# Ecological Enhancement of a Constructed Beach using ECOncrete® Tide Pools: Preliminary Report

October 2014

## Background

Man-made coastal defense structures such as breakwaters, revetments, and riprap belts are proliferating in urban coastlines world-wide in response to sea level rise and increase in magnitude and frequency of extreme weather events. These structures provide habitat for many species but generally support lower biodiversity than natural habitats, primarily due to the absence of environmental heterogeneity and water-retaining features, which are an integral part of natural rocky intertidal and shallow water habitats[1, 2].

In order to enhance the ecological value and increase the biological productivity of coastal defense structures, we have developed a simple precast tide-pool that integrates into coastal defense structures such as breakwaters or constructed riprap beaches. The unit takes the place of a standard armoring unit/rocks and due to its internal passive intake system fills up with water during high tide thus creating a stable habitat providing shallow water niches which are lacking from standard constructed beaches. (Fig 1.)

Figure 1. ECOncrete® tide pool integrated into riprap, Brooklyn Bridge Park, NY.



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## Pier 4 Pilot - Brooklyn Bridge Park

A total of seven ECOncrete® Tide Pools were integrated into the newly constructed Pier 4 beach at Brooklyn Bridge Park within the mean higher high water (MHHW) zone. Four were placed at the beach riprap belt during autumn 2013 and three at the bird island across it during spring 2014 (Fig 2.). Each pool retains a volume of 13 gallon and creates a submerged habitat disconnected from the open water at low tide.

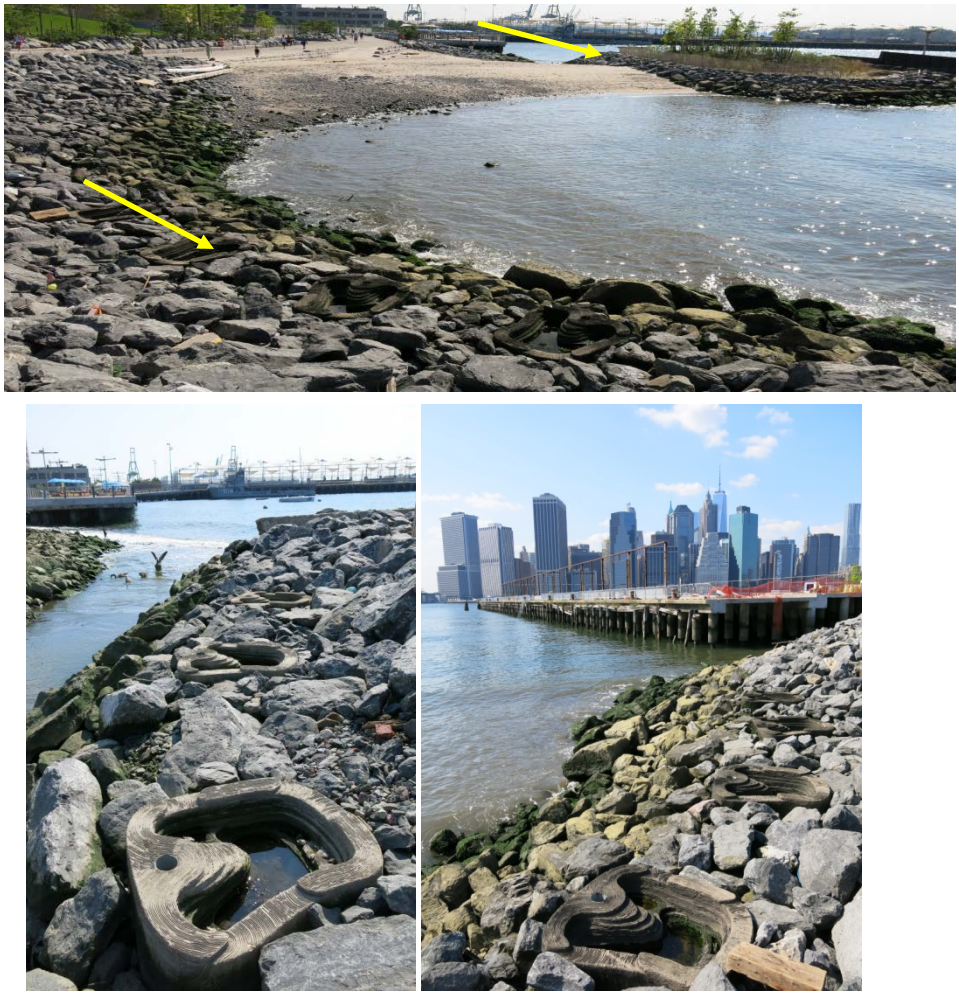

Figure 2. Pier 4 tide pools, Brooklyn Bridge Park, NY. Top: placement of two tide pools clusters (arrows). Bottom Right: Four Tide Pools placed at the beach riprap belt. Bottom Left: Three Tide Pools placed on Bird Island.

The tide pools placed during the autumn sustained the harsh winter during which they were iced for prolonged periods. Nonetheless, as early as February 2014, despite of the extreme winter and the construction work, we have observed initial recruits in the form of isopod crabs and initial turf algae (Fig. 3).

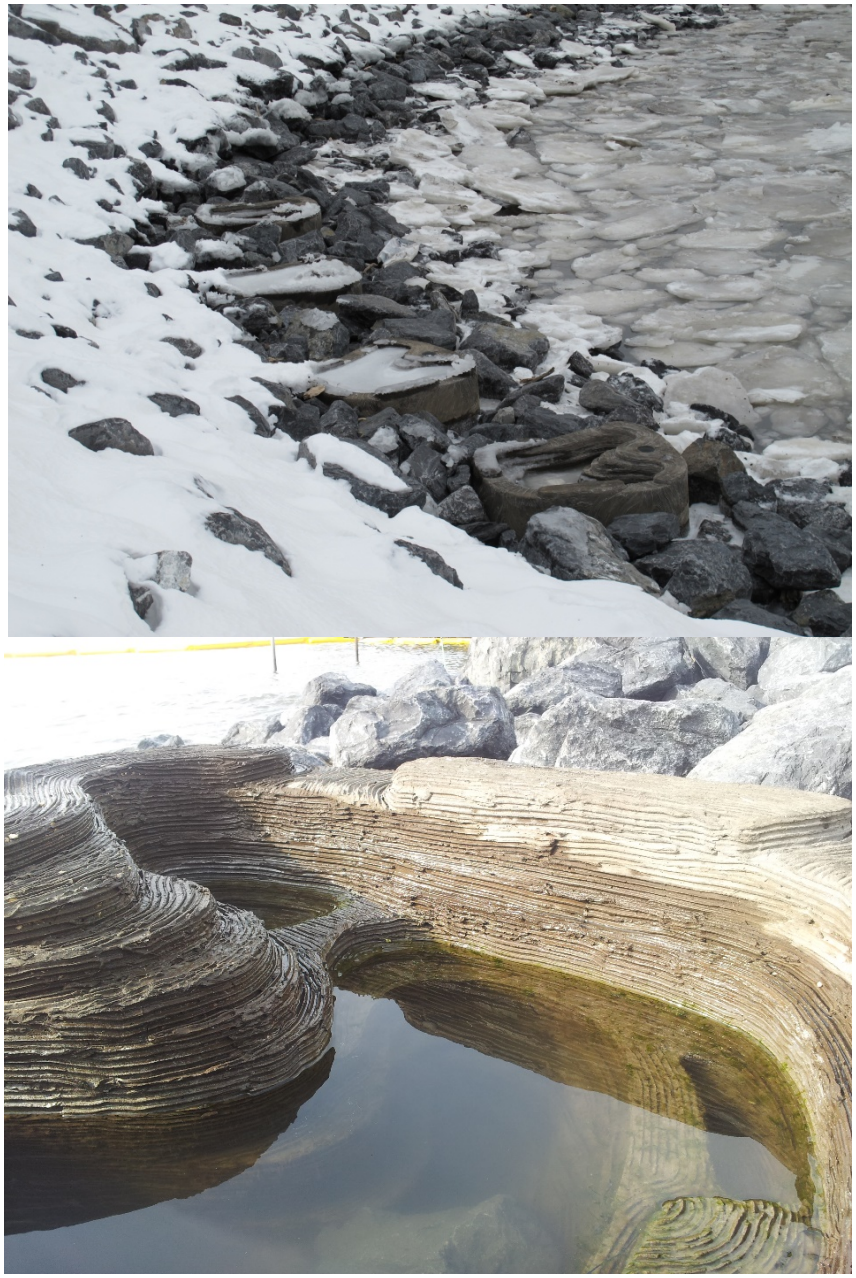

Figure 3. Pier 4 tide pools, Brooklyn Bridge Park, NY. Top: January 2014. Bottom: February 2014, initial succession stage with isopod crabs and turf algae.

In April 2014, when the last three tide pools where placed on the bird island, a preliminary monitoring of the tide at the Pier 4 beach was performed. During this survey, the pools exhibited a live cover of 85-100% of the water retaining portions of the pools, composed mostly of filamentous green algae (*Enteromorpha* sp.). In addition, small isopods and sabellidae worms were observed (Fig 4.). It is important to note that this survey followed a very harsh winter, during which the pools were completely iced, and during the time the survey was conducted water temperature was still extremely low, thus we did not expect significant growth/diversity.

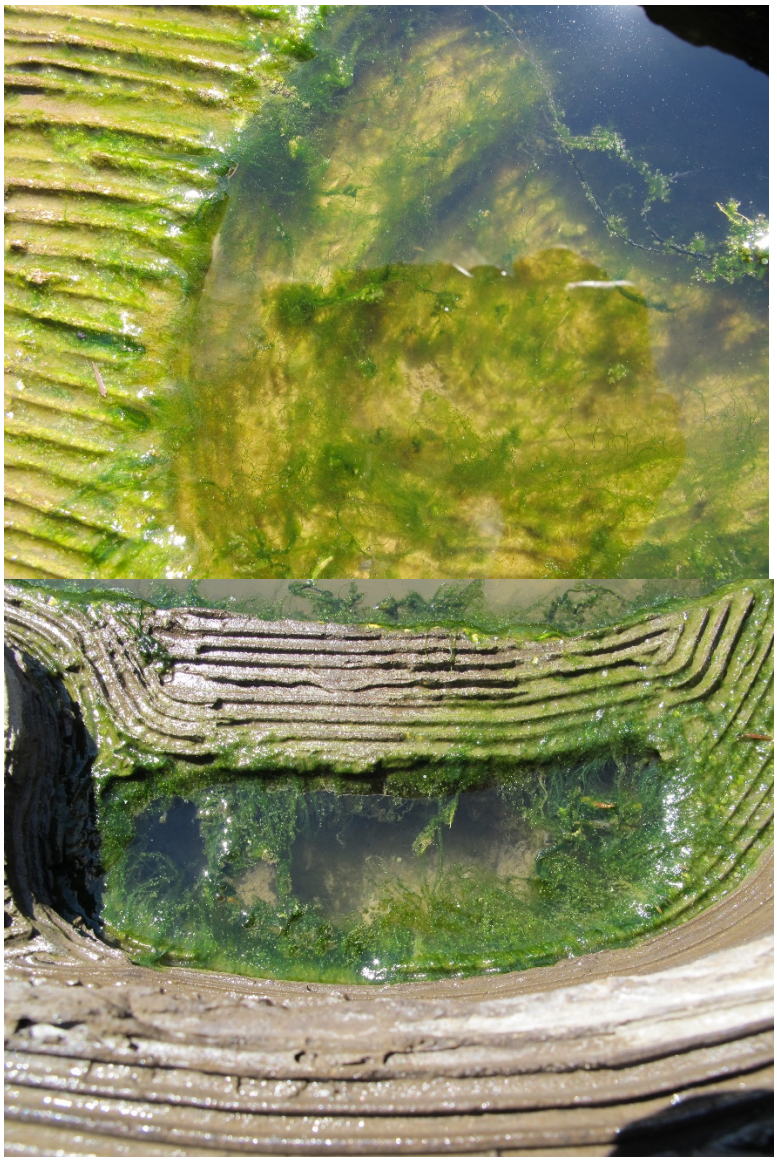

Figure 4. Pier 4 tide pools, Brooklyn Bridge Park, NY. April 2014

During August 2014, a first monitoring event of all 7 tide pools, both at the Pier 4 beach and Bird Island was conducted. The prior showed a live cover of 95-100% of the water retaining portions of the pools while the former had 89-100%. Both tide pool clusters presented a community composed mostly of filamentous green algae, branching brown algae, copepods, amphipods, isopods, as well as sabellidae and *Spirorbis* Worms (Table 1, Fig 5.). In addition, two individuals of the Harris Mud Crab (*Rithropanopeus harrisii*) and 17 individuals of an identified juvenile/post larval fish were noted. These motile organisms were found in more than on pool, both at the beach and the Bird Island clusters.

**Table 1:** Invertebrate species that colonized ECOncrete® tide pools over the monitoring period.

| PHYLUM | CLASS | TAXON (FAM/GENUS/SPECIES) |
|---|---|---|
| **Chlorophyta** | Chlorophyceae | *Enteromorpha* sp. |
| **Heterokontophyta** | Fucales | *Fucus* sp. |
| **Annelida** | Polychaeta | *Spirorbis* sp. |
| | | Sabellidae |
| **Arthropoda** | Malacostraca | *Rithropanopeus harrisii* |
| | Maxillopoda Subclass: Copepoda | *Acartia* sp. |
| | Maxillopoda Subclass: Amphipoda | *Ampelisca* sp. |
| **Chordata** | | Unidentified Juvenile fish |

The control area for this monitoring event included the rocky area surrounding the pools at a distance of 1-2f from the edge of the pools. This area (at the MHHW) was very poor in biological findings, with only a few patches of algae, mostly at lower part of the rocks, where moist areas were noted.

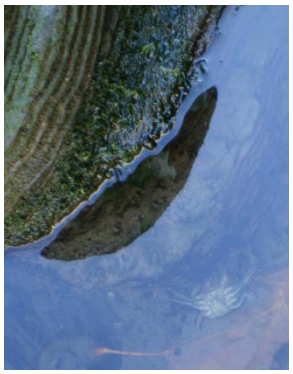

Figure 5. Pier 4 tide pools, Brooklyn Bridge Park, NY. August 2014

In light of these initial results, it seems that the tide pools are able to mimic conditions offered by natural rock pools, and thus are capable of extending the upper line of biological activity in the riprap area. The pools widen the wet tidal habitat while also widening the distribution of water dependent organisms in the area (Fig 6). As no comparable wet habitats were found in the preliminary surveys in the vicinity of the tide-pools, following monitoring will incorporate controls not only at the MHHW area, but also in the MLW-MHW areas. This will allow comparison of communities within the tide pools to a more comparable to submerged habitat that does not exist at this slope elevation.

Quantitative monitoring which will include water quality (Dissolved Oxygen, Turbidity, Salinity and Temperature) biodiversity measurements, species richness and species lists will start in spring 2015 and continue up to spring 2016.

The results of the detailed monitoring will provide data regarding the following questions:

1. The effect of wave/wake exposure on the tide pools community (the less exposed Bird Island cluster compared to the Pier 4 cluster).
2. Seasonal differences in water conditions between tide pools and open water nearby.
3. Seasonal differences in successional stages and biogenic buildup between tide pools placed at deferent time/seasons.
4. Differences in community structure and live cover between the pools, the adjacent riprap belt, and the lower (semi-submerged) intertidal riprap zone.

Figure 6. Pier 4 tide pools, Brooklyn Bridge Park, NY. Red line marks the upper algae line. Yellow line marks the upper frequently wet tidal area Arrows mark tide pools.

**Literature Cited:**

1. Firth, L.B., et al., *Biodiversity in intertidal rock pools: Informing engineering criteria for artificial habitat enhancement in the built environment.* Mar Environ Res, 2014.
2. Firth, L.B., et al., *The importance of water-retaining features for biodiversity on artificial intertidal coastal defence structures.* Diversity and Distributions. **19**(10): p. 1275-1283.