Tide Deck Report 2022

Purpose

The Tide Deck rests under the raised end of Pier 26 and is made up of tide pools carved into granite, native marsh plantings, and submerged oyster enhancement structures. In 2021, Hudson River Park staff began a pilot survey of the ecological conditions of the Tide Deck. Pilot-year imaging protocols of the pools proved ineffective due to intense glare, and thus new methods for observing the tide pools were developed and employed in 2022. Although there is not a full season of data, the observations herein provide a solid framework and baseline for subsequent years of analysis.

Tide pools are shallow pools that fill with water when the tide rising (**Fig. 1**) and hold on to this water when the tide recedes. This twice-daily exchange of water also carries organisms, from microscopic plankton and algae to shellfish, crustaceans and other organisms. During high tide, the Pier 26 Tide Deck becomes completely submerged by the Hudson River, refreshing the water in the tide pools and allowing sessile species on the Tide Deck to feed on plankton suspended in the river. At low tide, the pools and rocks of the tide deck become accessible to mallards, seagulls, sparrows and other bird species who feed on the algae, insects and marine organisms present here.

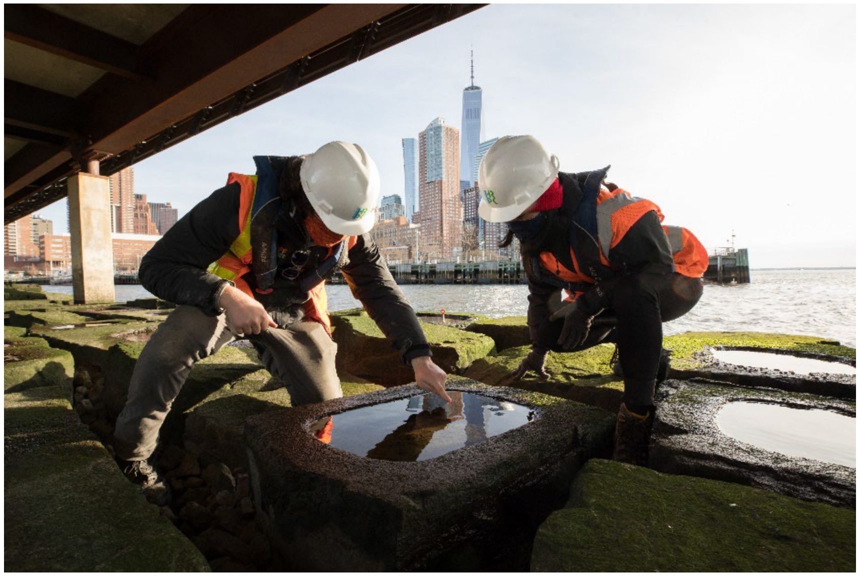
In addition to tide pools, the Pier 26 Tide deck also features a mix of native marsh plantings. The majority of these plantings are *Spartina alterniflora* (**Fig. 2**), a perennial rhizomatous grass native to the east coast of North America, but a similar species of the same genus – *Spartina patens* – is also present. At the onset of this project, juvenile spartina grasses were planted in PET mats on the Tide Deck developed by Biohabitats. These plantings will be monitored annually during the peak growth season in order to assess growth and

Fig.1 | One of the 108 tide pools on the Pier 26 Tide Deck, Summer 2021.

propagation success of the spartina. A very large portion of the spartina plants that were planted and living during last year's data collection process have succumbed to predation or died due to unknown stressors and were thus replanted during the 2022 season. The data included in this report regarding spartina growth will serve as baseline information that can be built upon in the coming years; at present there is not a long enough sampling period to make inferences about the state of the spartina growth at Pier 26.

Fig. 2 | River Project staff monitoring *Spartina* spp*.* Growth with nested quadrat, September 2022

Fig. 3 | River Project staff inspecting tide pools on the south side of the tide deck.



Key Questions

- How does water temperature within artificial tide pools vary compared to the Hudson?
- What is the incidence and abundance of settling organisms such as barnacles, anemones, and bivalves, within the tide pools?
- What is the growth rate and survivability of *Spartina sp.* on PET mats?

Methods

Tide pool monitoring

- Nine pools out of the total 108 were randomly selected for monitoring and marked with bolts.
- Settlement plates were deployed in these pools starting July and imaged approximately every two weeks through November
- Settlement plates were removed from pools by cutting zip ties fastening them to the bolts before imaging out of water, and then reset with fresh zip ties.
- Photos of pools were analyzed using ImageJ software.
- Water temperature of half the selected pools was measured in situ using HOBO tidbit MX2201 loggers, collecting data every 15 minutes.
- River temperature was continuously monitored by nearby (>100m) YSI EXO-2 sonde for comparison.

Spartina monitoring

- Performed annually in peak growth season (Aug-Sep).
- Two transects of 5 plots each per PET planting area were assessed using a nested 1m/0.25m^2 PVC quadrat, with each plot ~3m apart (**Fig. 5**).
- Within each 0.25m^2 area, the number of stems, the heights of 5 random stems, and the number flowering plants were recorded.
- Within each 1m^2 area the approximate range of percent cover of vegetation is recorded via observer consensus.
  - Ranges: 0%, <1%, 1 - 5%, 6 - 25%, 26 - 50%, 51 - 75%, 76 - 100%

Fig. 4 | Barnacles on the edge of a tide pool, outlining path where water lingers during tidal shifts.

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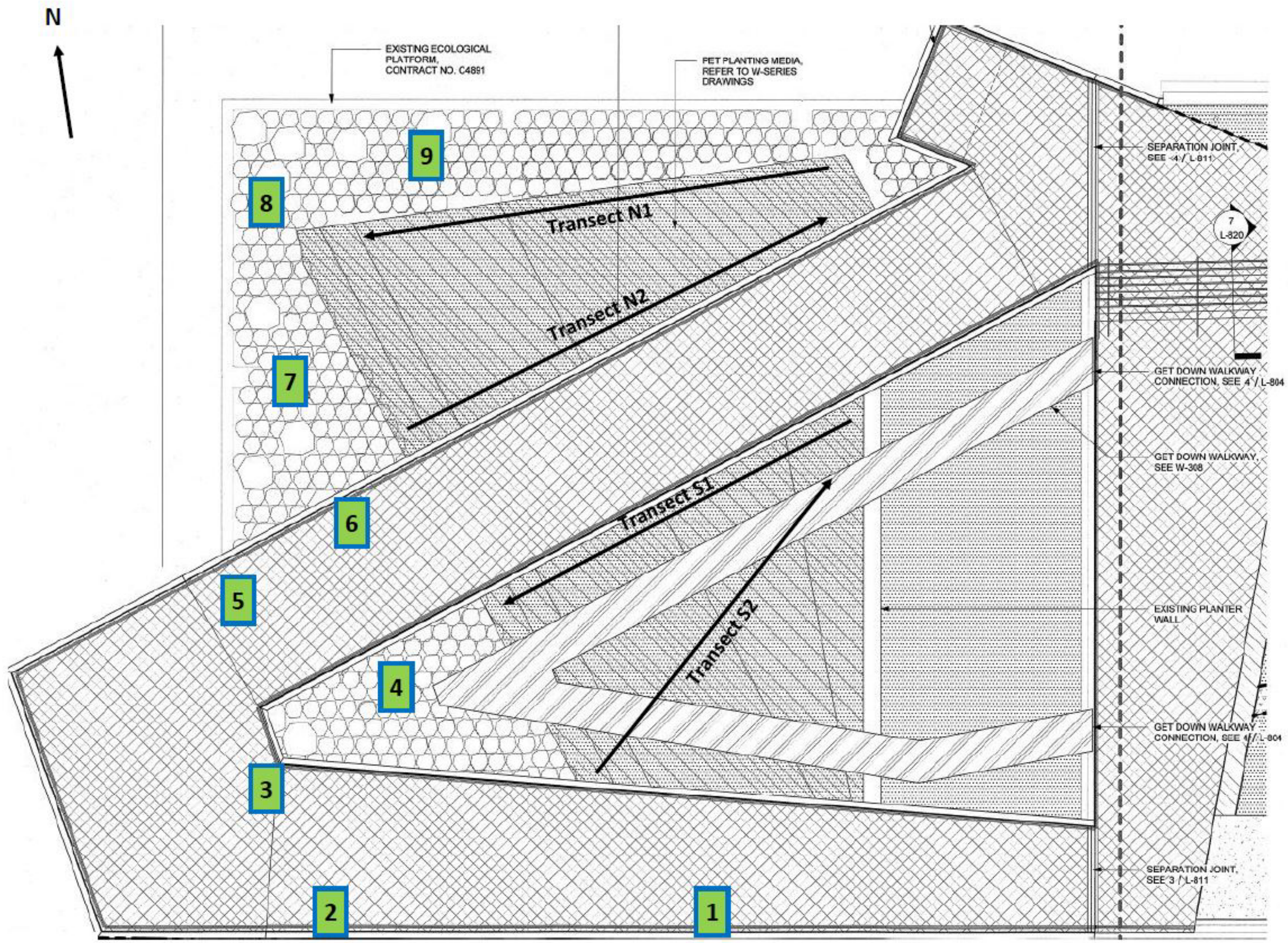

Fig. 5 | Top-down view of the Pier 26 tide deck. Green squares indicate approximate location of monitored tide pools. *Spartina* transect lines are also indicated on the respective north and south PET areas. Each transect contained 5 quadrats, ~1m apart.

Preliminary Findings

Settling Organisms

Settlement plates saw rapid and intense algal and plant growth (**Fig. 6**) which quickly fully covered the majority of the plates within the first few weeks of deployment (**Table 1 - appendix**), and mostly stayed consistent. Phytoplankton mats (chiefly diatoms but also cyanobacteria at times, often mixed) were ubiquitous, being both the pioneers and last remaining organisms as the waters cooled; they were found covering most other dominant species as well, especially the sponges. Sea lettuce and filamentous green algae (possible also genus *Ulva*) *was* highly prevalent on the plates that received the most direct sunlight along the north and south edges of Pier 26 (**Table 2 - appendix**)

Amphipod burrows were a common sight on the plates and in the pools (**Fig. 6**, Pool 3 July), and were joined by other invertebrates such as barnacles, limpets, anemones, isopods, blue, green, and mud crabs, polychaetes, comb jellies, and oysters!

Most pools did not lose phytoplankton mats as the season progressed toward winter, though the presence of *Ulva* and filamentous aglae, as well as mobile invertebrates, declined by November.

Fig. 6 | Settling organism growth in three tide pools from July to October 2022.

Water Temperatures

Most tide pools were significant different from river water temperatures ($p<0.05$) with high inter-pool variability. Overall, tide pools exhibited much more drastic temperature ranges than the river (**Fig. 8**). This was expected due to the pools' shallowness and small volumes compared to the river, which enjoys significantly larger temperature swing mitigation due to sheer volume, currents, and tidal exchange.

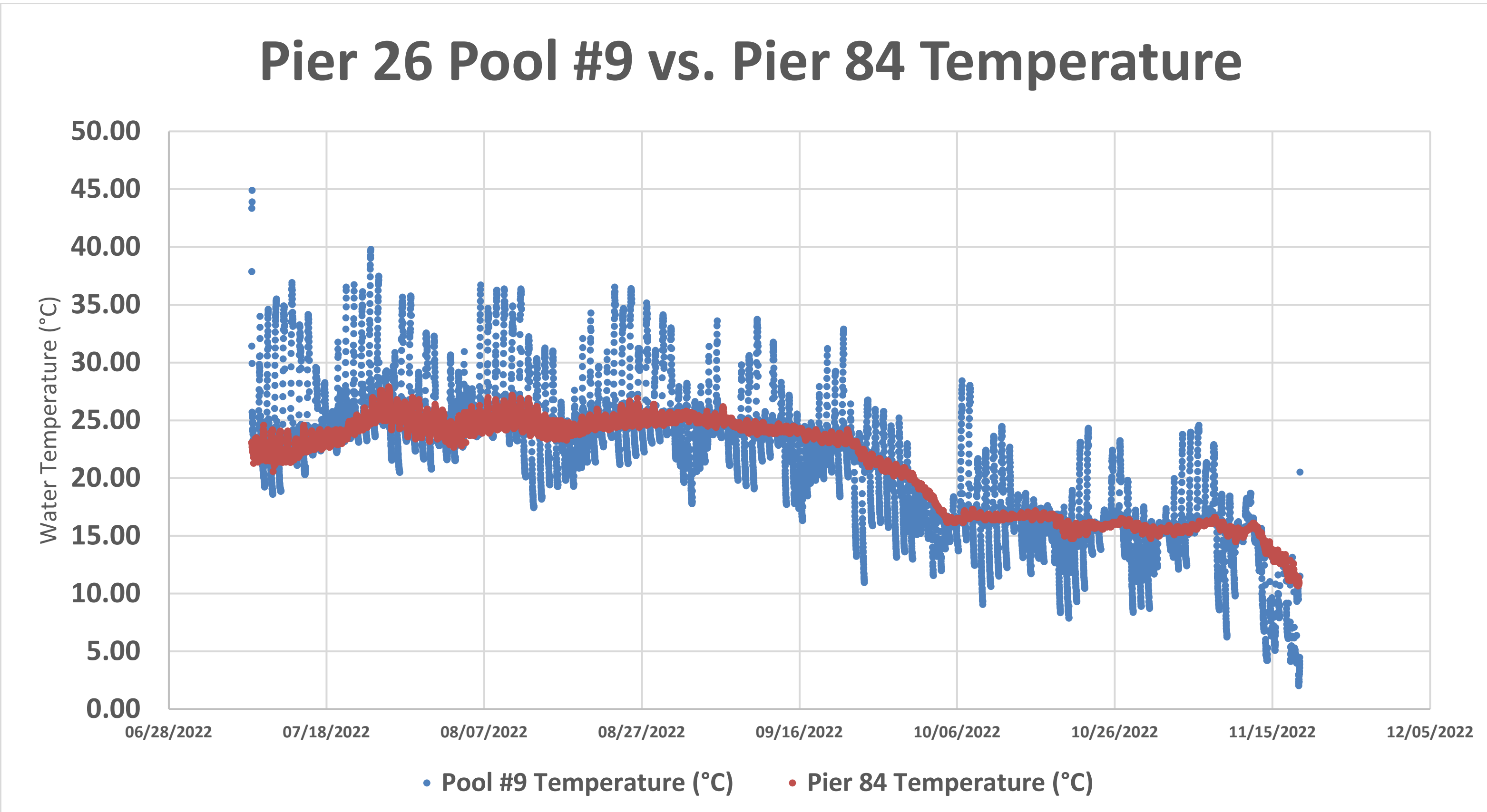

Fig. 8 | Tide pool temperature was measured using ONSET HOBO tidbit MX2201 loggers, river temperature with *in situ* YSI EXO-2 data sondes. Both devices took measurements every fifteen minutes over the course of the season.

Spartina

Spartina plantings were monitored in September. Similarly, to 2021, plantings were variably effective. Southern transect lines (S1 & S2) showed higher growth percentages overall, with nothing below 6-25% and coverage as high as 51-75%. The northern transect lines (N1 & N2), however, showed significantly less foliage, with none of the sampled quadrats exhibiting more than 6-25% coverage, with half of the examined areas only showing 1-5% coverage. In terms of species distribution, there does not seem to be a difference in growth between *Spartina patens* and *Spartina alterniflora*. Growth success may be influenced more by spatial location on the tide deck rather than a matter of species, as the quadrat with the highest percent coverage is the single most inland and consistently sunlit location.

Future Directions

In 2022, data was collected from July to October due to delayed bolt installation that would allow for settlement plate deployment. In 2023, plates will be deployed much earlier in the spring – April or May – in order to observe the initial settling and growth of the epibiota within the pools. Imaging will continue to be every two weeks for the full field season until November in order to observe the full growing season of most species. Plates may be left in year-round to assess interannual

One of the chief difficulties of tide pool image analysis proved to be ex post facto species identifcation, especially of the various algae. In order to improve understanding of codominance and succession characteristics of the tide pools, small samples of organisms are planned to be taken for microscope analysis to confirm identities to the lowest possible taxa (likely family or genus, depending). If possible, a few additional plates may be added in 2023 to serve as collection plates for species sampling.
The eventual goal is to compile a physical and digital database of settling species that can guide epibiont identification both internally and to be shared with partners and students.

Spartina will continue to be monitored during the peak of the growth season (August/September) each year. These data will help to answer the question of viability of the plants perennially within the PET mats and determine average growth rates, which can then be compared to other local data.

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References

National Park Service, U.S. Department of the Interior (2015). Northeast Temperate Network Long-Term Rocky Intertidal Monitoring Protocol. https://irma.nps.gov/DataStore/DownloadFile/518982

Tall, Laure, et al. "Bioassessment of Benthic Macroinvertebrates in Wetland Habitats of Lake Saint-Pierre (St. Lawrence River)." *Journal of Great Lakes Research*, vol. 34, no. 4, 2008, pp. 599–614., https://doi.org/10.1016/s0380-1330(08)71605-8

Appendix

Table 1 | Percent coverage of settlement plates in nine tide pools from July. *Plates 8 & 9 fell out of the pools and dried out between 10/10 and 11/18 but were recovered nearby.

	July 25th	August 10th	August 23rd	September 8th	September 26th	October 10th	November 18th
Plate 1	**97%**	**98%**	**99%**	**99%**	**60%**	**100%**	**100%**
Plate 2	**90%**	**99%**	**87%**	**82%**	**80%**	**74%**	**7%**
Plate 3	**97%**	**71%**	**93%**	**95%**	**94%**	**98%**	**96%**
Plate 4	**99%**	**19%**	**100%**	**100%**	**97%**	**100%**	**100%**
Plate 5	**99%**	**41%**	**94%**	**100%**	**98%**	**96%**	**100%**
Plate 6	**3%**	**100%**	**99%**	**94%**	**100%**	**100%**	**100%**
Plate 7	**98%**	**93%**	**100%**	**99%**	**89%**	**100%**	**99%**
Plate 8	**53%**	**66%**	**62%**	**97%**	**96%**	**68%**	**n/a***
Plate 9	**93%**	**87%**	**89%**	**100%**	**93%**	**47%**	**n/a***

Table 2 | Top three dominant species by plate. Cyanobacteria & Diatom mats were nearly ubiquitous, often covering other listed species, especially sponge.

Plate	Rank	Prevalent Species
1	1	Sponge (Haliclona loosanoffi)
	2	Cyanobacteria & Diatom Mats
	3	Amphipod (*Gammaridae*)
2	1	Sea Lettuce (*Ulva lactuca*)
	2	Filamentous Green Algae
	3	Cyanobacteria & Diatom Mats
3	1	Sponge (Haliclona loosanoffi)
	2	Cyanobacteria & Diatom Mats
	3	Sea squirt (*Molgula manhattensis*)
4	1	Cyanobacteria & Diatom Mats
5	1	Cyanobacteria & Diatom Mats
	2	Sponge (Haliclona loosanoffi)
6	1	Cyanobacteria & Diatom Mats
	2	Sponge (Haliclona loosanoffi)
	3	Filamentous Green Algae
7	1	Sponge (Haliclona loosanoffi)
	2	Filamentous Green Algae
	3	Cyanobacteria & Diatom Mats
8	1	Sponge (Haliclona loosanoffi)
	2	Cyanobacteria & Diatom Mats
	3	Filamentous Green Algae
9	1	Filamentous Green Algae
	2	Sponge (Haliclona loosanoffi)
	3	Sea Lettuce (*Ulva lactuca*)