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

Melanie Smith (Project Manager) & Erik Wiemer (Data Analyst)

Mentor: Jim Lodge, M.Sc.
Hudson River Foundation Senior Scientist

Advisor: Mauricio Gonzalez, M.Sc.
Marine Biology Research Department Chair,
Urban Assembly New York Harbor School

Supervisor: Maura Smotrich
CIVITAS Esplanade Project Manager

The Urban Assembly New York Harbor School

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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 popular venue where locals can go to take a walk or run along the East and Harlem River. It 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, the present waterfront ecosystem has virtually no visible wildlife. It was historically an abundant, thriving ecosystem, with low-lying marshes and creeks acting as drainage conduits to larger rivers for sections of northern Manhattan (MNLA, 2014). Yet it has become an unhealthy marine habitat with a hard sea wall and black mud river bed. The waters have been ecologically altered by combined sewage overflow and contaminants from the waterfront's industrial past (NY-NJ HEP, 1996). Improvements to this marine environment have been slow at best, and the New York Harbor remains among the 20 most toxic estuaries in the country (NYCDEP, 2009).

CIVITAS, a New York City based non-profit organization dedicated to improving quality of life on the Upper East Side and in East Harlem, has studied the East River Esplanade with the goal of identifying the work that needs to be done to begin the process of restoring both the Esplanade and waterfront as a whole. Much of the conventional concrete or stone bulkhead wall is in dire disrepair, and in need of remediation or reconstruction (MNLA, 2014). 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). Deterioration resulting from human impact needs to be addressed, as different environmental impacts can influence species composition or relative importance. Such events, even if of low frequency, can be major factors structuring ecosystems (Zedler *et al.* 1983). 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 hypothesized 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.

A baseline study to determine the nature of existing conditions is imperative to clarify the quality and idiosyncratic characteristics of the present ecosystem. In restorative efforts it is important to, compare an area's current state with the predicted state it would be in if it were under minimal or sustainable human use, and, in case of degradation, intervening to bring it back to the desired good status (Mee *et al.*, 2008). This ties into the CIVITAS mission to restore a living shoreline, for the current state of this ecosystem could justify the need to implement improvements through restoration. 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).

The baseline study of the lower Harlem River took place from January 2016 to October 2016. The goal was to monitor benthic and phytoplankton populations at four different sites, as well as the physical chemistry of the water and invertebrate species richness. Though these may seem like completely individual components, they are interconnected. The water quality of an environment greatly affects the benthic invertebrate populations of an ecosystem (Hoey, *et al* 2010), as well as phytoplankton populations. Nutrients, organic carbon, and temperature all contribute to growth. Additionally, sewer overflow, storm water runoff, industrial waste, and other contaminants resulting from human intervention increase nutrient supply. This can, in turn, alter the biodiversity and phytoplankton biomasses of an ecosystem (Goebel, *et al* 2006). Benthic sampling is done to detect or measure the size of environmental impacts (Underwood, *et al* 2005). In addition, commercially important fish, such as striped bass, are reliant on benthic invertebrates. These invertebrates are in turn reliant on phytoplankton, as they serve as the base of the food web.

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 how each calibrated component (plankton concentrations, benthic concentrations, physical chemistry and species richness)

contributes to the present health of the Harlem/ East River. It is predicted that there are differences in the results acquired from the three different sample sites for each component studied, located along the Harlem River Esplanade.

During a plankton monitoring study conducted in the New York Harbor between 2012 and 2014, the most common group of phytoplankton was pennate diatoms. (Wilson & Kalogrias, 2015). It is hypothesized that these will also be seen in the Harlem River baseline study. Table 01. shows the measured physical chemical parameters measured in the Upper New York Bay over a three- year period. It is predicted that the Physical-Chemical parameters measured in 2015 will be similar to those recorded during the baseline study.

Table 01. *Means and Ranges of Physical-Chemical Parameters Measured in the Upper New York Bay, 2012 –2015 (Gonzalez & Sommer, 2015).*

	Mean (Range)			
Parameter	**Battery West**	**Battery East**	**Manhattan**	**Governors Island**
pH	**7.6** (6.8 – 8.19)	**7.6** (6.4 – 8.3)	**7.4** (6.2- 8.3)	**7.5** (6.2 – 9.6)
Dissolved Oxygen (ppm)	**9.5** (6.6 – 14.0)	**8.3** (5.0 – 12.5)	**9.1** (6.6 – 12.0)	**8.6** (5.0 – 14.0)
Temperature (°C)	**8.7** (1.9 – 24.3)	**9.4** (1.0 – 22.8)	**7.3** (1.0 – 19.2)	**6.3** (1.8 – 19.0)
Salinity (ppt)	**18** (5 – 28)	**21** (10 – 28)	**21** (9 – 28)	**19** (10 – 27)
Ammonia (ppm)	**0.71** (0.25 – 5.00)	**0.61** (0.00 – 3.00)	**1.08** (0.00 – 3.00)	**0.39** (0.00 – 0.50)
Nitrate (ppm)	**2** (0 – 20)	**5** (0 – 20)	**2** (0 – 20)	**5** (0 – 20)
Phosphate (ppm)	**7** (5 – 30)	**8** (5 – 30)	**9** (5 – 30)	**7** (5 – 30)

It has also been found that oyster reefs and unvegetated soft-sediment areas have demonstrated substantial enhancement in habitat complexity, community density, and taxonomic richness in the oyster habitat (e.g., Luckenbach *et al.* 2005, Hadley *et al.* 2010, Shervette *et al.* 2011, Wong *et al.* 2011). This may be expressed in the data collected from the control, located at the Governors Island Oyster Reef.

Table 02. *Macrofaunal benthic community-level summary statistics (mean and 1 SE) for van Veen grab samples (0.04 m^2 sampling area) taken in 2010 before reef construction. BRF=Bay Ridge Flats, GI=Governors Island, Taxonomic Richness=number of Family level and lower taxa per grab sample (Grizzle* et al, *2012).*

Site	Density (#/0.04 m^2)	Mean	SE	Biomass (g/0.04 m^2)	Mean	SE	Taxonomic Richness	Mean	SE
GI	450			0.5			8		
GI	69			37.6			6		
GI	14			1.8			6		
GI	101			0.8			4		
GI	352			8.0			9		
GI	647			2.0			8		
GI	29			20.7			9		
GI	25	**210.9**	**85.09**	3.1	**9.3**	**4.68**	7	**8.3**	**0.48**

Overall, if the goals of the study predict that there is value in restoring East Harlem's shoreline, the project will benefit both the East Harlem neighborhood contiguous to the Esplanade, from 100^{th} to 116^{th} Streets, and New York City as a whole. The possibility of a future living shoreline in this location will change the dynamic of the city relative to how nature is viewed in and around New York waterways. The improved health of the river ecosystem, and, in turn, wildlife, will both improve environmental health and provide New Yorkers with the opportunity to interact with a potentially new living space along the waterfront for recreation, education, and public health improvements through access to the water.

Project Design Chart

Table 03. *Project Design Hierarchy* *Scientific Problem Explanations, Hypotheses, and Objectives*	
Category	**Entry**
Scientific Problem:	What currently exists in the Harlem River?
Hypothesis 01:	There are differences between sample sites for plankton concentrations.
Hypothesis 02:	There are differences between sample sites for benthic populations.
Hypothesis 03:	There are differences between sample sites for physical chemistry.
Hypothesis 04:	There are differences between sample sites for biodiversity/species richness.
Null Hypothesis 01:	There are insignificant differences between sample sites for plankton concentrations.
Null Hypothesis 02:	There are insignificant differences between sample sites for benthic populations.
Null Hypothesis 03:	There are insignificant differences between sample sites for physical chemistry.
Null Hypothesis 04:	There are insignificant differences between sample sites for biodiversity/ species richness.
Objective 01:	Determine how plankton concentrations define the health of the Harlem River and Buttermilk Channel.
Objective 02:	Determine how benthic concentrations define the health of the Harlem River and Buttermilk Channel.
Objective 03:	Determine how physical-chemistry parameters define the health of the Harlem River and Buttermilk Channel.
Objective 04:	Determine how biodiversity/ species richness define the health of the Harlem River and Buttermilk Channel.

Table 04. *Experimental design* *Breakdown of experiment in terms of what will be measured and where.*			
PROPOSED EXPERIMENTAL VARIABLES		**PROPOSED CONTROLS**	**PROPOSED CONSTANTS**
INDEPENDENT (Treatments or experimental group)	**DEPENDANT (What you'll measure)**	Governors Island site at Pier 101- Buttermilk Channel	Protocols for each sample site Samples from same depth Physical Chemistry: 1 m Phytoplankton: 1 m Benthos: 10 m Biodiversity: 6 m Sample at sea wall
3 Sites: Site 1: Harlem River (103rd Street) Site 2: Harlem River (Pier 111) Site 3: Harlem River (116th Street)	Species Richness Phytoplankton/mL Benthic Diversity/ $0.04m^2$ Parameter Concentrations		

Table 05. *Statistical Design* *Experimental Definitions*	
Define total # trials you'll run:	1
Define # of treatments in project:	3 treatments with 1 control
Define sample unit (SU):	Water Quality: Test Tube (~80 mL) Plankton: 100 mL Benthic: Benthic Grab Collection Biodiversity: Individual Species
Define # of SU replicates per treatment and control:	2
Define # of sample sites (site replicates):	3
Define the sample Event:	Each sample day
Define sample size (# of SUs) per event:	24 Sample units in Harlem; 32 including Governors Island
Total sample size (total # of sample events) of project:	Total sample events x 32 = total sample size 4 (sites) x 4 (parameters) x 2 (collections) x ~7 (sample days)
LIST YOUR POSSIBLE OUTCOMES	
Biodiversity: Species Richness/ Percent Coverage Benthos: Number of organisms per 0.04 m^2 Physical Chemistry: Dissolved Oxygen, pH, Salinity, Temperature Phytoplankton: colonies/mL OR filaments/mL OR individuals/mL	

EXPLAIN HOW YOU PLAN ON REPRESENTING YOUR DATA
• Graphs (bar) • Tables • Percent of Mass • Percent of each species • Central tendency (statistical averages)
LIST AND EXPLAIN ANY STATISTICS YOU WILL USE TO SUPPORT YOUR RESULTS
• Standard Deviation (SD), Standard Error (SE), and error bars.

Table 06. *Project Scope*
Project limits that may affect the data collected/ results.

WHAT ARE THE ASSUMPTIONS OF YOUR PROJECT?			
2 Samples/site per sample day of benthos is enough to capture all species and is sufficient	The amount of benthic sediment collected is the same amount collected each time		
WHAT ARE THE LIMITATIONS OF YOUR PROJECT?			
Can't randomly sample sites	Unable to get 30 sample units per sample event		
WHAT ARE THE RISKS OF YOUR PROJECT?			
Bias because of current	Treatment error	Working from boat on water	

Locality

The project will be conducted between 103rd and 116th Streets along the Harlem/ East River Esplanade bulkhead structure bordering the Harlem River (Figure 01). Site 01 (40°47.641665'N, 73°55.863572'W) is situated between 115th to 116th Streets and is also along low-level relieving platform bulkhead construction, but without the added spatial complexity. Moving further south, Site 02 (40°47.490298'N, 73°56.109390'W) is located at the periphery of the 111th Street Pier; a small, closed off, dilapidated pier built off of low-level relieving platform bulkhead construction. This site offers a habitat bulkhead construction that differs from Site 03 further south, in addition to encompassing the added variable of spatial complexity contributed by a pier that has been left vulnerable to the forces of nature for many years. Site 03 (40°47.210192'N, 73°56.301825'W) is located at approximately 103rd street, along the bulkhead just north of where the Harlem River opens up into Rheinlander Bay, leading to a change in the current's speed as it picks up with changing water flow dynamics. The fourth site is located at the Governors Island Reef in Buttermilk Channel. Site 04 (40°41.20781666'N, 74°0.7383'W) serves as the control for the project, as it is subjectively far away enough from the other sites to serve as a possible reference point for comparison.

Table 07. Exact locations of experimental and control sites. They are expressed by street location, exact GPS coordinates, and the water body they are a part of.

Site	Street Location	GPS Coordinates	Water Body
1	115th-116th Streets	40°47.641665'N, 73°55.863572'W	Harlem River
2	111th Street	40°47.490298'N, 73°56.109390'W	Harlem River
3	103rd Street	40°47.210192'N, 73°56.301825'W	Harlem River
4 (Control)	Governors Island	40°41.20781666'N, 74°0.7383'W	Buttermilk Channel

Figure 01. Sample stations in relation to Manhattan. The section labelled as "A" refers to the Harlem/ East River experimentation sites, while "B" refers to the Governors Island/ Buttermilk Channel control site.

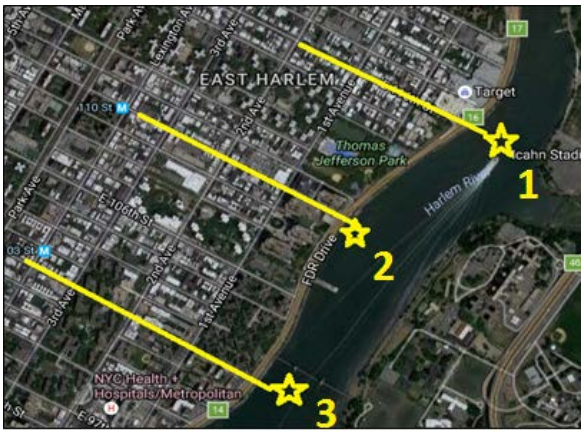

Figure 02. Sample Sites along East River Esplanade.
Site 01. (40°47.641665'N, 73°55.863572'W)
Site 02. (40°47.490298'N, 73°56.109390'W)
Site 03. (40°47.210192'N, 73°56.301825'W)

Figure 03. Sample Site (control) along Governors Island/ Buttermilk Channel. Site 04. (40°41.20781666'N, 74°0.7383'W).

Procedures:

Benthic/Biodiversity Collection Procedures:

To collect a benthic sample, a benthic grab is used. The jaw springs are pulled upwards and back, so that the jaws of the grab are opened. The device is then lowered into the water with line to the benthic layer, and a messenger is sent down to close the grab. If done properly, and under ideal circumstances (meaning there is minimal current influence and enough sediment to hold in the grab), the sampler will have a collected sample. After raising the gear, the jaws are opened over a bucket, which is measured with a scale to record mass. Once mass is recorded, pour the mud into the sieve (500um) and pour water over it. The sediment, after being watered down, reveals the organisms living in the benthic layer.

Benthic calculations were analyzed with a method comparable to that used in Ray Grizzle's 2010 study. In this project, Ekman grabs were used, in which the area of the mouth of the Ekman grab is $0.023m^2$. Unit area is determined, in this case, by the 2-dimensional area of benthos that has the potential to be collected by the Ekman grab. In comparing to Ray Grizzle's 2010 study, this unit area is converted to 0.04 m^2 by multiplying both organisms and area by a ratio of 1.74.

Biodiversity calculations documented species richness, the variability of species in a given area; as opposed to the abundance of organisms. DNA barcodes allow non-experts to objectively identify species – even from small, damaged, or industrially processed material. Just as the unique pattern of bars in a universal product code (UPC) identifies each consumer product, a "DNA barcode" is a unique pattern of DNA sequence that identifies each living thing. Short DNA barcodes, about 700 nucleotides in length, can be quickly processed from thousands of specimens and unambiguously analyzed by computers (DNA Learning Center Barcoding 101, 2016).

Phytoplankton Collection Procedures:

To collect phytoplankton samples, a beta bottle is used. First, it must be rinsed out, followed by resetting the beta bottle, and lowering it one meter below the water's surface. After the beta bottle is lowered, a messenger is used to close and collect the water sample. Once lifted, the sample bottle is filled to the 100 mL mark and capped. After water has been collected into the sample bottle, approximately 3-7 drops of Lugol's Iodine is mixed into the sample for preservation. The sample should be mixed thoroughly. Continue to add Iodine until the sample is amber colored. This process is repeated two times at each station, totaling to eight samples from each sample event.

After the sample is transported back to the lab, the sample is transferred from sample container to a 100mL graduated cylinder. It is left to settle for 24 hours. Once the sample has settled to the bottom of the cylinder, the top 90 mL of water is removed. With only 10 mL left in the cylinder, 1 mL is taken and placed onto a Sedgwick- Rafter counting cell. The counting is then placed under a microscope. Individual plankton are then counted by grid.

Physical Chemistry Collection Procedures:

To collect physical chemistry samples, a beta bottle is used. First, it must be rinsed out, followed by resetting the beta bottle, and lowering it one meter below the water's surface. After the beta bottle is lowered, a messenger is used to close and collect the water sample. Aquacheck test strips are used according to their directions to test for ammonia, nutrients, and pH. In addition, a YSI Proplus is used to measure physical chemistry parameters, specifically salinity. The values are then recorded on the data sheet, and inputted into an online database. In order to process physical chemistry, the mean of each

parameter - excluding pH, a logarithmic parameter that called for a median - was taken as a means of comparing large amounts of data using a single value for each category.

Results:

Physical Chemistry

When comparing the first three stations - the stations on the Harlem River - to our control, the oyster reef on Governors Island, there are several clear differences in terms of physical chemistry (Table 08). A big difference between the control and the other three stations can be seen in Secchi depth, a measure of the murkiness or turbidity of the water. The Secchi depth was higher along the Harlem River, averaging in the 200 cm range unanimously, compared to the flat value of 100cm on Governors Island. While this is not expected, it could still be a pattern resulting from human activity on the Harlem River. The natural sediment in the water on the Governors Island oyster reef could potentially be suspended in the water, causing the water to be less turbid than the water at the other three stations.

*Table 08. Physical Chemistry means and ranges for parameters measured at three sites (Harlem River) and the Governors Island control (Buttermilk Channel). *pH is recorded in median, as mean is not applicable to logarithmic values.*

	Mean (Range)			
Parameter	**116th Street**	**111th Street**	**103rd Street**	**GI Oyster Reef**
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** (0-0.3)
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)

The physical chemistry parameters measured during the 2015- 2016 baseline were comparable to those measured in the Upper New York Bay from 2012 to 2015. When looking at pH, it is clear to see that there is not much of a difference between the medians and ranges in both studies. All calculated pH averages regarding both studies range between 7.2 and 7.6. The highest recorded Ph measurement for each study was collected at the Governors Island site.

In dissolved oxygen, the averages found during the current study are lower than the dissolved oxygen average levels at sites of the prior study. The average of dissolved oxygen levels at the Governors Island site, sampled in 2016, showed lower measurements than those recorded at Governors Island in 2015 (dropping to an average of 4.67 ppm from 8.6 ppm).

Temperature averages for the Harlem River sites were similar if not exact, with the lowest recorded measurements being within $0.1^{\circ C}$ of each other and the highest recorded measurements being within $0.4^{\circ C}$ of each other. The temperature averages collected from the baseline study are higher than the temperature averages collected at Battery East, Battery West, Manhattan, and Governors Island sites.

Salinity, while having higher recorded averages4 than in the previous study, is not higher by a huge amount. The averages still fit within the range of the previous study, but the averages recorded at the Harlem sites are higher than those recorded for the Lower New York Harbor.

Ammonia is consistently lower in this study than in the last– in the previous study, the highest value recorded was 5.00 (Battery West), while in the current study the highest recorded value was 0.5 (Site 2).

Nitrate averages calculated in the 2016 baseline study were generally lower than those recorded in the 2015 previous study. Nitrate concentrations decreased during the period between the two studies at the Governors Island site. The highest measurement of nitrates in the Harlem River was taken from Site 3.

Phosphates in the current study, while having generally higher averages than in the previous study, all averaged at 10 ppm for Sites 2-4. Site 1 had an average measurement of 9.42 ppm.

Benthos & Biodiversity

It was found that as the stations go further south, increasing in number, the benthic density decreases (Figure 04). The data ranges from 14.87 to 0.00 organisms per 0.04 m^2 (0 being at Site 4). When compared to Ray Grizzle's 2013 analysis of benthic density on Governors Island, the data from the three sites in this study is almost negligible; where the mean in Grizzle's study is 210.9, the highest mean in this study is only 14.87. The use of van Veen grabs in Ray Grizzle's study as opposed to Ekman grabs, used in our study, could explain this stark difference in part, although multiplying the mean benthic density of each station in this study by 1.74 was expected to allow for clear comparison of the data. Strong currents could have dragged the Ekman grab along the bottom, preventing it from capturing a benthic sample each time. The result of this can clearly be seen in Site 3 and Site 4's benthic density.

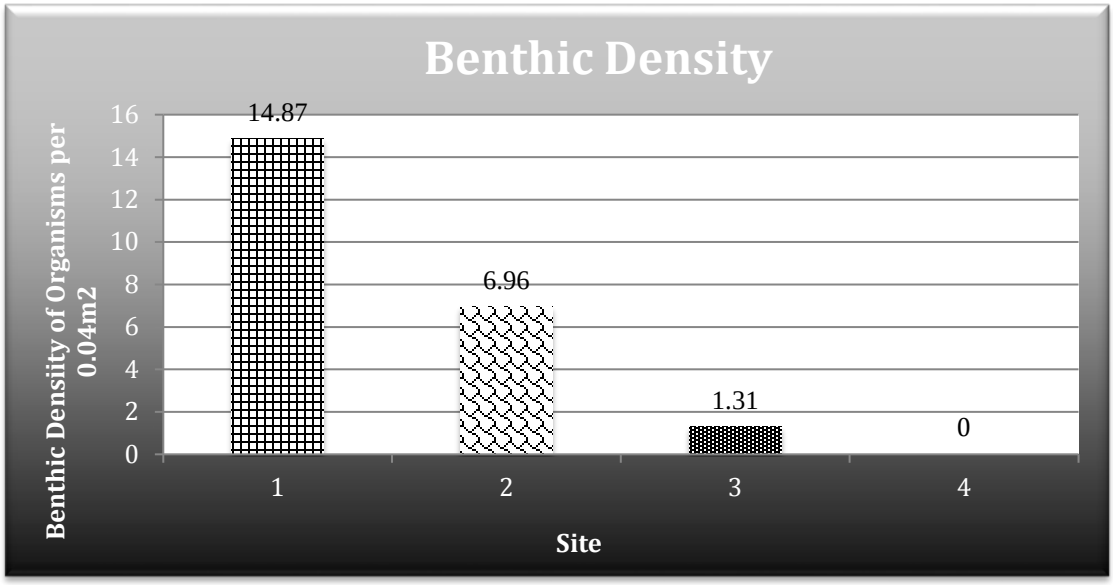

Figure 04. Benthic diversity of organisms per 0.04m^2 by station. As stations go further south (moving from Site 1 towards Site 4), density decreases.

The species most broadly found in this study was *Hediste diversicolor* (Table 09). It was found in every site, excluding Site 3. After this species, the only other species found in more than one site was *Ilyanassa obsoleta*, or the Eastern Mud Snail. Site 4 had more species richness than Site 1 and Site 2, with six species recovered versus Site 1's two species and Site 2's five species. Regarding this, it should be noted that Site 4 was sampled rather more frequently than its Harlem River counterparts, and so this surplus of species recovered could be due to the frequency of sampling. In addition, although it seems unsupported by the lack of benthic density, this is due to the fine sediment falling through the benthic grab before it reached the surface.

Table 09. 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.

Site 1 (116th St)			Site 2 (111th St)			Site 3 (103rd St)		Site 4 (GI Oyster Reef)		
Genus	**Species**	**Identified by**	**Genus**	**species**	**Identified by**	**Genus**	**species**	**Genus**	**species**	**Identified by**
Hediste	*Diversicolor*	(Müller, 1776)	*Hediste*	*diversicolor*		*Ilyanassa*	*obsoleta*	*Hediste*	*Diversicolor*	
lyanassa	*obsolete*	(Say, 1822)	*Ilyanassa*	*obsoleta*		-	-	*Mytilus*	*galloprovincialis*	(Lamarck, 1819)
-	-		*Crepidula*	*plana*	(Webster, 1879)	-	-	*Mytilus*	*edulis*	(Linnaeus, 1758)
-	-		*Streblospi*	*benedicti*	(Say, 1822)	-	-	*Amphibalanus*	*variegatus*	(Darwin, 1854)
-	-		*Urosalpinx*	*cinerea*	(Say, 1822)	-	-	*Amphibalanus*	*improvisus*	(Darwin, 1854)
-	-		-	-		-	-	*Botrylloides*	*Violaceus*	(Oka, 1927)

Phytoplankton

Most of the results for phytoplankton were collected from Site 4 (Figure 05). There is very little data for Sites 1 through 3, and as a result, it is difficult to analyze these sites. Given this, however, it is noted that for all sites (barring Site 1, which has no data) filamentous phytoplankton is the largest sum. In Sites 2 and 3, this could be chocked up to the fact the researchers simply collected filamentous phytoplankton at random. At Site 4, however, there is enough data to say that there is a strong likelihood that filamentous phytoplankton is simply more common, at least on the Governors Island oyster reef. Unicellular and colonial phytoplankton both add up to relatively similar values, although colonial is slightly larger than unicellular (in Site 4).

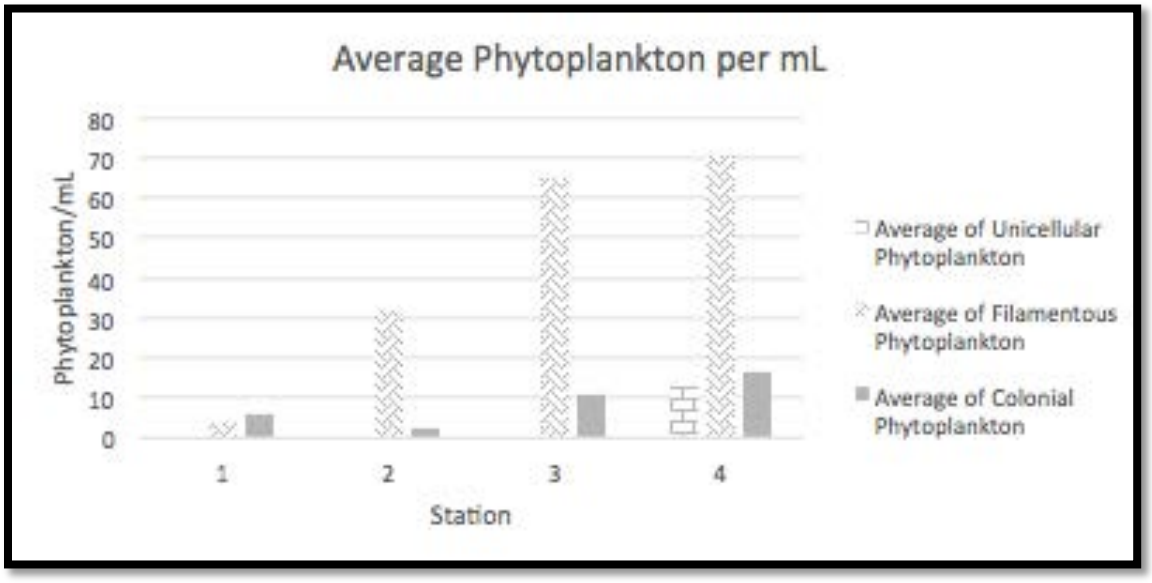

Figure 05. Phytoplankton Concentrations collected at three sites (Harlem River) and the GI control (Buttermilk Channel). Higher levels of all plankton at Site 4, as more data was present at this site (Conklin, 2017).

Discussion:

Based on the collected data, visible relations were seen between the components. As sites moved south, benthic density per 0.04m^2 decreased 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 moving south, filamentous concentrations also increased moving south. pH and dissolved oxygen were within tolerance levels for phytoplankton, with ranges of 6.32- 9.24 for pH and 3- 11.78 ppm for dissolved oxygen.

The prediction that there are differences between sample sites for each measured component was supported by the baseline study data.

The physical chemical parameters measured for ammonia were determined not healthy. The USEPA recommends a limit of 0.02ppm as NH_3 in freshwater or marine ecosystems, whereas it was found that the NH3 in the Harlem River had levels as high as 0.5. These levels are toxic to marine invertebrates (Alken Murray Corp.), and 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, is speculated to 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 thus, 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 minimal today, and unsafe as the seawall continues to decay.

Suggestions for Improvement

This yearlong baseline study, although impressive in its entirety, easily could have avoided some of the mishaps that were experienced. Better planning using checklists and communication could have been implemented to make the most out of sample days, and any other time dedicated to the project. Sampling days were limited to once a month, due to scheduling conflicts and weather, and could not occur during the winter months. If this project could be improved, sampling should have occurred year-round, with more frequent sampling dates.

Suggestions for Future Research

Phase 2 of this baseline study is to implement different kinds of restoration materials to see what organisms will begin to thrive in these ecosystems lacking areas. The research conducted can lead to other research studies that involve environmental

restoration. The phytoplankton, benthic, biodiversity, and physical chemistry information collected about the East/ Harlem River can be compared to other water bodies, and determine the health of other ecosystems in the future.

Acknowledgements

I would like to thank the Harbor SEALs Citizen Science volunteers for their assistance and dedication to this project, be it time dedicated in the lab or field. Thank you to the team mentors who taught the younger volunteers different research skills, and thank you to the team members who spent time learning these skills and looking up to their peers. In addition, thank you to our data analysts, Erik Wiemer and Matthew Chiu, for the time they put into creating graphs and discovering new patterns. Thank you to the New York Harbor School Vessel Operations Crew for their accompaniment on sampling days and for allowing our research team to use their vessels. Lastly, thank you to Mauricio Gonzalez, Maura Smotrich, the CIVITAS organization, and the Hudson River Foundation for their mentoring, supervision, support, and advisement of this project.

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Annex

Detailed Methods and Materials

Benthic Grabs: Procedures for the Collection and Analysis of Benthic Organism Populations (Tier I)

Materials list

Item	***Qty.***	***Purpose***
Bucket	2	To obtain water so that samples may be sieved through
Eckman Benthic Grabber	1	To obtain our sample
Metal Trays	2	To hold any found samples
Digital Microscope	2	Used to get a better visual of sample for identification
Dissection Kit	2	Move around and observe samples
Petri Dish	5	Used to hold specific samples
Rodi Water	3	To rinse of the equipment
Permanent Marker	2	To mark zip lock bags
Zip lock bags	9	Will hold various samples from multiple test sites
Sieve (500um)	2	To go through the benthic samples

Identification Key	-	To keep track of data being uploaded
Digital weighing scale	1	To weigh the total mass of every sample we get
Weights	-	To fight against currents when sampling

Benthic Field Sample Collection

01. Fill one bucket with water. Using an empty 5 gallon bucket weigh its weight with a digital weighing scale.
02. Tare the weight until the scale reads 0.00 .
03. Position jaw springs so that they are placed on top of the circular metal pieces on the side, to ensure that the grab will close properly.
04. Adjust the benthic grab cables so that they are held upward and hold the jaws open.
05. Make sure the sampler has enough slack in the line to lower the benthic grab when it's ready to be lowered.
06. Slowly lower the benthic grab. Wait, until it reaches the bottom of the water body.
07. Place messenger to the line. Hold line straight and throw the messenger down the line fast and with force.
08. Bring messenger up to the surface. Let water drain out before putting into the bucket.
09. Place the ENTIRE sample into the bucket. Use a plastic spoon or your finger if you have gloves on.
10. Weigh the bucket and record onto data sheet.
11. Fill the sieve an approximate ¾ of the way with the mud sample. Have the water bucket under when sample is being place into the sieve.
12. Pour water from a separate water bucket over the mud until sediments are watered down and organisms can be easily picked out and seen.
13. Label a Ziploc bag with a sharpie and place the macro organisms into the Ziploc bag using forceps.
14. Record the date and sample location, along with the original sample weight in the samplers research journal, and on the bag.
15. When done placing the macro organisms found in the sample, close the Ziploc bag and place it into the cooler.
16. Duplicate sampling at each site about two (2) or three (3) times.
17. Rinse out buckets for use at the next site.

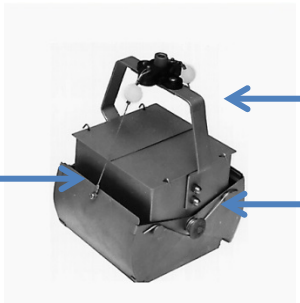

Figure. Benthic Sampler (Eckman Grab) (Source www.hoskin.ca)

Benthic Lab Sample Processing

01. Fill an empty bucket with warm water.
02. Set up microscopes in the lab and the light lamp correctly.
03. Take the Ziploc bag samples out of the freezer and place samples into bucket.
04. Allow the bag to defrost in the water before analyzing the samples, (Approximately 10-12 minutes).
05. Remove organism from bags, and place on Petri dish.
06. Turn the microscope light on, if necessary.
07. Use dissecting kit tools to move the organism across the petri dish surface.
08. Use *Marine Animals of Southern New England and New York* to identify any organisms you may find.
09. Record any identified organisms found into data sheet.
10. Place processed sample back into Ziploc bag, and label with the "process" symbol and the date with a permanent marker. Do the same in your research journal.

Phytoplankton Beta Bottle Sampling
(From Suthers and Rissik, 2009)

Materials list

Materials	Purpose	Quantity
Beta Bottle (1.7L)	Capture sample	1
Bucket (5 gallon)	Hold sample	2
Sample Vial (100mL) labeled	Contain plankton samples	7
Lugol's Iodine Solution (200mL bottle)	Preserve samples	1
Cooler	Store plankton samples	1
Ice Packs (Large)	Preserve samples	3
Sink	Thaw plankton samples	1
Pipette (20mL) and Pear	Drawing volume to concentrate subsample	1
Plastic Pipette (1mL)	A) Add Lugol's Iodine Solution to sample & B) Apply plankton samples on Sedgwick-Rafter Counting Cell	2
Plankton Field Data Table	Record sample obtaining	1
Plankton Lab Data Table	Record sample processing	1
Graduated Cylinder (100mL)	Allow subsample to settle	7
Sedgwick-Rafter Counting Cell and slip	Process phytoplankton samples	3-6
Digital Microscope	Observe and take pictures of plankton samples	1
Dichotomous Key	Identify species in plankton samples	1

Phytoplankton Field Sample Collection

01. Populate field data table
02. Lower set Beta bottle to 1.0m below the surface
03. Replicate x 2
04. Pour replicate contents into 2 separate buckets
05. Mix contents of each bucket
06. Take a 100mL subsample from the well mixed bucket
07. Preserve with Lugol's Iodine preservative solution (sample settles quicker with preservative for lab steps)
08. Take an additional 100 mL subsample without preserving and add to cooler for live organism i.d.
09. Populate field data table

Phytoplankton Lab Sample Processing

01. Take plankton sample vials out of cooler/storage
02. Place sample in a 100mL graduated cylinder and let rest for 24 hours (more if nanoplankton are present) in order for plankton to settle
03. Draw off the top exactly 90mL from the cylinder with a large (*e.g.* 20ml) pipette and pear or suction pipette (use care not to disturb cells at bottom of cylinder)
04. This gives a 10x concentration
05. Mix 10mL subsample thoroughly by swirling
06. Add Sedgwick-Rafter* counting cell to the microscope stage
07. Place cover slip** obliquely on chamber with just one corner open
08. Decant 1mL subsample carefully into the one corner with a Pasteur pipette until slip just begins to float.
09. Rotate slip completely to cover chamber (this avoids introducing air bubbles into subsample)
10. Let sample stand in chamber for 15min to allow plankton to settle to the bottom
11. Count at 100x magnification and use high power if there is a need to ID small sized algal cells
12. Identify and count each taxon (that is, each species or 'type') using the steps that continue:
13. A. Count a required minimum of 30 squares by determining the squares randomly using the special plankton die (there are 50 squares across and 20 squares down)
    OR
    B. To avoid differential settling (plankton concentrate towards the edges), as an alternative to random box counting, count a row across (traverse) of 40 boxes
14. On the lab data table record the number of grid squares counted as well as the number of algal species or 'types' counted
15. If an algal species or 'type' lies across the line engraved in the base of the counting cell so that if falls between two squares, the simple **RULE**: is that if it lies on the right side of the square grid include it in the count, but if it lies on the left side, exclude it. Similarly, if it falls across the top line of the square, include it, but exclude any algal units falling across the bottom. Algal units are often

smaller than the width of the lines engraved, so the same applies for any units lying within the grid lines delineating the squares

16. The number of algal units present per 1mL within the actual water body is calculated as:

$$\text{No. of units/mL} = \frac{(\text{Units counted } \mathbf{x}\ 1000\text{mm}^3)}{(\text{No. grid squares counted } \mathbf{x} \text{ concentration factor - typically 10})}$$

17. For filamentous and colonial units, it's necessary to convert units/mL to cells/mL. To do this, figure out how many cells in the typical colony of filament and multiply by that number. However, cyanobacteria don't have a uniform number of cells. For cyanobacteria:
    a. Find 30 random filaments
    b. Count the number of cells in each
    c. Average the amount
    d. Multiply by Units to convert top cell/mL
18. If samples contain large colonies or tangled aggregations of filaments containing thousands of cells making it impossible to count take discard the sample. If the second is the same as the first, estimate a portion of the colony or aggregation – say 5% or 10% of the total colony size – and count or estimate the number of within that portion. Remember that the colonies or aggregations are three dimensional and cells will fall out of the plane of focus. Once you have an estimate of the number of cells of 5% or 10% of the colony, multiply this by 20 or 10, respectively, to obtain an estimate of the total cells per colony. This procedure can introduce large error and are indicative of a possible algal bloom and thus is only acceptable for sampling during blooms. This must be stated in results. Sonification or homogenization by chemicals is unacceptable.

*[Sedgwick-Rafter Cell – is a four sided counting chamber that is 50mm long by 20mm wide by 1mm deep, giving a bottom area of 1000mm^2, and an internal volume of 1mL; they have a grid engraved on the bottom, with lines 1mm apart; if correctly calibrated and filled, the volume of sample covering each grid square is 1mm^2; used on the stage of a compound microscope]

** Cover the Sedgwick-Rafter counting chamber with a thin (No. 01 thickness) cover slip

DNA Barcoding Methods

(As adapted from Dr. Alberto Stolfi's and dnabarcoding101.org protocols)

The specimens will be collected from their environment from two locations. One of these locations is Pier 101, located on Governors Island and the other is Bush Terminal Piers, located in southern Brooklyn. The invertebrate species will be removed from bricks that were submerged in the Upper New York Bay's water and placed in collection tubes, and the samples will be collected from the water and placed in collection bags.

In the field, collect specimens using a collection tube. Take pictures of each specimen in its natural habitat with sample code. Use forceps and scissors to cut away a sample from the specimen. Freeze the specimen at -20℃, until preparations for isolation are complete.When ready, take samples out of the freezer, placing each into a separate test tube. Label each test tube using a permanent marker with sample number, type of sample, etc (identifying features).

In the lab, using a P1000 micropipette and a fresh tip, add 300 microliters (µl) of lysis solution to each test tube, changing the tip after each tube. Twist a clean plastic pestle into each test tube until each sample is completely ground into the solution, using a different pestle for each test tube. Incubate each test tube in a water bath for ~10 minutes at 65℃. After incubation, place the test tubes into a microcentrifuge in a balanced formation, with cap hinges pointed upward. Turn the centrifuge on for 1 minute at maximum speed to pellet debris. Label new test tubes for each sample, with all of the same information. Using a P1000 and a fresh tip for each tube, transfer 150 µl of the supernatant (clear solution at the bottom of the tube) to each new tube. Do not touch or disturb the pellet at the bottom of the tube. Discard of all old tubes. Using a P10 and a fresh tip for each tube, add 3 µl of silica resin to the tubes. Mix well with a vortexer, finger vortexing, or pipetting up and down. Close and incubate each tube in a water bath or heat block for 5 minutes at 57℃. Place the tubes in a microcentrifuge, again with hinges upward. Centrifuge for 30 seconds at maximum speed. Using a P1000 and a fresh tip for each tube, remove the supernatant from each tube without disrupting the pellet. Add 500 µl of cold wash buffer to the pellets. Close the tube and mix well by vortexing or pipetting up and down, to resuspend the silica resin. Place each tube into the microcentrifuge in the same fashion as before. Centrifuge at maximum speed for 30 seconds. Using the P1000 and a fresh tip for each tube, remove the supernatant from each tube without disrupting the pellets. Add 500 µl of cold wash buffer to each pellet. Close the tube and mix well by vortexing or pipetting up and down. Place the tubes in a balanced formation in the microcentrifuge, with cap hinges pointed outward. Centrifuge at maximum speed for 30 seconds. Using a P1000 and a fresh tip for each tube, remove the supernatant from each tube without disturbing the pellets. Briefly spin the tubes to collect any drops of supernatant, removing these drops with a micropipette and a new tip. Using a P100 and a fresh tip for each tube, add 100 µl of distilled water to each silica resin pellet. Mix well by vortexing or pipetting up and down. Incubate each test tube at 57℃ for 5 minutes. Place each tube within the microcentrifuge. Centrifuge at maximum speed for 30 seconds. Label new tubes with the same information as previous tubes, and transfer 90 µl of the supernatant from each tube to its new tube without disturbing the silica resin pellet. Freeze the new samples or put them in the fridge to preserve tissue. In terms of PCR, 'DNA will also be extracted directly from mixed samples and used as a

template for PCR. Mixed species' PCR products will then be cloned "shotgun-style" into TOPO vector, and individual clones sequenced at random. This aims to identify species that may not be easily isolated, such as parasitic species. However, these rare species' sequence might not be detectable due to being masked by high amounts of DNA from much more abundant species.' (Stolfi, 2015) (Grace Carter, Jared Rosin, 2015).

Data Sheets (Filled Out)

SAMPLE DAY _____

NYHS Harbor SEALs – NYHF – CIVITAS
Revision Number: 03
March 22nd, 2017

Biodiversity Field Data

Name(s): Marcus Charles, Jackie Obermayer, Isabella Torres, Jared Rosin
Date: 3/25/17 Time: 8:33am
Location:
Station: 2

Weather:
Wind speed/direction: 16 km/h Waves/tide/current: slack (no tide)
Air temp: 53°F 15°C % cloud:
Moon phase:

Water @ start (from ___:___ to ___:___):
Salinity: 17.5 °C: 4.84 Secchi Depth:
pH: 7.49 DO: 10.11
Comments:

Method of Sampling:
A) Eckman Grab
B) Line
C) Oyster Cage
D) Tile

Water @ end (from ___:___ to ___:___):
Salinity: °C: Secchi Depth:
pH: DO:
Comments:

All were the same organism (tentative Eastern Mud Snail)

NYHS Harbor SEALs – NYHF – CIVITAS
Revision Number: 03
March 22nd, 2017

	Annelida Polly	Porifera	Cnidaria	Mollusca	Echinodermata	Arthropoda LAOS	Chordata Rosti
1	3			46			
2	5			26			
3				22		1	
4	1			15			
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							
21							
22							
23							

Phytoplankton Laboratory Data

LOCATION: Peir 101 STATION: ~~Peir 101~~ Planliton
Sorter's name: [illegible] Date: 4/6/16
Sample 01 #: 040516P1GI Sample 02 #:
Location: Lab
Gear and Mesh: Beta bottle Tow duration/speed:

Organisms	Sample 01 Tally	Comments:	Sample 02 Tally	Comments:
Filaments	𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸		𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸	
Colonies	1			
Unicellular				
casinodiscus	1			
# of Squares Counted in Sedgewick-Rafter	Sample 01: 100	Additional squares:	Sample 02: 50	Additional squares:
Units of Colonies:	Sample 01: 1	Additional units:	Sample 02: 0	Additional units:
Units of Filament:	Sample 01: 70	Additional units:	Sample 02: 35	Additional units:
Units of Unicellular Algal Cells:	Sample 01: 0	Additional units:	Sample 02: 0	Additional units:

"If counting 30 grid squares or two traverses does not yield a sufficient number of units (that is more than 23), then additional grid squares or traverses will need to be counted" – Suthers and Rissik (2009)

BENTHIC LABORATORY DATA

LOCATION: East River STATION: 1

Sorter's name: Cindy, Marcus, Melanie Date: 4/07/2015 Analyzed: 4/12/15

Location/GPS: _____ Gear: _____

Sample 01 #: F15107B1S1 Sample 02 #: F15107B2S1

Organisms	Sample 01 Tally	Comments:	Sample 02 Tally F15107B2S1	Comments:
Eastern Mud snail	1111 1			
Threeline Mud snail				
Lunar Dove snail				
Atlantic Dog Winkle Snail				
Eastern Melampus snail	1		1	Small in size.
Streblospio Benedicti Polychaeta				
Brania Spp Polychaeta				
Opal worm Polychaeta				
Aquatic Earthworm Oligochaeta				
Typical Oligochaete Worm				
Typical Tubificid Oligochaete				
Northern Horsemussel Bivalvia				
Blue Mussel Bivalvia				
Sea Grapes /Squirt Ascidiacea				
Pagurus ssp Crustacea (hermit crab)				
Other:				

Sample day 8

Benthic Field Data

Site 1

Team: Marcus, Cindy Sample number:
Date: 10/15/16 Time: 10:29
Location: SI 01
Station: 1 Depth:

Weather:
Wind speed/direction: 5mph (SW) Waves/tide/current: 4.91ft (ebb)
Air temp: 70 % cloud: 0%
Moon phase: waning gibbous 99%

Water @ start:
Temperature/Salinity: 24.3 °C: 18.1 Secchi Depth:
pH: 1.61 DO: 6.64
Comments:

Sampling gear: Benthic Grab
a) Sample #: 1 Time: 10:30 Mass: N/A - 5 snails
b) Sample #: 2 Time: 10:41 Mass: N/A - one poly. 3 mud snails
c) Sample #: Time: Mass:
d) Sample #: Time: Mass:

Water @ end:
Temperature/Salinity: 24.8 °C: 18 Secchi Depth:
pH: 1.55 DO: 6.60
Comments:

mud

Citizen Science QAPP Template #12

Field Data Sheets

Physical Chemistry Parameters Tier (I)

Project name _Citizen Science Water Quality Monitoring of Harlem/East River_ page ____ of _____

Initial date 03/25/17 Final Date _____ Location/GPS Coordinates _____

Sampler's Name(s) Chelsea Sumba Station 2 Sample #_____

Sampling Day #	Date (mmddyy)	Time	Sample Vial # (optional)	T °C	D.O. ppm	pH units	PO_4 ppm	NO_2 ppm	NO_3 ppm	NH_4 ppm	SiO_3 ppm	Sal ppt	Secchi Depth (cm)	Total Rain (1-5 days prior)	Air T °C	Wind-speed	Waves/tide/current	% cloud coverage	Depth	Moon phase	pH strip	DO**
	03/25/17	8:35		4.84	10.11	7.49	15	0	0	0		17.5				1	South mooring	100%			7.0	7.2
	Initials	CS		CS	CS	CS	CS	CS	CS	CS		CS									7.0	6.8
DAY	[redacted]	9:07		4.81	10.13	7.09	15	0	0	0		17.5		[redacted]								
—	Initials	CS		CS	CS	CS	CS	CS	CS	CS		CS										
	[redacted]													[redacted]								
	Initials																					

Use pencil only please. Make sure all required cells are completed including time + initials. *Measured with Hanna Combo Sensor **Measured with YSI

***Measured with Dewy Winkler Method, Hach Test Strips, or other instrument

General Comments:

OIK -> 0 (1) PO_4 = 15 ppm OIK = 0

PO_4 = 15 ppm

Gas (Ref) 17 (1)

Ask your group leader if you have any questions.

SAMPLE DAY _____

NYHS Harbor SEALs – NYHF – CIVITAS
Revision Number: 07
December 12th, 2015

Citizen Science QAPP Template #12

Physical Chemistry Parameters Tier (I)

Project name _Citizen Science Water Quality Monitoring of Harlem/East River_ **page** ____ **of** _____

Initial date _____ **Final Date** _____ **Location/GPS Coordinates** _____

Sampler's Name(s) _____**Station** _____ **Sample #**_____

Sampling Day #	Date (mmddyy)	Time	Sample Vial # (optional)	T °C	D.O. ppm	pH units	PO_3 ppm	NO_2 ppm	NO_3 ppm	NH_3 ppm	SiO_3 ppm	Sal ppt	Secchi Depth (cm)	Total Rain (1-5 days prior)	Air T °C	Windspeed	Waves/tide/current	% cloud coverage	Depth	Moon phase
DAY ___																				
	Initials																			
	Initials																			
	Initials																			

Use pencil only please. Make sure all required cells are completed including time + initials. ***Measured with Hanna Combo Sensor** ****Measured with YSI**

*****Measured with Dewy Winkler Method, Hach Test Strips, or other instrument**

General Comments:

_____

_____

_____

SAMPLE DAY _____

Plankton Field Data

Team:_____
Latitude:_____
Date:_____
Longitude:_____
Location:_____
Time:_____
Station:_____
Depth:_____

Weather:
Wind speed/direction:_____
Waves/tide/current:_____
Air temp:_____
% cloud:_____
Moon phase:_____

Water @ start:
Temperature/Salinity:_____ ˚C:_____
Secchi Depth:_____ pH:_____
DO:_____
Comments:

_____

Sampling gear:_____
a) Sample #:_____ Time:_____
Flowmeter:_____
b) Sample #:_____ Time:_____
Flowmeter:_____
c) Sample #:_____ Time:_____
Flowmeter:_____
d) Sample #:_____ Time:_____
Flowmeter:_____

Water @ end: Temperature/Salinity:_____ ˚C:_____
Secchi Depth:_____ pH:_____
DO:_____ Comments:_____

Phytoplankton Laboratory Data

LOCATION:_____
STATION:_____
Sorter's name: _____
Date:_____
Sample 01 #:_____
Sample 02 #:_____
Location:_____
Gear and Mesh:_____
Tow duration/speed:_____

Organisms	Sample 01 Tally	Comments:	Sample 02 Tally	Comments:
# of Squares Counted in Sedgewick-Rafter	*Sample 01:*	*Additional squares:*	*Sample 02:*	*Additional squares:*
Units of Colonies:	*Sample 01:*	*Additional units:*	*Sample 02:*	*Additional units:*
Units of Filament:	*Sample 01:*	*Additional units:*	*Sample 02:*	*Additional units:*
Units of Unicellular Algal Cells:	*Sample 01:*	*Additional units:*	*Sample 02:*	*Additional units:*
"If counting 30 grid squares or two traverses does not yield a sufficient number of units (that is more than 23), then additional grid squares or traverses will need to be counted" – Suthers and Rissik (2009)				

Benthic Field Data

Team: _____
Sample number: _____
Date: _____
Time: _____
Location:_____
Station:_____
Depth:_____

Weather:
Wind speed/direction:_____ _
Waves/tide/current:_____
Air temp: _____ %
cloud:_____
Moon phase: _____

Water @ start:
Temperature/Salinity:_____ ˚C:_____ Secchi
Depth:_____ pH:_____
DO:_____ Comments:

Sampling gear:_____
a) Sample #:_____ Time: _____ Mass: _____
b) Sample #:_____ Time: _____ Mass: _____
c) Sample #:_____ Time: _____ __ Mass: _____
d) Sample #:_____ Time:_____ __ Mass: _____

Water @ end:
Temperature/Salinity:_____ ˚C:_____
Secchi Depth:_____ pH:_____
DO:_____ Comments:

Benthic Laboratory Data

Location:_____
Station:_____
Sorter's name: _____
Date: _____
Location/GPS: _____
Gear:_____
Sample 01 #: _____ Sample 02 #:_____

Organisms	Sample 01 Tally	Comments:	Sample 02 Tally	Comments:
Eastern Mud snail				
Threeline Mud snail				
Lunar Dove snail				
Atlantic Dog Winkle Snail				
Eastern Melampus snail				
Streblospio Benedicti Polychaeta				
Brania Spp Polychaeta				
Opal worm Polychaeta				
Aquatic Earthworm Oligochaeta				
Typical Oligochaete Worm				
Typical Tubificid Oligochaete				
Northern Horsemussel Bivalvia				
Blue Mussel Bivalvia				
Sea Grapes /Squirt Ascidiacea				
Pagurus ssp Crustacea (hermit crab)				

Organisms	Sample 01 Tally	Comments:	Sample 02 Tally	Comments:
Other:				
Other:				
Other:				
Other:				
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