Baseline Study of the Marine Natural Resources of the Harlem/ East River (Hudson-Raritan Estuary 2017)

Abstract

The Harlem/East River was monitored for one year in order to determine the health of the ecosystem based on physical chemistry parameters, littoral invertebrate species richness, benthic populations, and phytoplankton concentrations. It was predicted that there would be differences between sample sites for each component. Sampling occurred at four different stations with the control at the Governors Island Oyster Restoration Project Reef between January 2015 and October 2016. The collected data supported the hypothesis in that there were differences between the same sites for each component. In addition, the collected data justifies the need for restorative repair.

Introduction

The East River Esplanade is a place where you would expect to discover the natural beauty New York City has to offer, slightly removed from city life and along the water's edge. However, it has been difficult for organisms to survive as the waters have been ecologically altered by combined sewage overflow and contaminants from the waterfront's industrial past (NY-NJ HEP, 1996). Much of the conventional concrete or stone bulkhead wall is in dire disrepair, and because of its state of structural decline, it requires critical attention to keep portions of it from falling into the river within the decade (MNLA, 2014). These negative impacts have been changing the Harlem River for decades, destroying the natural ecosystem and making it nearly uninhabitable for all but a few organisms. If restoration is implemented along the shoreline, it is predicted that the area would once again be habitable by a far greater number and range of organism types, and become supportive of numerous species of flora and fauna. The United Nations Convention of Biological Biodiversity (1993) has also made it clear that an important requirement of restoration is to begin with an ecosystem based approach. Baseline studies are a strategy for the integrated management of land, water, and living resources that promotes conservation and sustainable use in an equitable way (UNCBB, 1993).

This project is critical to monitoring the current marine habitat of the Harlem/ East River area. It is hoped that it will serve as the foundation for predictions for ecological uplift, and also serve as the basis for future studies that will determine the overall effects of different construction materials on marine biodiversity enhancement in this location. The main objectives are to determine plankton concentrations of the Harlem River, benthic density of the Harlem River, physical- chemical parameters of the Harlem River, and species richness of the Harlem River. It was hypothesized that there would be differences between sample sites for each component measured.

Food Web

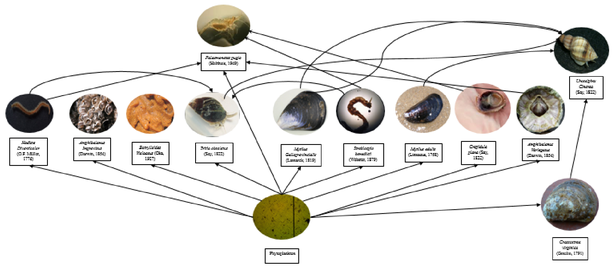


Figure 01. Food web of organisms identified in the East/ Harlem Rivers, as well as Buttermilk Channel. Phytoplankton serve as the base of the food web.

Locality

Figure 02. Sample stations in relation to Manhattan. The section labeled as "A" refers to the Harlem/ East River experimentation sites, while "B" refers to the Governors Island/ Buttermilk Channel control site.

Figure 03. Sample Sites along East River Esplanade. Site 01. 103rd Street; Site 02. Pier 111; Site 03. 116th Street.

Figure 04. Sample site (control) along Governors Island/ Buttermilk Channel. Site 04.

Methods

Physical Chemistry (From Gonzalez and Sommers, 2015)

1) Collect water sample (~80 mL at 1m below surface using Beta Bottle; 2 collections per site)

2) Measure physical chemical parameters using YSI Proplus or Aquacheck test strips

3) Record measurements on data sheet (the mean of each parameter - excluding pH – was used to compare large amounts of data using a single value for each category.

Benthos/Biodiversity (EPA-Approved Standard Collection Methods)

1) Collect sediment sample (Ekman Grab Collection ~6 – 10m; 2 collections per site)

2) Measure the mass of the sample with a scale

3) Sieve (500 um) the sediment and record what organisms are revealed.

Phytoplankton (From Suthers and Rissik, 2009)

1) Collect water sample (100 mL at 1 m below surface using Beta Bottle; 2 collections per site)

2) Transfer sample to 100 mL graduated cylinder and let sample settle.

3) Remove 90 mL of the remaining 10 mL, 1 mL is placed onto a Sedgwick-Rafter counting cell. Individual plankton are counted by grid.

Results

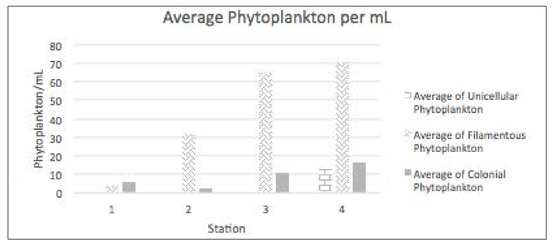
Physical Chemistry

*Table 01. Physical Chemistry means and ranges for parameters measured at three sites (Harlem River) and the GI control (Buttermilk Channel). *pH is recorded in median, as mean is not applicable to logarithmic values. . This data is representative of 6 sample events, with 2 collections per site; total of 48 samples.*

	Mean (Range)			
Parameter	Site 01	Site 02	Site 03	Site 04
pH*	7.29 (6.45-7.58)	7.44 (6.46-7.6)	7.42 (6.67-7.95)	7.50 (6.32-9.24)
Dissolved Oxygen (ppm)	8.36 (6.6-9.95)	7.81 (6.71-9.51)	8.85 (6.81-11.78)	4.67 (3-6)
Water Temperature (°C)	16.78 (8.4-22.8)	17.11 (8.4-22.4)	15.89 (8.3-22.8)	12.56 (7.8-17.2)
Salinity (ppt)	22.06 (16.33-24.86)	23.83 (20.26-25.3)	21.01 (15.32-24.8)	24.67 (18.09-33)
Ammonia (ppm)	0.43 (0-1)	0.14 (0-0.5)	0 (0-0)	0.2 (0-3)
Nitrite (ppm)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)
Nitrate (ppm)	0 (0-0)	0 (0-0)	3.33 (0-20)	3.5 (0-15)
Silicate (ppm)	93.75 (7.5-180)	80 (80-80)	None	50 (50-50)
Phosphate (ppm)	9.42 (1.5-15)	10 (5-20)	10 (0-30)	10 (5-20)
Secchi Depth (cm)	221.42 (100-500)	283.33 (125-500)	258.33 (125-500)	100 (100-100)

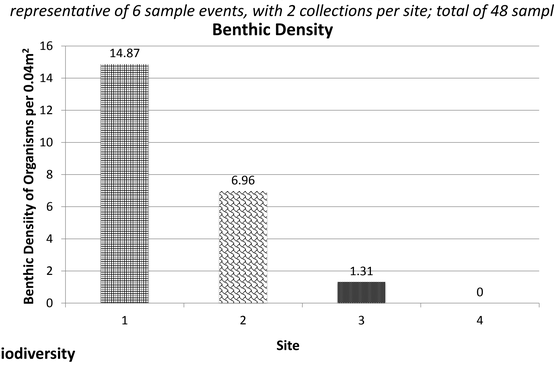
Phytoplankton

Figure 05. Phytoplankton concentrations collected at three sites (Harlem River) and the GI control/reference (Buttermilk Channel). Higher levels of all plankton at Site 4, as more data was present at this site. . This data is representative of 6 sample events, with 2 collections per site; total of 48 samples.



Benthos

Figure 06. Benthic density of organisms per 0.04m² by site. As sites go further south (increase in number), density decreases significantly. This data is representative of 6 sample events, with 2 collections per site; total of 48 samples.



Biodiversity

Table 02. Species richness sample site (Harlem River and Buttermilk Channel), (Carter et al. 2016). No organisms were found at Site 3. Significantly more organism types were found at Site 4. . This data is representative of 6 sample events, with 2 collections per site; total of 48 samples.

Site 1 (116th St)		Site 2 (111th St)		Site 3 (103rd St)		Site 4 (GI Oyster Reef)	
Genus	Specific epithet	Genus	Specific epithet	Genus	Specific epithet	Genus	Specific epithet
Hediste	*diversicolor*	*Hediste*	*diversicolor*	*Tritia*	*obsoleta*	*Hediste*	*diversicolor*
Tritia	*obsoleta*	*Tritia*	*obsoleta*	-	-	*Mytilus*	*galloprovincialis*
-	-	*Crepidula*	*plana*	- -	- -	*Mytilus*	*edulis*
- -	- -	*Streblospio*	*benedicti*	- -	-	*Amphibalanus*	*variegatus*
-	-	*Urosalpinx*	*cinerea*	-	- -	*Amphibalanus*	*improvisus*
- -	-	-	-	-	-	*Botrylloides*	*violaceus*

Results (cont.)

Recorded data was organized by station and component to create different tables and figures. As sites moved south, benthic density per 0.04m² decreased (comparable to Ray Grizzle's 2012 benthic analysis of the Governors Island Oyster Reef) and average phytoplankton per mL increased. Sites 3 and 4 had little sediment collected compared to the first two sites, which led to a decrease in benthic density. As nitrates increased, filamentous concentrations increased.

Discussion

The hypothesis, that there would be differences between sample sites for each measured component, was supported by the collected data. There were in fact different levels of benthic density, different levels of phytoplankton concentrations per mL, and different physical chemical parameters.

The physical chemical parameters measured for ammonia were determined not healthy. The USEPA recommends a limit of 0.02 ppm as NH3 in freshwater or marine ecosystems, whereas it was found that the NH3 in the Harlem River ranged from 0-0.4. These levels are toxic to marine invertebrates (Alken Murray Corp.), and in order for the habitat to be sustainable, these levels need to decrease. In addition, as pH levels increase, toxicity increases (Dr. Brian Oram, Professional Geologist (PG), Water Research Center). The increase in pH ranges moving south, therefore, may have a detrimental impact on benthic organisms. This supports the decreasing benthic density trend seen in Figure 04. Sewage treatment plants are a direct source of ammonia emissions, along with improper disposal of ammonia products and may be transferred to the river ecosystem through the numerous CSO outlets along Manhattan's shoreline.

A living shoreline would decrease runoff, and as a result, help to lower the ammonia levels in the river. In addition, it would create habitats that would be inviting to marine organisms that would thrive in ideal water quality levels. Biodiversity would increase, benthic density would increase, phytoplankton would continue to serve as the base of the food web, and water quality improvements would allow for public interaction with the waterfront, which is not possible today.

Phase 2 of the project will be determining what kinds of construction materials are best for organisms to grow on, in order to begin the restoration process. Living shorelines can filter CSO emissions, which can lead to a decrease in ammonia levels and stabilize the ecosystem.