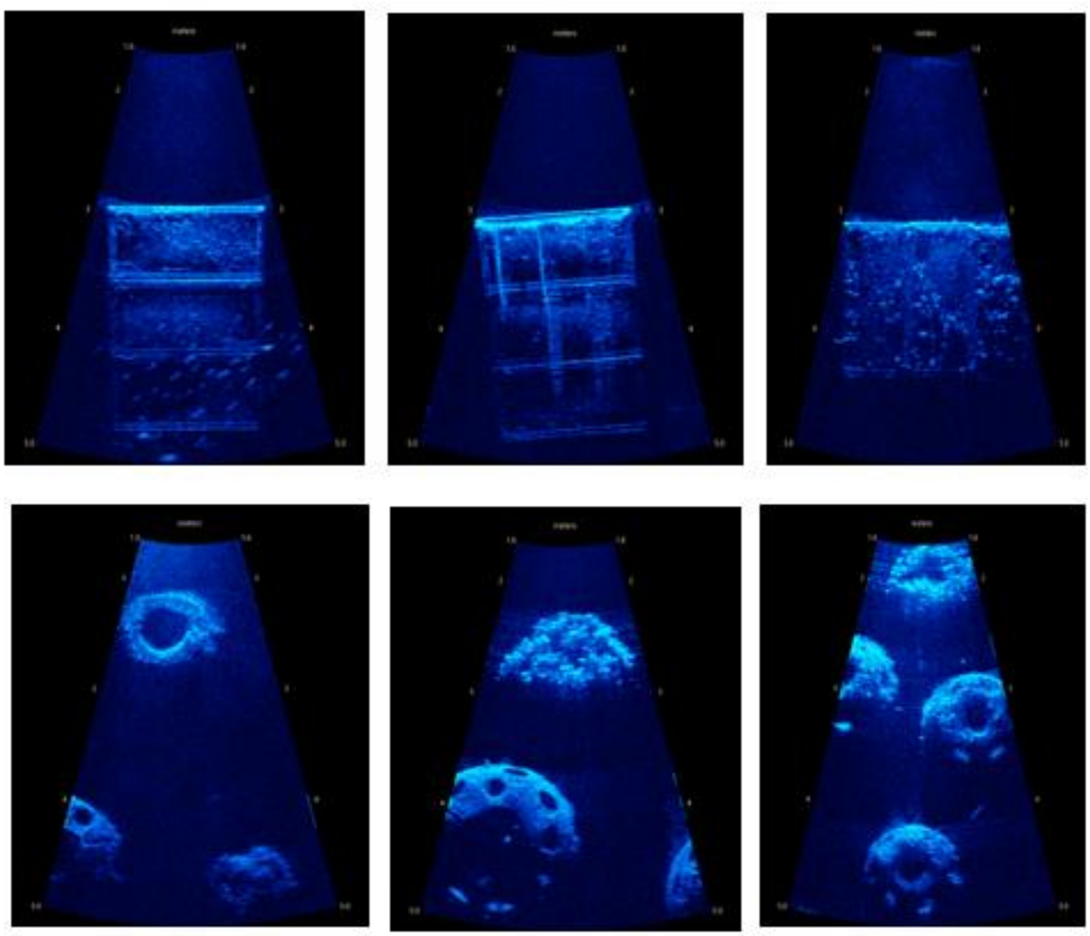

Figure 2. Images of ARIS sonar videos of both gabion (a,b,c) and reef ball structures (d,e,f).

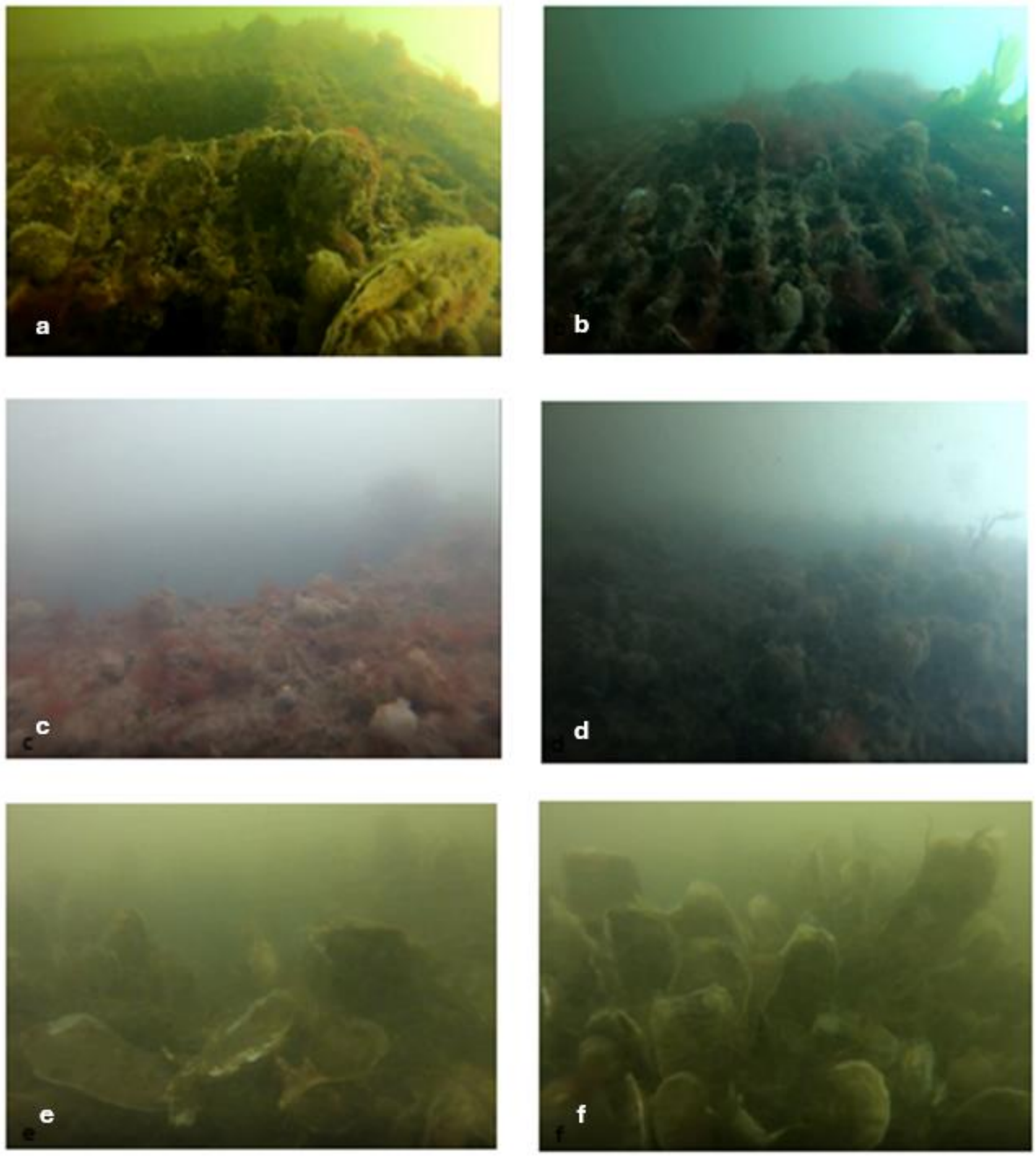

Figure 3. Clipped images from GoPro videos used for qualitative analysis: a) and b) are images from gabion structures; c) and d) are images from large reef balls; e) and f) are images from small reef balls.

Oyster spat recruitment and growth were planned to be monitored using mini-reef ball proxy structures, secured to the revetment of the salt marsh and recoverable by hand. Due to delays and issues with aquaculture facility spat stocks, the proxy reef balls were unable to be set with enough time to include in Year 1 monitoring. Nonetheless, two of five proxy reef balls were deployed along the marsh by Park staff to test functionality of the planned protocols. The reef balls saw highly variable spat survivorship, but spat that did persist generally grew significantly, as would be expected during the warm fall months. A full set of proxy reef balls will be deployed in 2025 to be monitored with the assistance of community scientists as part of this monitoring effort.

Oyster condition and disease were assessed for 30 randomly selected oysters from designated pre-seeded reef balls located in three sections (West, Mid, and East) in the Gansevoort underwater Enhancement area on August 1, 2024. The collected oysters were shipped to the Marine Animal Disease Laboratory at Stony Brook University to be processed for Dermo disease diagnostics, histopathology, and condition index. The average condition index of the analyzed oysters was 4.4 ± 1.0, which is higher than the average condition index of 3.2 reported for other oysters analyzed from the Hudson River Estuary in 2024. Dermo (*Perkinsus marinus*) was not detected in any of the collected oysters. MSX (*Haplosporidium nelson*) infections were observed in four of the collected oysters, with three of the infections classified as light and one as moderate. One oyster was observed to have a heavy trematode infection. All oysters displayed reproductive activity with most being in spawning stages, while others had completed spawning and were undergoing a new round of gonad development, indicating the potential for a second spawning cycle for that season.

Table 1. Observed pathological conditions (n=30).

Condition	Number of Oysters
H. nelsoni (MSX)	4 (1 moderate, 3 light)
Trematodes/Turbellaria worms	1 (heavy trematode infection in gonad area)
Chlamydia	0
Ciliates	0
Inflammation/Hemorrhage	Minor diffuse inflammation in MSX-infected oysters
Other	0

Estuarine Community Utilization & Water Chemistry

Acoustic mapping of the Gansevoort underwater Enhancement area using an Autonomous Surface Vehicle (ASV) was conducted on June 25, 2024, and Baited Remote Underwater Video (BRUV) surveys followed on September 18 and 27, 2024. The ASV survey produced useful maps of bathymetry and surficial features in water as shallow as 0.6 meters, including areas underneath alongshore pier structure (Park Esplanade). The mapping revealed a predominantly featureless, gently sloping mud bottom with minimal debris or relief, except under the Park's Esplanade and in the Enhancement area and its adjacent riprap shoreline. Submerged relict pilings were also revealed to the north of the Enhancement area alongside Little Island. A few low-density SONAR targets, likely foraging fish schools, were detected in open water, though they were not quantified. The small size of the ASV and inertia relative to waves during operation made the ASV susceptible to heave and pitch, which can degrade the SONAR return and create scatter when the transducers are pitched above the water or occluded by bubbles during splashes. Future ASV deployments should account for wind conditions and periods of high vessel traffic.

BRUV sampling was limited by low visibility, often failing to extend beyond the armature to the bait bag, which resulted in a reduced volume of water sampled. While two juvenile striped bass *(Morone saxatilis*) were observed together during a test deployment at the Tribeca Habitat Enhancement area, no fish and only a single blue crab (*Callinectes sapidus*) were observed in any videos taken inside or adjacent to the Gansevoort Habitat Enhancement area. Visual range encounter rates for wire mesh traps and BRUVs are likely similar, given their comparable dimensions and directionality (trap opening and camera direction). However, bait scent can attract fish from beyond the visual range, potentially giving traps an advantage in detection. The BRUVs' inability to detect fish is consistent with the low trap catch-per-unit-effort observed at the Tribeca Habitat Enhancement area, which recorded approximately 0.5 fish per trap in a

Figure 4. The SeaRobotics ASV navigating the Gansevoort Habitat Enhancement area.

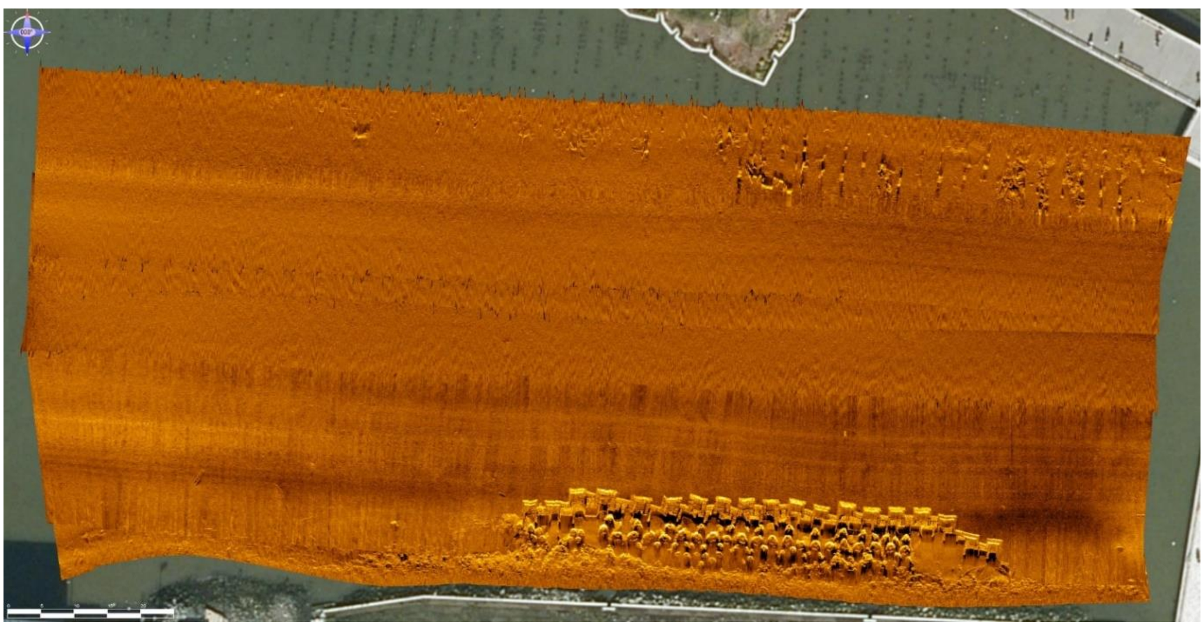

Figure 5. Mosaicked high frequency (1610 kHz) side-scan imagery of the Gansevoort Habitat Enhancement area.

168-hour soak period, or 0.003 fish per hour. While the trap catch rate underrepresents encounter rates, because not all fish that approach the trap will enter, it underscores the difficulty of obtaining statistically significant data under the current fish density. Alternative methods, such as the use of a chemical light (e.g., Cyalume GloStick) at night instead of scented bait during the day may be considered for future monitoring efforts.

Fish were visible in underwater video and sonar imagery obtained during oyster coverage and growth surveys. In the 24 underwater videos, at least four individual fish, including one black sea bass and three striped bass, were observed, all of which were associated with gabions. Although fish were difficult to identify to species level with ARIS sonar imagery, 169 fish were observed with a mean total length estimated at 10.57 cm ± 6.71 cm.

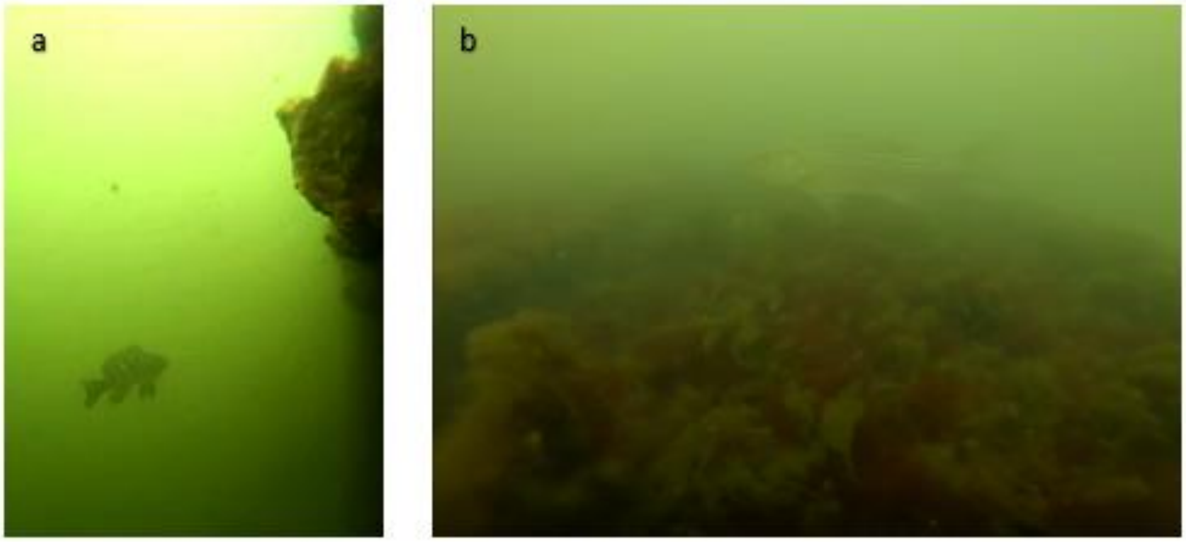

Figure 6. Examples of identified fish using gabion structures; a) black seabass b) striped bass.

Water quality measurements including temperature, conductivity, salinity, turbidity, depth, pH, and dissolved oxygen, were taken at the Gansevoort Habitat Enhancement area on eight occasions between July and September using a handheld YSI device. Surface and bottom measures were similar, indicating a well-mixed water column. Water temperature (averaged across surface and bottom measures) ranged from 21.55°C to 25.30°C and pH ranged from 7.45 to 8.15, following a slight decline similar to temperature trends. Salinity was inversely correlated with dissolved oxygen concentration, ranging from a low of 10.18 psu to a high of 21.84 psu. Dissolved oxygen concentration stayed above the 4.00 mg/L stress level accepted for many estuarine fish, rarely fell below 5 mg/L and rose as high as 9.70 mg/L (corresponding to 128.2% supersaturation) with periods of freshwater influence. These conditions are typical of dynamic mesohaline estuarine reaches in the Middle-Atlantic region.

Salt Marsh Condition

Salt marsh condition was assessed in July and September 2024 through measurements of plant percent coverage, stem height, stem density, marsh sediment accrual, and presence of salt marsh mobile epifauna. Surveys of saltmarsh infauna, nitrogen cycling, plant below-ground biomass, and carbon fluxes were performed in September and October 2024. Results from the 2024 salt marsh monitoring indicated strong marsh growth from 2023 to 2024, with greater than twofold increases in percent coverage, stem density, stem height, and belowground biomass. Denitrification in vegetated sediments of the salt marsh was more than double that in unvegetated sediments. Nitrogen (N_2) gas fluxes in vegetated and unvegetated cores increased from 2023 to 2024, significantly increasing the ecosystem service of nitrogen removal provided by the marsh. Sediment oxygen demand also increased in both vegetated and unvegetated sediments. The observed changes in plant biomass and associated changes in microbial community activity likely drove the differences in N_2 gas flux and sediment oxygen demand observed between 2023 and 2024. Measurements of percent organic matter, carbon content (%C), and nitrogen content (%N) suggested that the marsh is accumulating organic material, consistent with natural marsh processes. Although the analysis of carbon pools showed that most of the carbon was stored in the above-ground plant material rather than in the sediments, ideally the primary storage location, this proportion

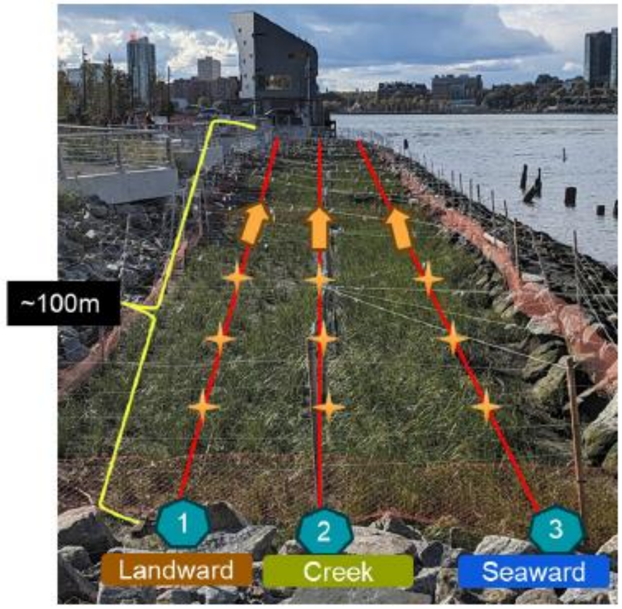

Figure 7. A schematic of the transects and monitoring points across the Gansevoort marsh.

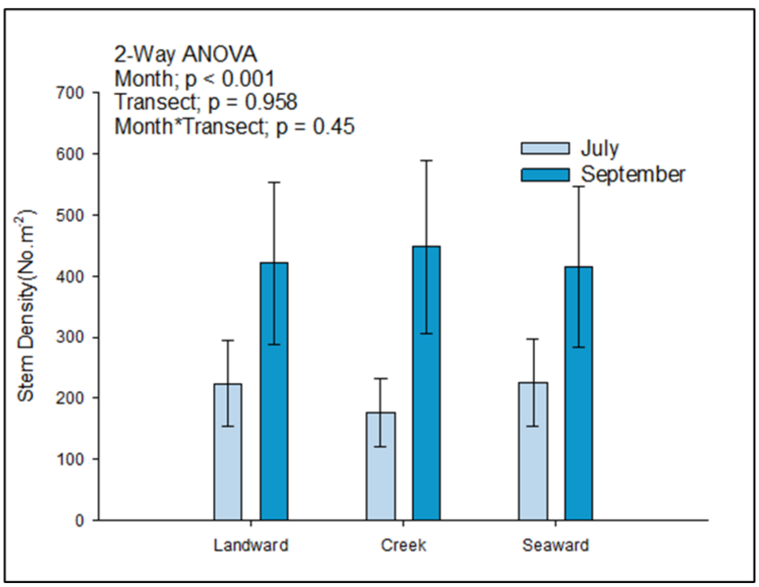

Figure 8. A comparison of the stem density of *Spartina alterniflora* between July and September 2024 and across transects.

is expected to shift as the marsh ages. Measured carbon dioxide (CO_2) emission rates were within the range of those measured at other natural and restored marsh sites in New York City (Zarnoch, unpublished; Wigand et al. 2014). While no significant change in marsh elevation was detected between 2023 and 2024, creek elevations were higher in 2024, potentially indicating that the creek is beginning to fill in. Few mobile macrofauna were observed at monitoring points in the salt marsh during surveys in July and September 2024. However, minnow traps placed along the seaward transect captured more macrofauna than those placed along the landward transect, likely due to differences in inundation periods. Future monitoring could investigate the influence of below-ground biomass, porewater nutrients, and biofilms on soil respiration, as well as seasonal surveys of mobile macrofauna using baited traps among various locations (e.g., rock sill, inlet, channel, etc.).