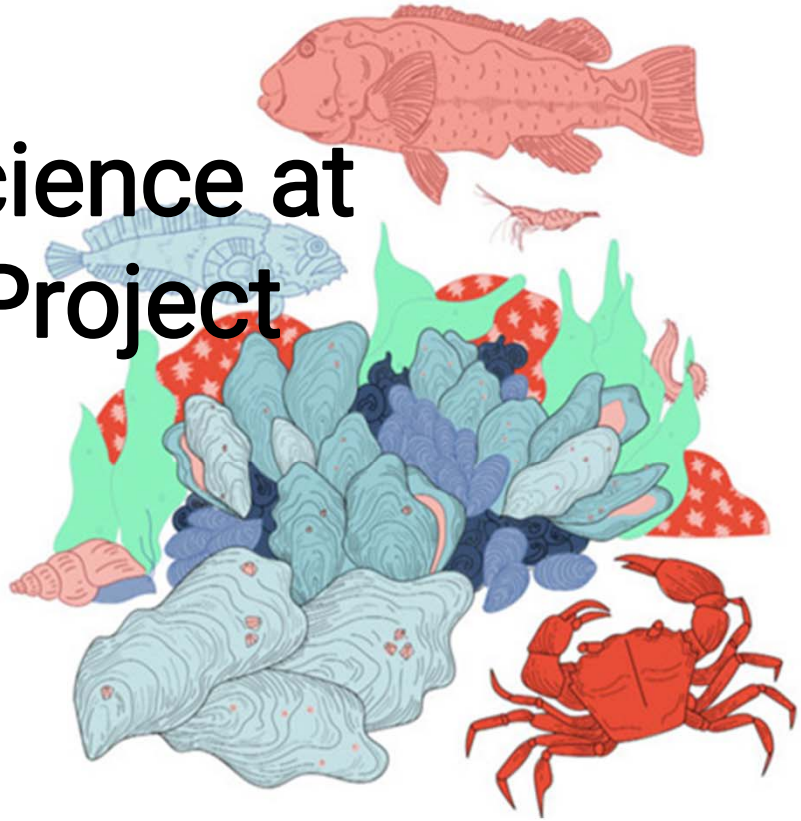
Community Science at Billion Oyster Project

Kristin Schreiber
Data Curriculum Specialist



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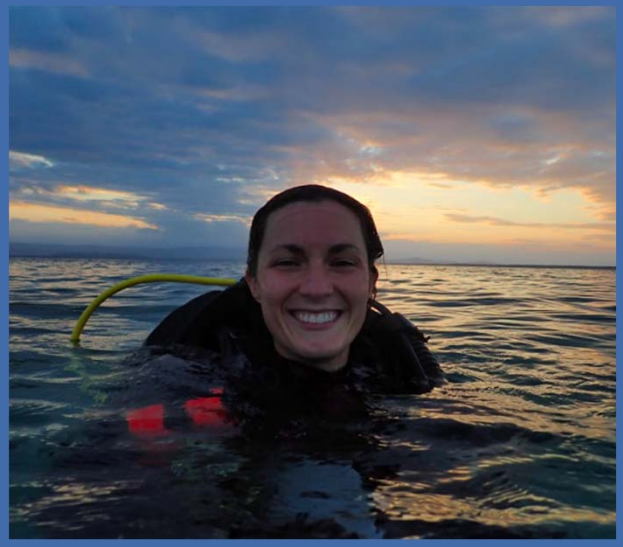


Kristin Schreiber is the Data Curriculum Specialist at the Billion Oyster Project. Kristin works with teachers throughout New York City, providing professional learning opportunities and developing harbor-related data analysis curriculum. She has a M.S in Marine Biology from Northeastern University and a B.S. from the University of Texas at Austin. Prior to graduate school, she was a middle school science teacher for a number of years in both Texas and Massachusetts.

What is the Billion Oyster Project?

Billion Oyster Project (BOP) is an ecosystem restoration and public education project aimed at restoring a sustainable oyster population and re-igniting a passion and appreciation for New York Harbor by engaging New Yorkers directly in the work of restoring one billion oysters to the estuary by 2035.

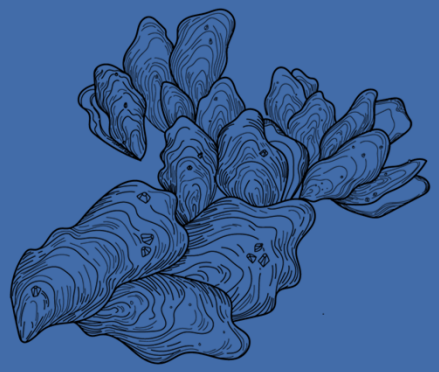
Our Mission

To restore oyster reefs to New York Harbor through public education initiatives

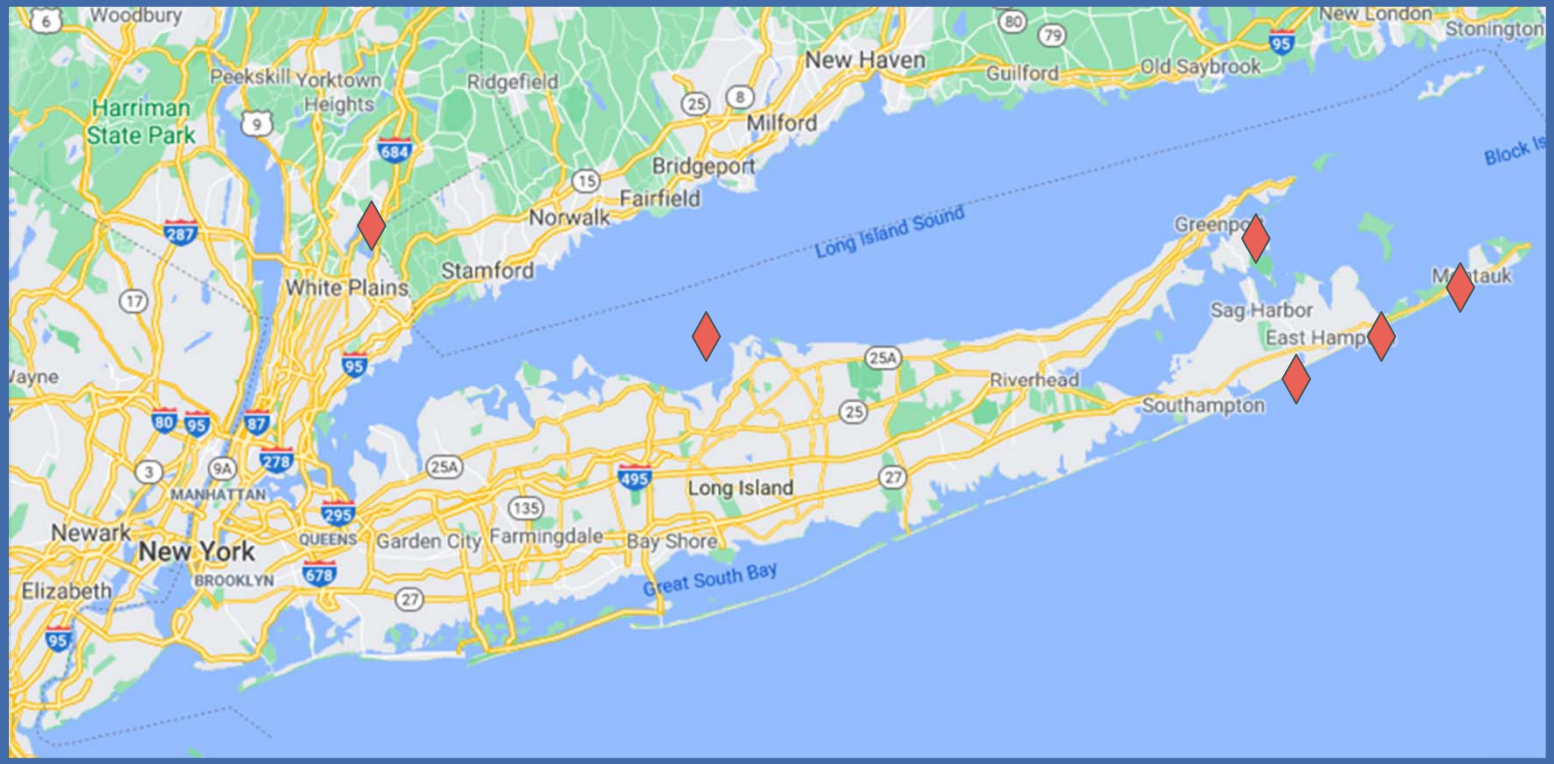
Our Vision

A future in which New York Harbor is the center of a rich, diverse, and abundant estuary.

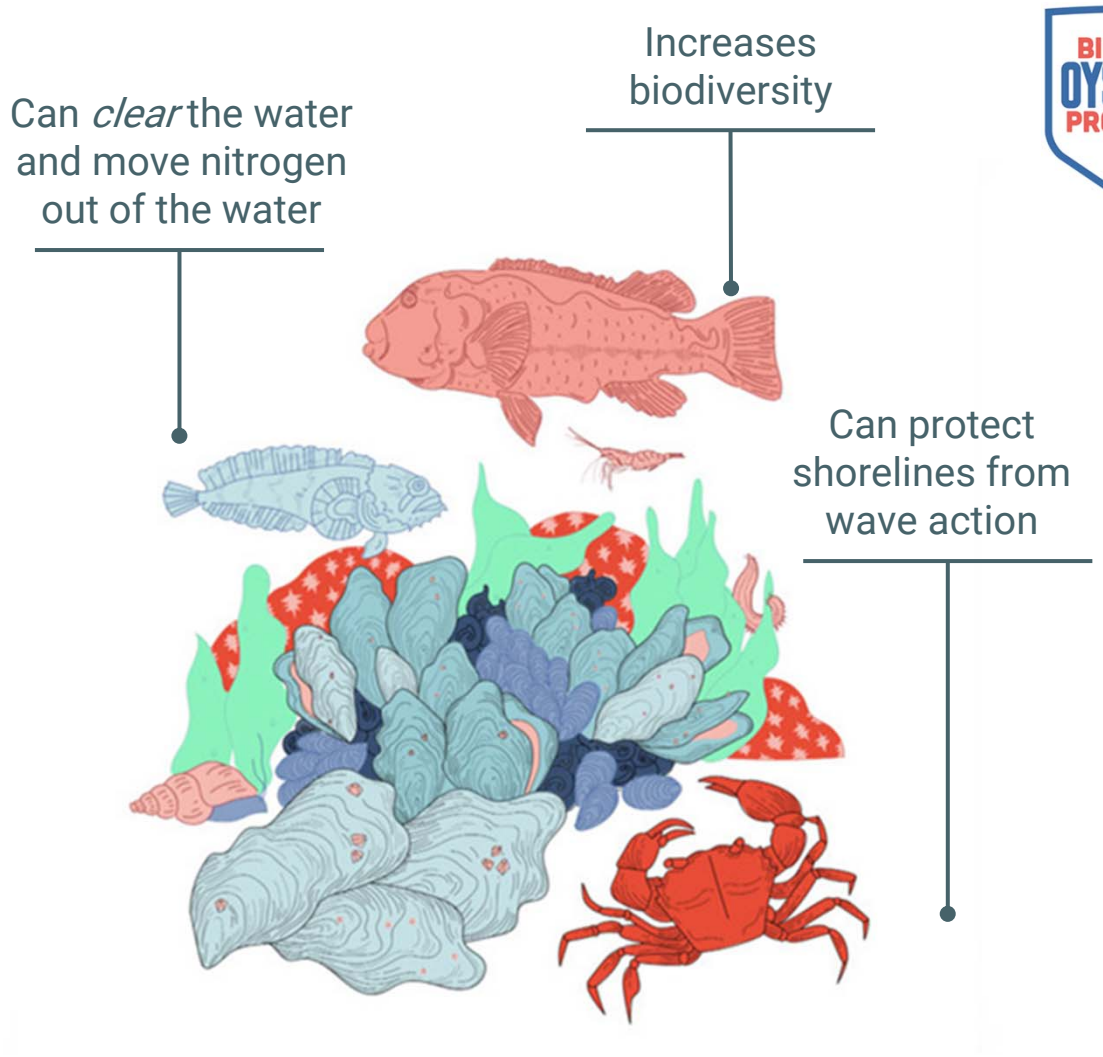
The communities that surround this complex ecosystem have helped construct it, and in return benefit from it, with endless opportunities for work, education, and recreation.



BILLION OYSTER PROJECT


Woodbury
Peekskill
Yorktown Heights
Harriman State Park
Ridgefield
New Haven
Guilford
Old Saybrook
New London
Stonington
Milford
Bridgeport
Fairfield
Norwalk
Stamford
White Plains
Long Island Sound
Greenport
Montauk
Sag Harbor
East Hampton
Riverhead
Southampton
Long Island
Farmingdale
Bay Shore
Great South Bay
Garden City
QUEENS
MANHATTAN
BROOKLYN
New York
Newark
Elizabeth
Jayne

What do oysters do?



One BILLION Oysters by 2035

Life Cycle of a BOP Oyster

Larvae

Shell pile

Bagged Shell

Spat

Oyster Structure

Adult Oyster Cluster

So far we have...

47 MILLION

Live Oysters Restored

1.6 MILLION

Pounds Of Shells Collected

8,000+

NYC Students Engaged

Where are the restoration projects?

BILLION OYSTER PROJECT

Our Work with Community Scientists

What is Community Science at BOP?

- Community science is public participation and collaboration in scientific research initiatives to increase scientific knowledge.
- Through community science, people share and contribute to data monitoring and collection programs.
- We use ‘community scientist’ because we don’t want to exclude anyone. Everyone, citizen or not, can participate in community science.

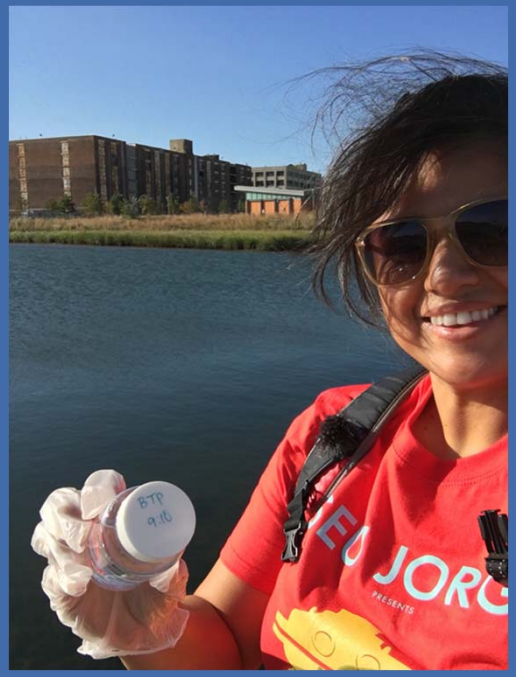
Who participates in community science at BOP?

K-12 classrooms

NYC Community

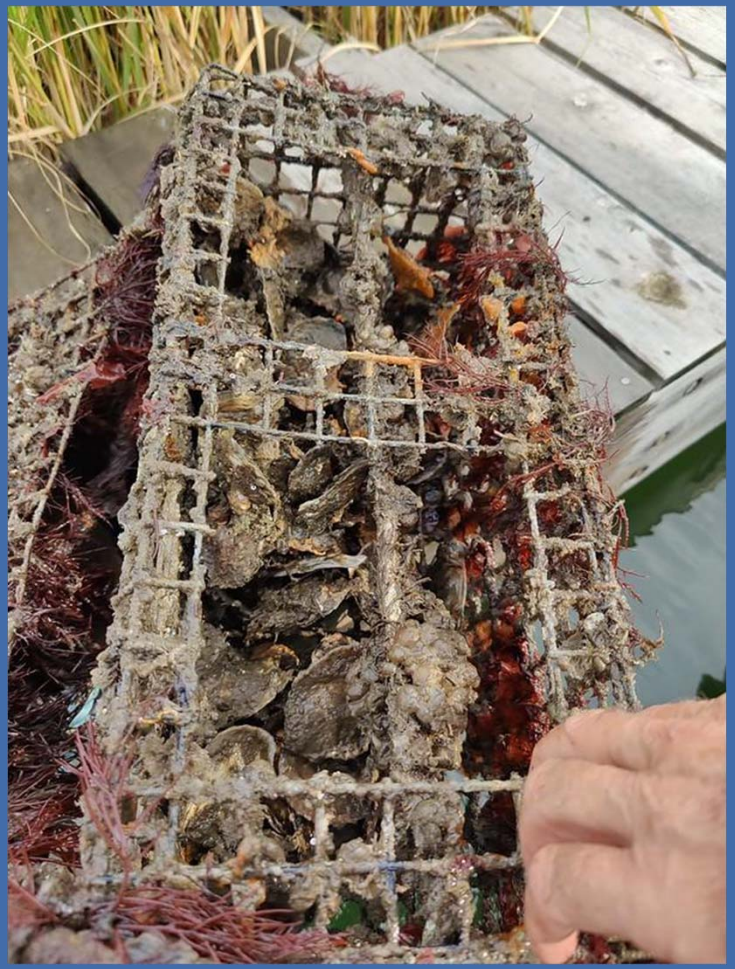
BOP Ambassadors

How do Community Scientists partner with BOP?



- Stewardship of Oyster Research Stations (ORS)
- Monitoring Field Stations
- Citizen’s Water Quality Testing (CWQT)
- Wild Oyster Surveys

Oyster Research Stations (ORS)



Reasons people steward ORS

- ORS as an educational tool
- Community science data adds value to BOP & other harbor organizations
- Students of NYC & future generations

Oyster Research Station Timeline

Attend Basic ORS Training

Install ORS

Monitor ORS

Share your monitoring data

Oyster Research Station (ORS)

- All ORS participants monitor cages & upload data twice (2x) per year

- Parameters include one or more of the following:
  - Mortality count
  - Oyster measurements
  - Water quality
  - Associated species

Oyster Measurement Protocol

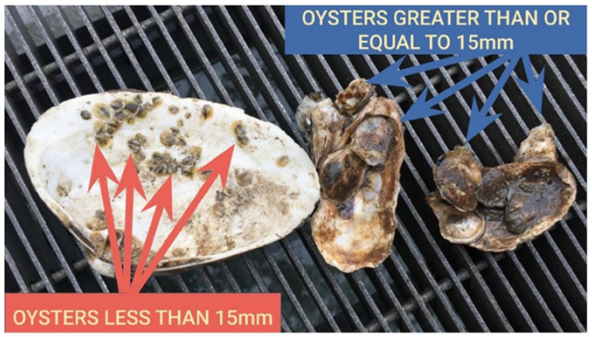
The purpose of this protocol is to track oyster mortality and growth over time.

Check Your Supplies!

- ☐ bucket & line
- ☐ calipers
- ☐ pen or pencil
- ☐ handheld counter
- ☐ scrub brush
- ☐ scissors
- ☐ silicone mat or tub
- ☐ data sheet

Preparation

1) After completing the ORS retrieval steps, dump out all the oysters onto the silicone mat or into the tub. For first time installations, cut the net bags open and lay the clumps or set shells on a pile or piles next to the empty ORS; once they are counted and measured they can be placed in the cage.
2) If the oysters are especially muddy or covered with sessile organisms, feel free to clean the oysters by dunking them in a bucket of harbor water and/or cleaning them with the scrub brush. Be careful not to damage the live oysters.
3) Identify the size of oysters you have (see below) and choose the appropriate data collection methods detailed in the next section.



Oyster Measurements Data Sheet

Metadata	
School/Organization Name: (if applicable)	
School Grade (if applicable):	
Name(s) of Team Members:	
Name of Site or Waterbody:	
Oyster Research Station Tag #:	
Date of data collection:	
Time of data collection:	
Notes or other observations: *Ex: It's raining, there is trash in the water, most oysters are >15mm and some are <15mm, etc.*	

Please select the data collection method used.

- ❑ **Standard**
- ❑ **Short-on-Time**

What type of oysters do you see in your ORS?

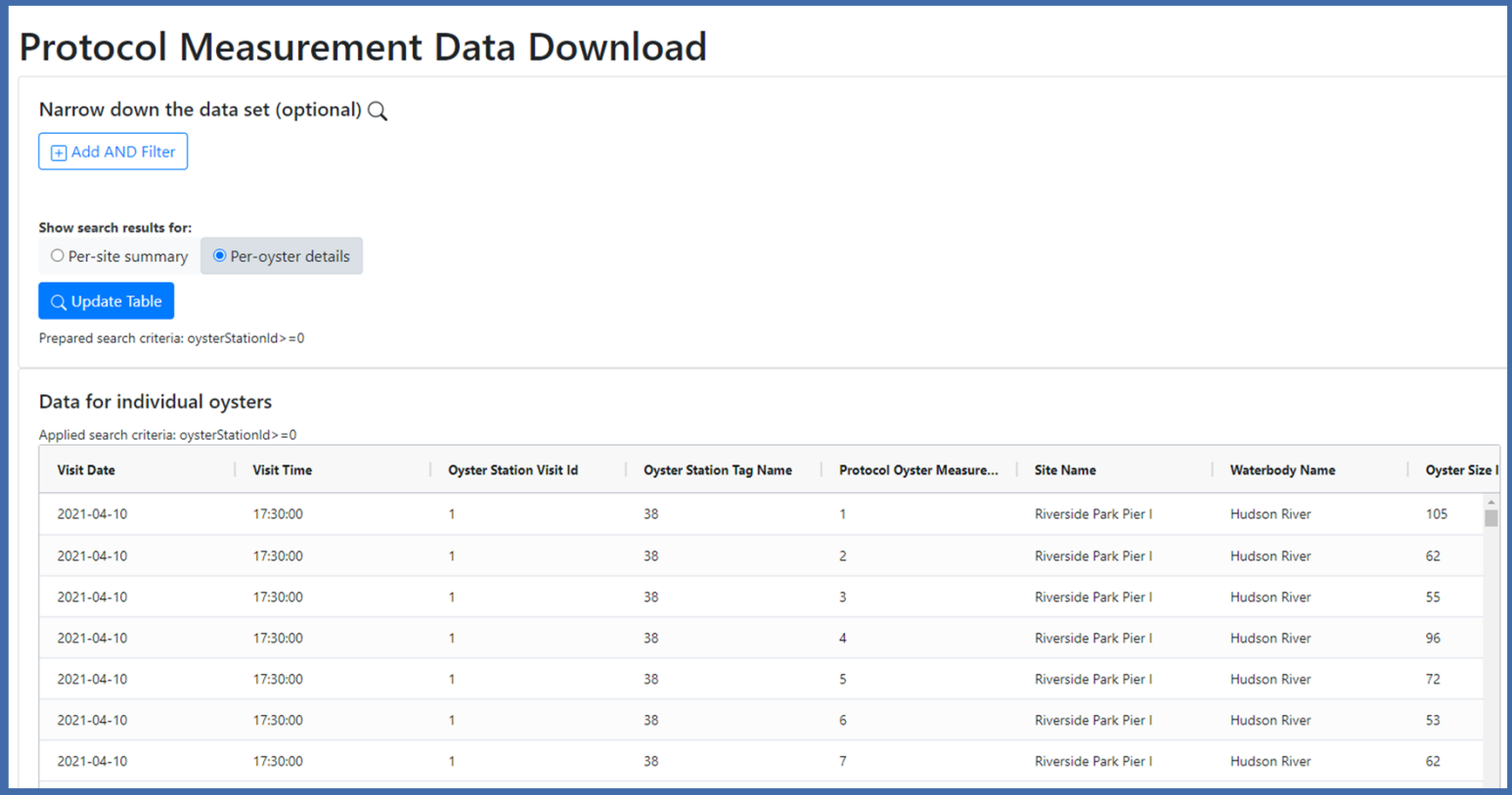
- ❑ **Oysters less than 15mm**
- ❑ **Oysters greater than or equal to 15mm**

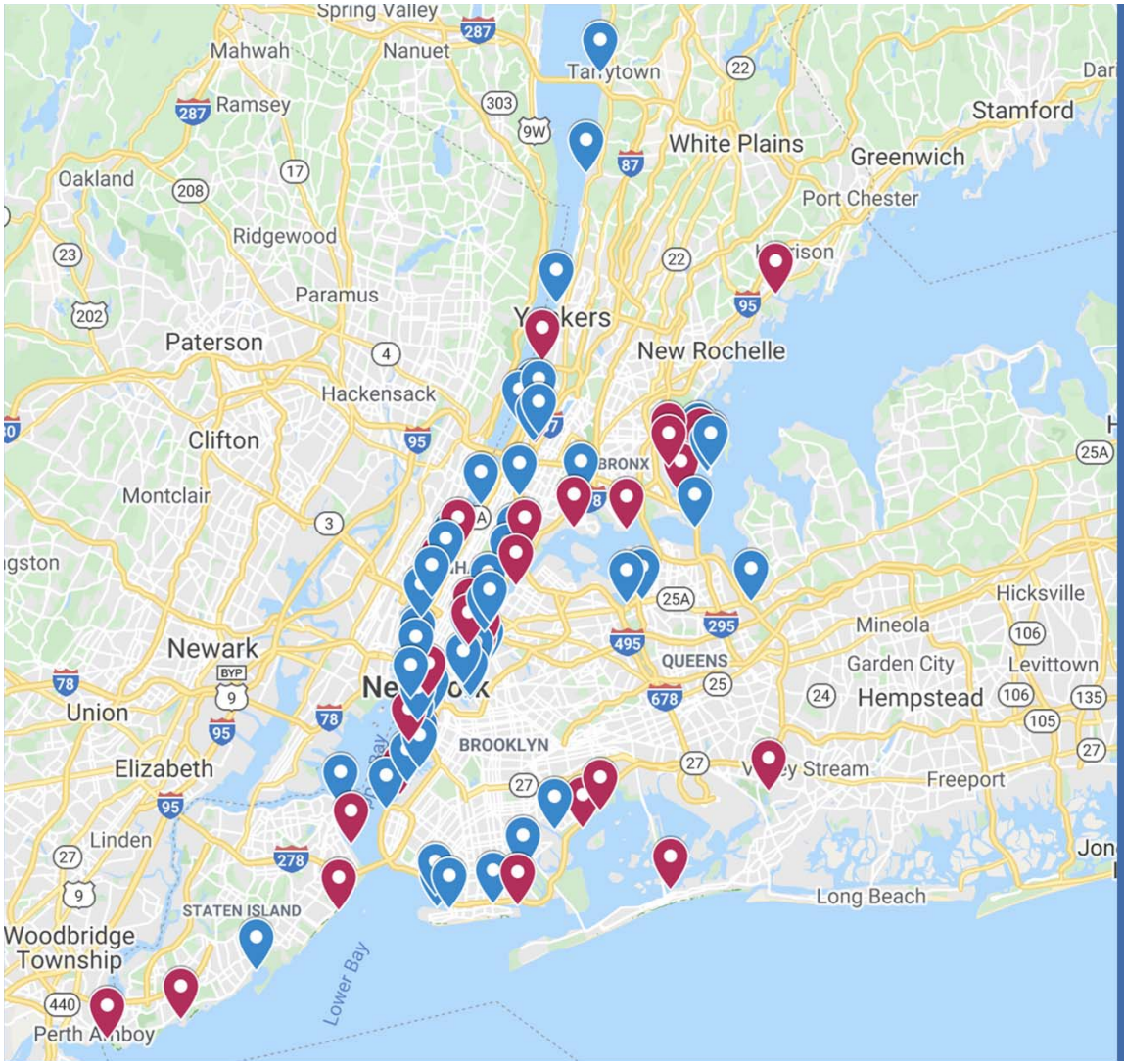
Total Number of oysters less than 15mm_____

Total Number of oysters greater than or equal to 15mm_____

Measurements (ONLY for oysters greater than or equal to 15mm)					
	MEASUREMENT (mm)		MEASUREMENT (mm)		MEASUREMENT (mm)
1.		11.		21.	
2.		12.		22.	
3.		13.		23.	
4.		14.		24.	
5.		15.		25.	
6.		16.		26.	
7.		17.		27.	
8.		18.		28.	
9.		19.		29.	
10.		20.		30.	

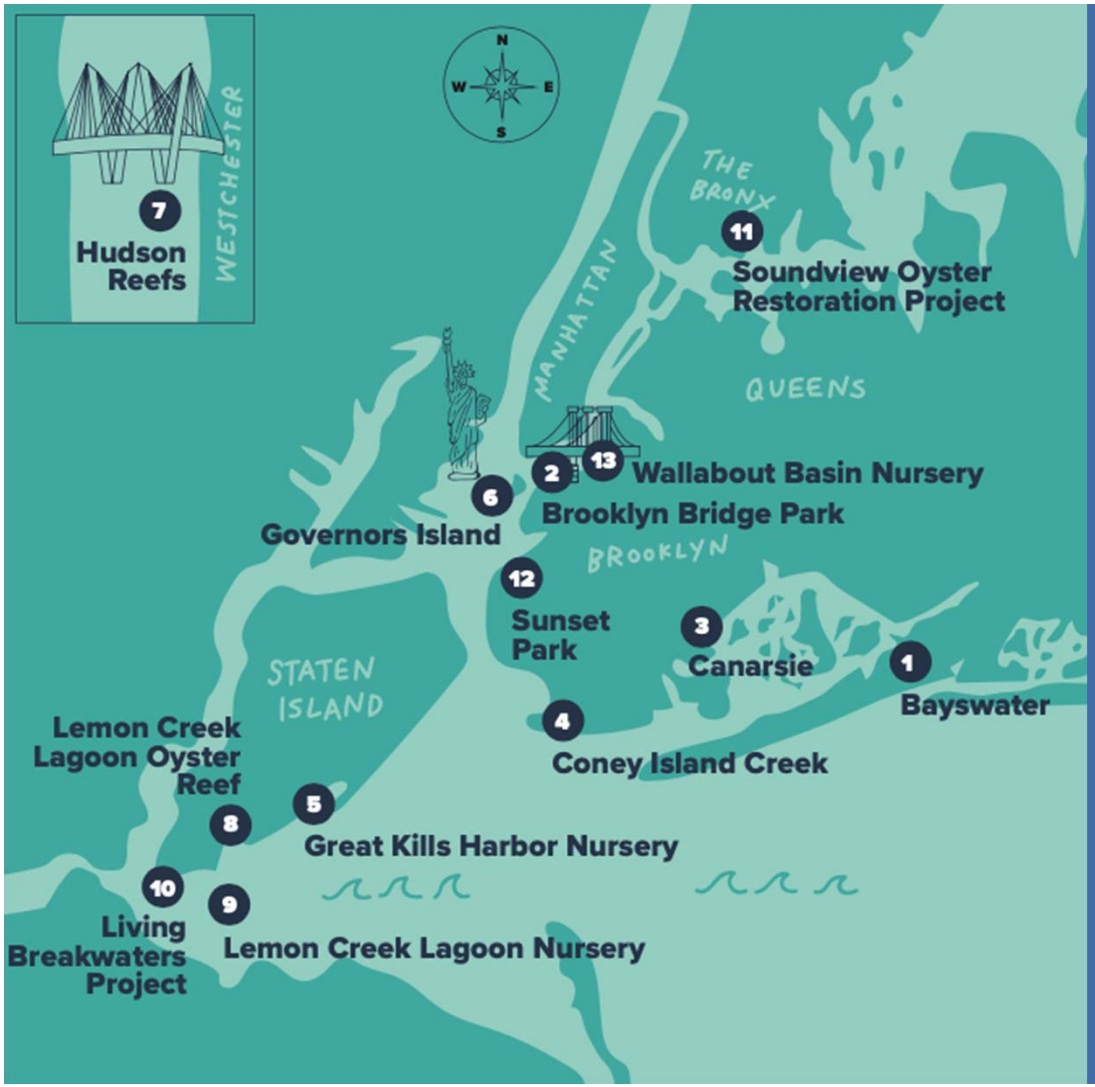
Data download





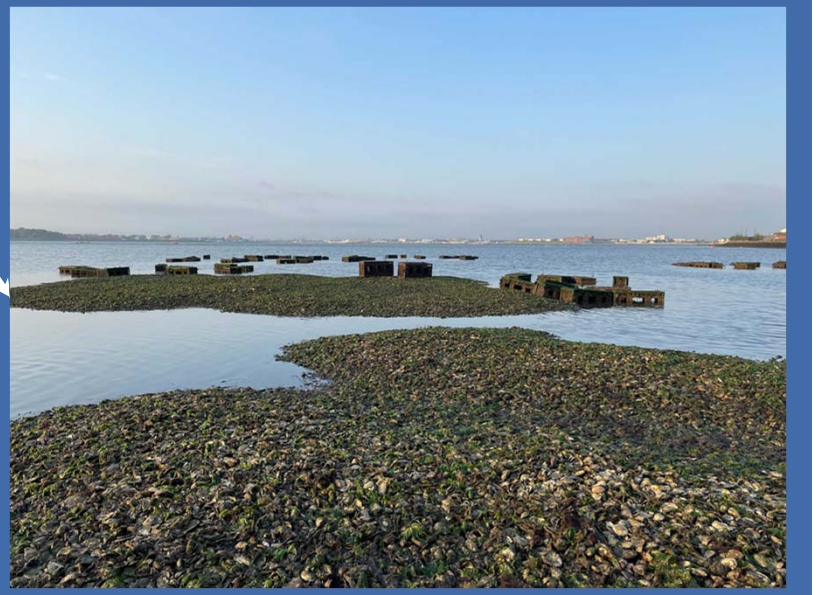
ORS Sites around the city

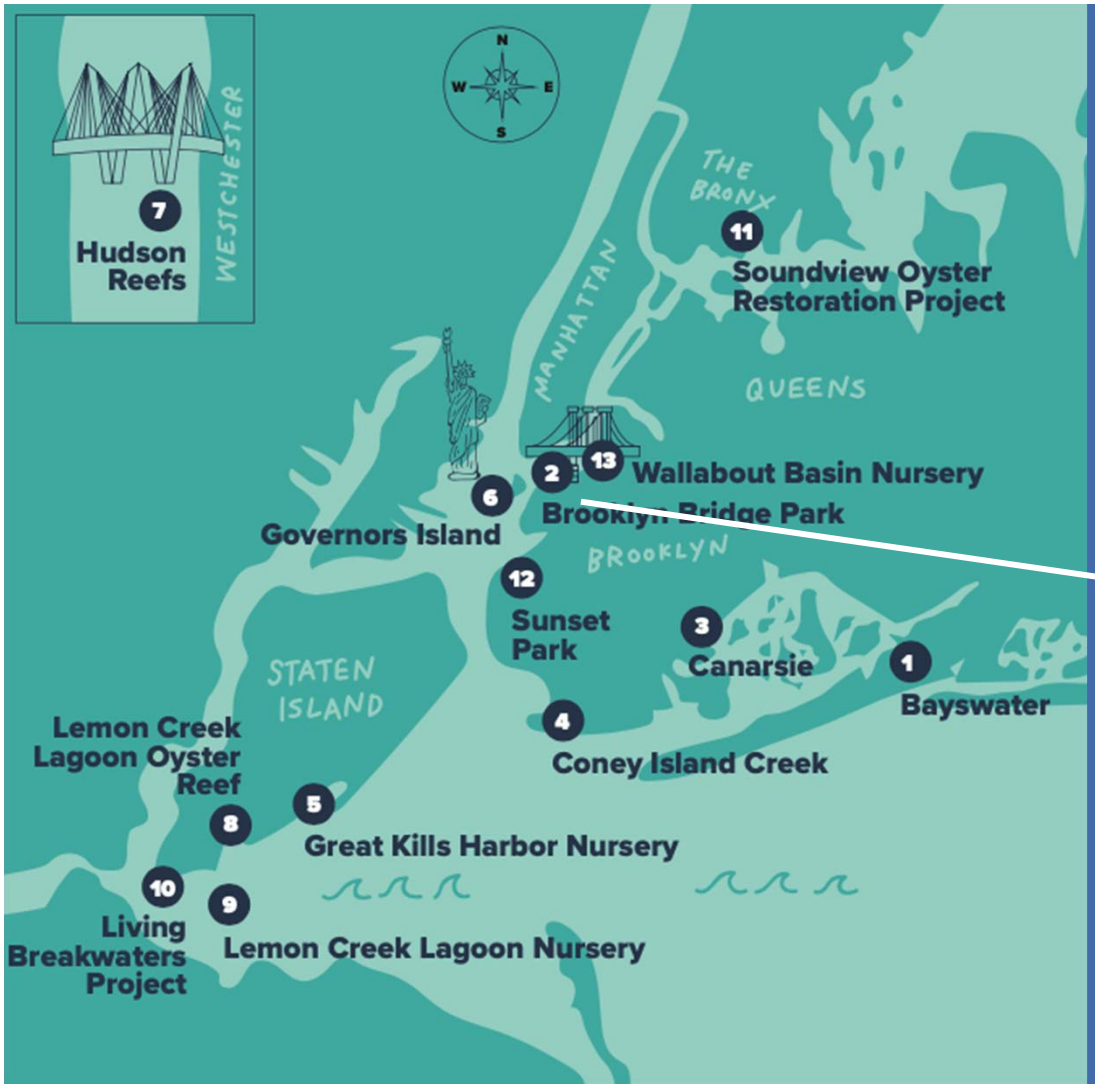
Oyster Reef Monitorings



Oyster Reef Sites


WESTCHESTER
7
Hudson Reefs
N
W
E
S
THE BRONX
11
Soundview Oyster Restoration Project
MANHATTAN
QUEENS
2
13
Wallabout Basin Nursery
Brooklyn Bridge Park
6
Governors Island
BROOKLYN
12
Sunset Park
3
Canarsie
1
Bayswater
STATEN ISLAND
4
Coney Island Creek
Lemon Creek Lagoon Oyster Reef
8
5
Great Kills Harbor Nursery
10
9
Living Breakwaters Project
Lemon Creek Lagoon Nursery





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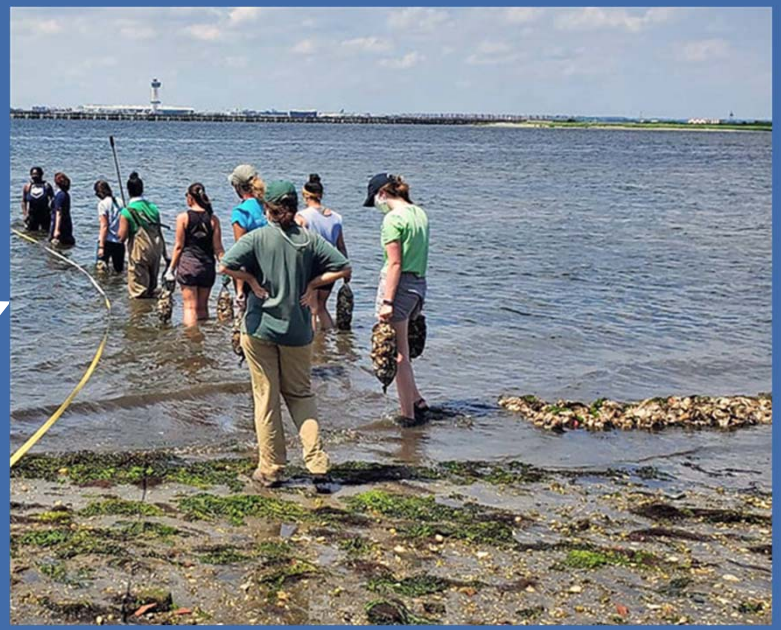


Field Stations

- A Billion Oyster Project Field Station is a community reef or waterfront site targeted for long-term restoration where the community can work alongside BOP to promote:
  - Public access
  - Educational programming
  - Ongoing stewardship

Reef Monitoring ~2x/year

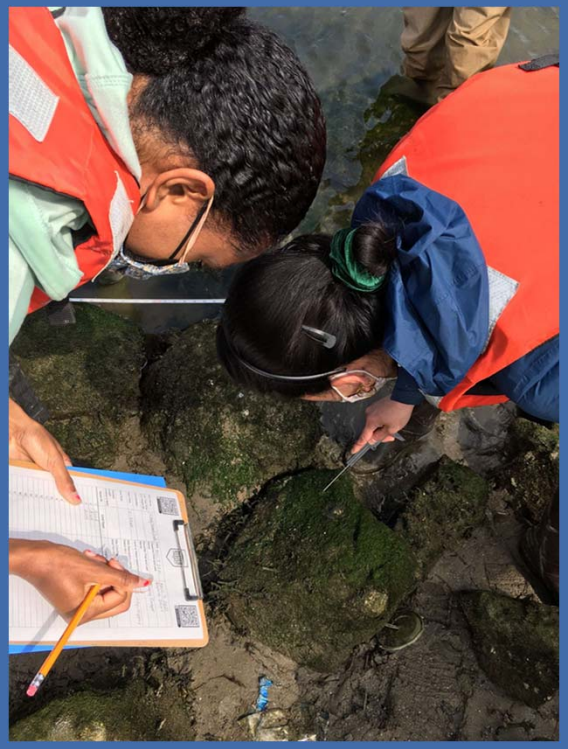
Wild Oyster Surveys

Wild Oyster Surveys

Why? To help us choose great sites for future oyster restoration. The presence of wild oysters is a key indicator of habitat suitability - please help find these sites and study how oysters are doing there!

How will survey data be used?
We will create an interactive map to show where oysters are growing (without human intervention) in NY Harbor.

Wild Oyster Surveys



Wild Oyster Surveys

Wild Oyster Survey

Site:	Tide station:
Date:	Low tide time:
	Low tide height (ft):

	Transect 1		Transect 2	
Transect length				
Substrate type(s)				
Observer Initials				
Recorder Initials				
Start Time				
End Time				
	height (mm)	live/dead	height (mm)	live/dead

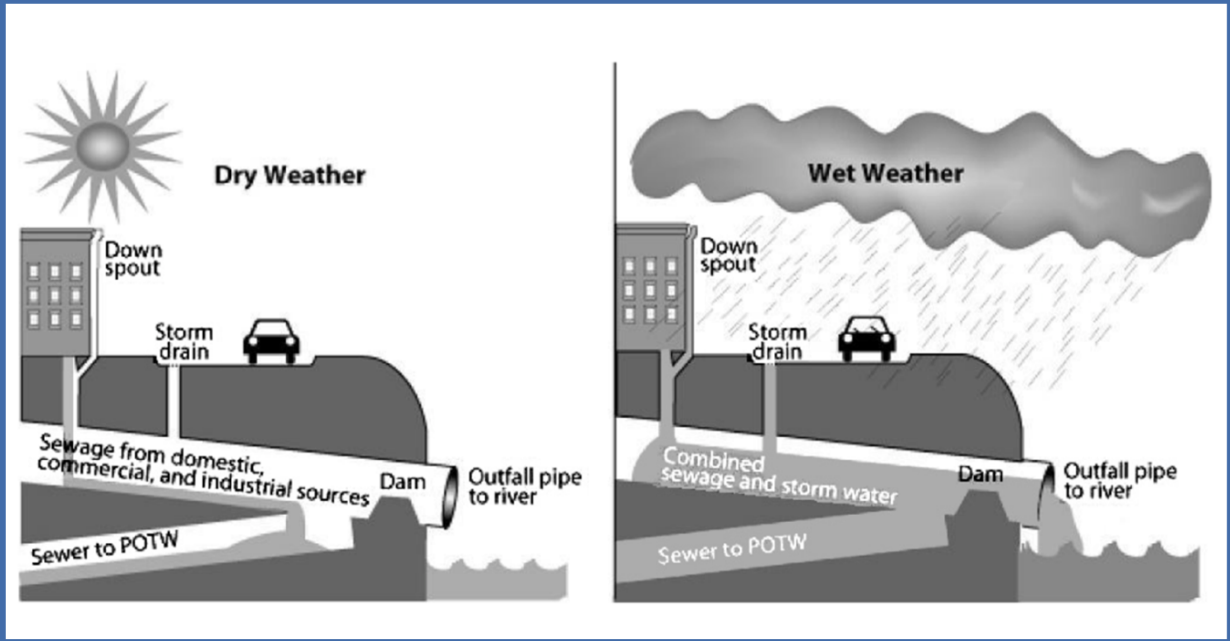
rt/end
so efforts can
next transect

Water Quality Monitoring

Water Quality Monitoring

- Billion Oyster Project partners with the Citizen's Water Quality Testing Program, a 9-year-old volunteer program founded by recreational boaters.
- This summer volunteers tested at 40 sites every Thursday for 20 weeks from May-October.
- Tests reveal fecal indicator bacteria, the same indicator the NYC Department of Health tests for at public bathing beaches.

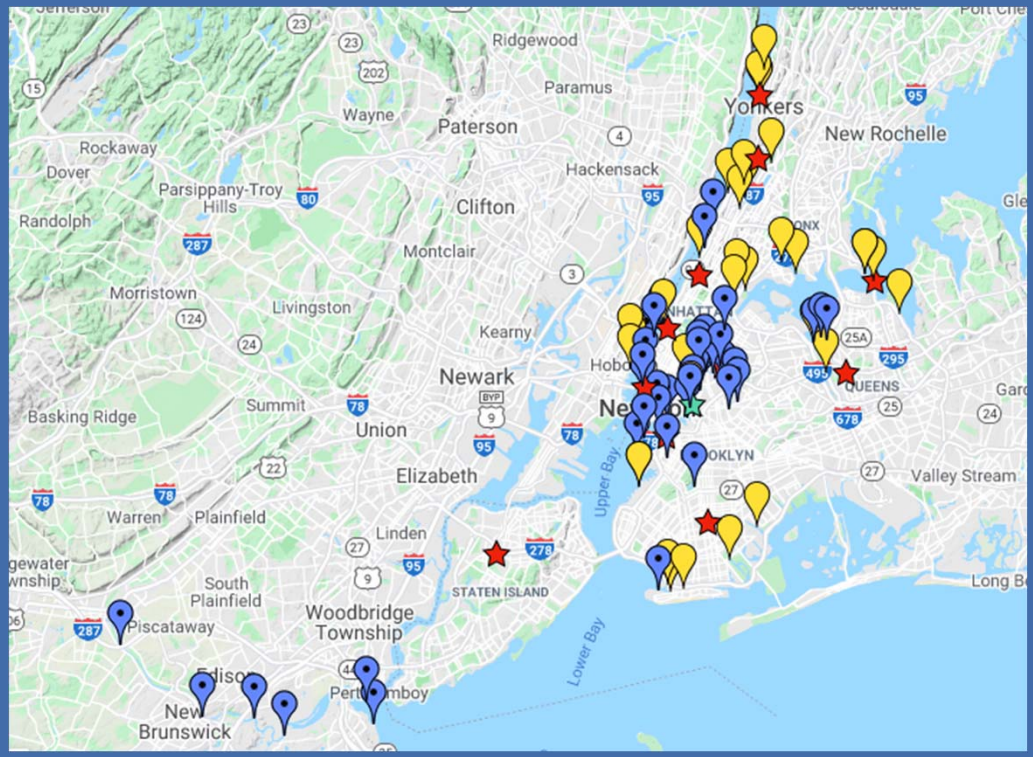
Combined Sewer Overflow (CSO)



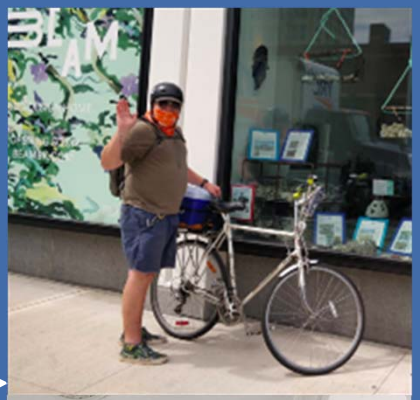
An estimated 27 billion gallons of combined sewage and stormwater are discharged into NY Harbor every year (on the NY side; NJ contributes a similar amount).

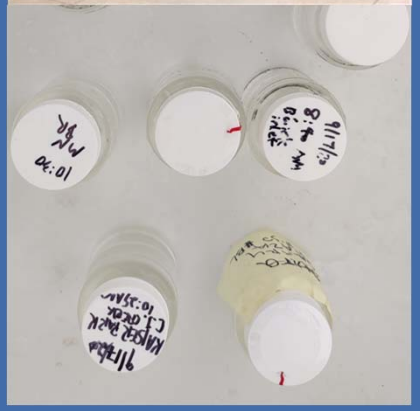
Water Quality Testing Sites

- Sites are chosen by boaters & other volunteers who want to know the water quality at their local launch site or access point
- Blue icons = active testing sites
- Red icons = testing labs
- Yellow icons = sites that were inactive in 2020 due to the pandemic



The Testing Process



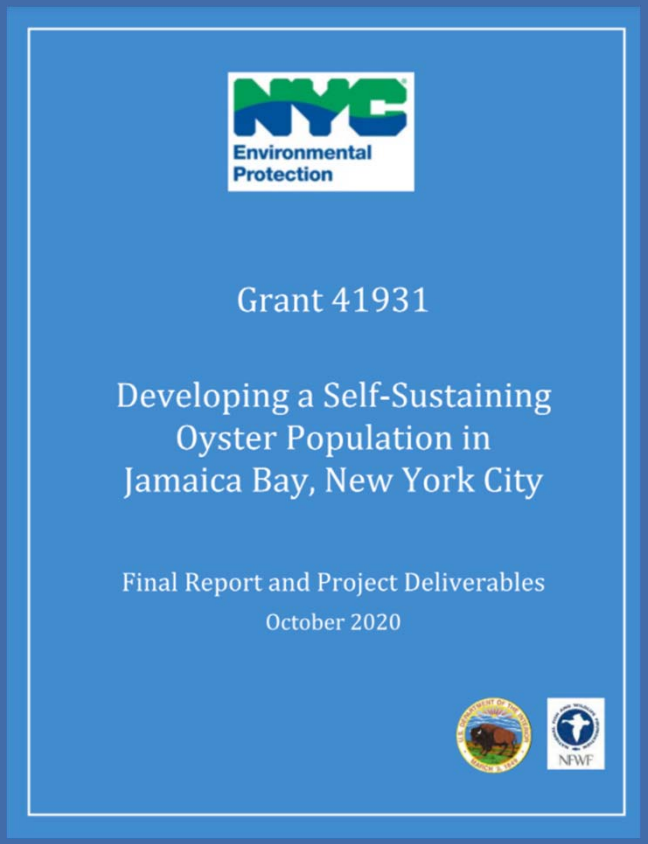


Results - The Big Picture

2020 Citizens Water Quality Testing Program	NYC DOH Enterococcus Standards (for swimming) Green: <35 MPN--acceptable Yellow: 35-104 MPN--unacceptable if levels persist Red: >104 MPN--unacceptable						NYC DOH Enterococcus Standards (for swimming) Green: <35 MPN--acceptable Yellow: 35-104 MPN--unacceptable if levels persist Red: >104 MPN--unacceptable					
Central Park rainfall (source: https://forecast.weather.gov/product.php?site=NWS&issuedby=NYC&product=CLI&format=CI&version=1&glossary=1&highlight=off)	9/25/2020	0		9/18/2020	0		9/11/2020	Trace		9/4/2020	0	
	9/26/2020	0		9/19/2020	0		9/12/2020	0		9/5/2020	0	
	9/27/2020	0.03		9/20/2020	0		9/13/2020	0		9/6/2020	0	
	9/28/2020	0.02		9/21/2020	0		9/14/2020	0		9/7/2020	0	
	9/29/2020	0.47		9/22/2020	0		9/15/2020	0		9/8/2020	0	
	9/30/2020	1.14		9/23/2020	0		9/16/2020	0		9/9/2020	0	
	10/1/2020	Trace		9/24/2020	0		9/17/2020	0		9/10/2020	1.2	
Sampling Date:	**10/1/2020**			**9/24/2020**			**9/17/2020**			**9/10/2020**		
Battery High Tide:	8:46 AM			2:38 AM			8:40 AM			2:23 AM		
Sampling Sites	**Sample Time**	**Most Probable Number (MPN) of Enterococcus colonies per 100 ml**	**Notes**	**Sample Time**	**Most Probable Number (MPN) of Enterococcus colonies per 100 ml**	**Notes**	**Sample Time**	**Most Probable Number (MPN) of Enterococcus colonies per 100 ml**	**Notes**	**Sample Time**	**Most Probable Number (MPN) of Enterococcus colonies per 100 ml**	
Hudson River, West 172nd Street	10:15 AM	75					9:40 AM	52		9:45 AM	41	
Hudson River, West 145th Street	9:20 AM	107					10:10 AM	85		9:15 AM	10	
Hudson River, Pier 96				10:12 AM	31		10:36 AM	20		10:02 AM	529	
Hudson River, Pier 84				10:26 AM	20		10:48 AM	197		10:09 AM	20	
Hudson River, Pier 66				10:35 AM	52	52 (lab split)	11:00 AM	<10		10:21 AM	836	
Hudson River, Gansevoort Peninsula				8:56 AM	10		9:31 AM	121		9:44 AM	24196	
Hudson River, Pier 40				9:04 AM	<10		9:38 AM	<10		10:15 AM	>24196	
Hudson River, Pier 26				8:45 AM	<10		9:46 AM	<10	10 (Lab Split)	10:08 AM	670	
East River, SUNY Maritime Waterfront Center (MAR)	9:19 AM	331		9:12 AM	<10							
East River, SUNY Maritime campus entrance (IT)	9:17 AM	488		9:12 AM	52							
East River, Hammond Cove (HC)	12:45 PM	41		1:35 PM	20							
Flushing Bay, World's Fair Marina Pier 1 east	10:05 AM	934		10:33 AM	31		10:05 AM	10		11:45 AM	>24196	
Flushing Bay, World's Fair Marina boat ramp	9:55 AM	780		10:29 AM	318		10:11 AM	52		11:35 AM	>24196	
Flushing Creek	9:40 AM	19863		10:26 AM	173		10:25 AM	712		11:55 AM	>24196	
East River, Hallets Cove	12:08 PM	733		10:53 AM	228		12:23 PM	450		12:01 PM	546	
East River, Anable Basin	12:21 PM	221		11:08 AM	41		12:30 PM	41		12:21 PM	512	
East River, Gantry State Park	11:30 AM	85		11:20 AM	10		11:30 AM	<10		11:34 AM	199	
Newtown Creek, Second Street kayak launch	11:42 AM	278		11:30 AM	<10		11:20 AM	74		11:29 AM	467	

Who uses the collected data?

Monitoring Reports



Data Analysis Curriculum

[Lesson 4: Make and test your predictions]

Grade: 6-12 **Class Periods:** 4-6 **Setting:** classroom
Subject Area(s): science, data, math

Summary: Students work through their data analysis, troubleshooting and making adjustments along the way.

Outline:
In this lesson, students...

1. predict answers to their data analysis question(s).
2. test their predictions, taking notes and making adjustments along the way.
3. troubleshoot during Help Sessions, held regularly throughout the analysis process.

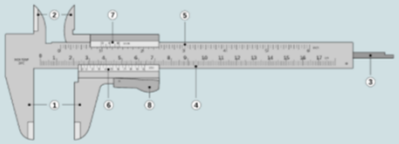
Description
Students begin to analyze the data based on their question of interest. They keep track of adjustments, challenges, questions, and ideas they have along the way.

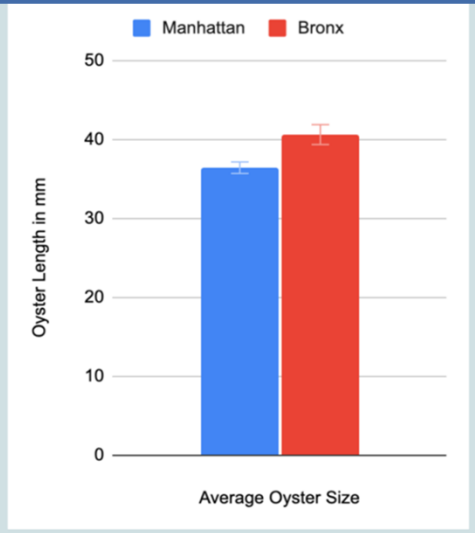
Objectives

- Make directional hypotheses that specify what happens to a variable when another variable is changed.
- Apply mathematical and statistical techniques and concepts to scientific questions, using digital tools.
- Analyze data using tools, technologies, and/or models in order to make scientific claims.

Bar graph of Oyster length using information from calipers on Manhattan and the Bronx ORS sites.

Each bar graph represents the average size of the oysters in all of the sites in the bronx and all of the sites in Manhattan





Annual Student Symposium

Data Analysis: Comparison of Oyster Shell Height

Reid Mandell and Ethan Lieman Science Research Course Frank McCourt High school 145 W 84th St, New York, NY 10024

Advisor's Name: Ms.Miklos

INTRODUCTION

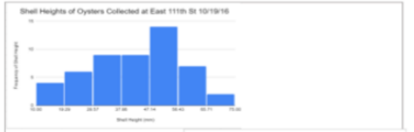
The New York/ New Jersey harbor has been the cleanest in the last century. This is thanks to the restoration of oysters in the last two decades. Oysters provide numerous environmental benefits.Our subtopic is the progression of the oyster shell height at the same location from 2 different time periods. We compared data from two locations that measured the height of oysters.

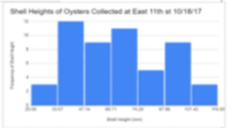
We used the provided data from the Billion Oyster Project. When the school collected the data they were following Billion Oyster Project protocol. The measurements were from the bill to the umbo.

Oysters provide numerous benefits for ecosystems and especially the NY harbor. This topic is relevant and important because the progress of the oysters growing will show us if we are getting closer to adding more oysters to the population.

CURRENT RESEARCH

We compared the data of oyster size form different testing sites. Specifically, the oysters from the site at East 111 Street collected by Central Park East II School. The data collection followed the Billion Oyster Project protocol using the Methods of Measurements: BOP Protocol. We used the data provided by the Billion Oyster Project to compare the data. Oyster sizes were compared from 10/19/2019 and 10/18/2017. Two formulae were used to find the median and average between the sizes of the oysters from each year. The main takeaways are the growth of the oysters and that they grew significantly.





RESULTS: ANALYSIS AND IMPLICATIONS

First we had to choose which data set we wanted to use for the location we chose. We chose the data sets that were a year apart because they had a big enough difference. Then we made the graphs and averages on google sheets.

The data analysis can show us the progress of the oysters. We can see the growth over time and then from there you can decide what that means.

The data shows how the oysters are developing

RESULTS:

- The average shell height for 10/19/16 is 42.12mm
- The average shell height for 10/18/17 is 65.27 mm
- The mean shell height for 10/19/16 is 44 mm
- The means shell height for 10/18/17 is 62

FUTURE DIRECTIONS

As the oysters continue to develop we can later bring in the factor of what they are actually doing to the water. We could then see how effective they are at cleaning the water as they get older. Exploring the effects of the oysters on the ecosystem and the water would be interesting to test over time. We already know that they are beneficial but we are curious about adding the factor of their age.

CONCLUSION

How did the shell height grow and how did they compare to one another over time? The goal of this project was to compare oyster growth over time, we saw growth in them. We could compare the shell growth and overall size to other locations to ours.

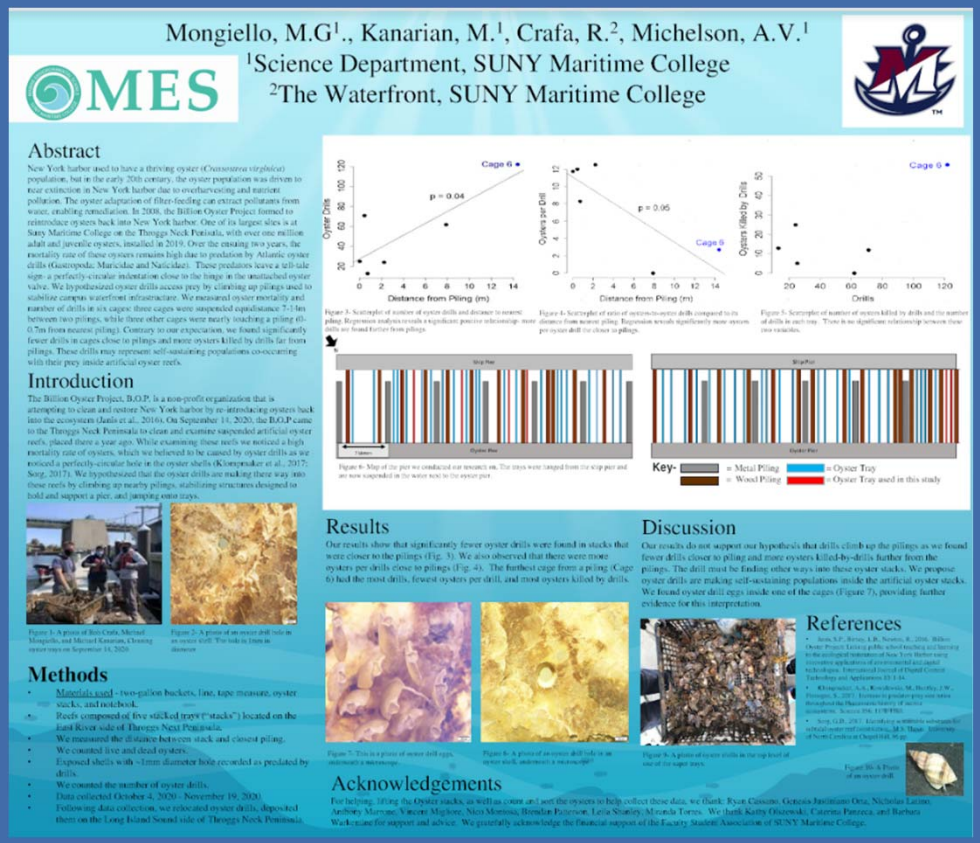
REFERENCES

https://docs.google.com/document/d/18tKQ07-8AkULR8UUhwQ5WZRnaF833Xu6WKWmFf4aOg/edit?usp=sharing

https://docs.google.com/spreadsheets/d/1tQOJrFLQuvKzNphtmYYZT6xBN64m3KbfvYOH5AuW9g/edit#gid=0

McCann, M. 2019. Restoring Oysters to Urban Waters: Lessons Learned and Future Opportunities in NY/NJ Harbor. The Nature Conservancy, New York, NY, USA.

1st Annual Scy-posium



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Abstract

New York harbor used to have a thriving oyster (*Crassostrea virginica*) population, but in the early 20th century, the oyster population was driven to near extinction in New York harbor due to overharvesting and nutrient pollution. The oyster adaptation of filter-feeding can extract pollutants from water, enabling remediation. In 2008, the Billion Oyster Project formed to reintroduce oysters back into New York harbor. One of its largest sites is at Suny Maritime College on the Throggs Neck Peninsula, with over one million adult and juvenile oysters, installed in 2019. Over the ensuing two years, the mortality rate of these oysters remains high due to predation by Atlantic oyster drills (Gastropoda: Muricidae and Naticidae). These predators leave a tell-tale sign- a perfectly-circular indentation close to the hinge in the unattached oyster valve. We hypothesized oyster drills access prey by climbing up pilings used to stabilize campus waterfront infrastructure. We measured oyster mortality and number of drills in six cages: three cages were suspended equidistance 7-13m between two pilings, while three other cages were nearly touching a piling (0-0.7m from nearest piling). Contrary to our expectation, we found significantly fewer drills in cages close to pilings and more oysters killed by drills far from pilings. These drills may represent self-sustaining populations co-occurring with their prey inside artificial oyster reefs.

Introduction

The Billion Oyster Project, B.O.P. is a non-profit organization that is attempting to clean and restore New York harbor by re-introducing oysters back into the ecosystem (Janis et al., 2016). On September 14, 2020, the B.O.P came to the Throggs Neck Peninsula to clean and examine suspended artificial oyster reefs, placed there a year ago. While examining these reefs we noticed a high mortality rate of oysters, which we believed to be caused by oyster drills as we noticed a perfectly-circular hole in the oyster shells (Klompmaker et al., 2017; Song, 2017). We hypothesized that the oyster drills are making there way into these reefs by climbing up nearby pilings, stabilizing structures designed to hold and support a pier, and jumping onto trays.

Figure 1: A photo of Rich Crafa, Michael Mongiello, and Michael Kanarian, Cleaning oyster trays on September 14, 2020

Figure 2: A photo of an oyster drill hole in an oyster shell. Two holes in 1mm in diameter.

Methods

- Materials used - two-gallon buckets, line, tape measure, oyster stacks, and notebook.
- Reefs composed of five stacked trays ("stacks") located on the East River side of Throggs Neck Peninsula.
- We measured the distance between each stack and closest piling.
- We counted live and dead oysters.
- Exposed shells with ~1mm diameter hole recorded as predated by drills.
- We counted the number of oyster drills.
- Data collected October 4, 2020 - November 19, 2020.
- Following data collection, we relocated oyster drills, deposited them on the Long Island Sound side of Throggs Neck Peninsula.

Figure 3- Scatterplot of number of oyster drills and distance to nearest piling. Regression analysis reveals a significant positive relationship: more drills are found further from pilings.

Figure 4- Scatterplot of ratio of oysters-to-oyster drills compared to its distance from nearest piling. Regression reveals significantly more oysters per oyster drill the closer to pilings.

Figure 5- Scatterplot of number of oysters killed by drills and the number of drills in each tray. There is no significant relationship between these two variables.

Figure 6- Map of the pier we conducted our research on. The trays were ranged from the ship pier and are now suspended in the water next to the oyster pier.

Results

Our results show that significantly fewer oyster drills were found in stacks that were closer to the pilings (Fig. 3). We also observed that there were more oysters per drills close to pilings (Fig. 4). The furthest cage from a piling (Cage 6) had the most drills, fewest oysters per drill, and most oysters killed by drills.

Figure 7- This is a picture of oyster drill eggs, underneath a microscope.

Figure 8- A picture of an oyster drill hole in an oyster shell, underneath a microscope.

Discussion

Our results do not support our hypothesis that drills climb up the pilings as we found fewer drills closer to piling and more oysters killed-by-drills further from the pilings. The drill must be finding other ways into these oyster stacks. We propose oyster drills are making self-sustaining populations inside the artificial oyster stacks. We found oyster drill eggs inside one of the cages (Figure 7), providing further evidence for this interpretation.

Figure 9- A picture of oyster drills in the top level of one of the super trays.

Figure 10- A Picture of an oyster drill

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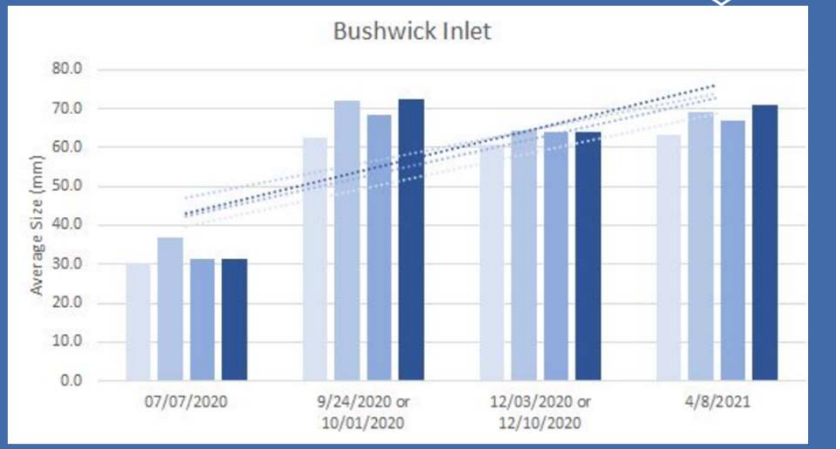

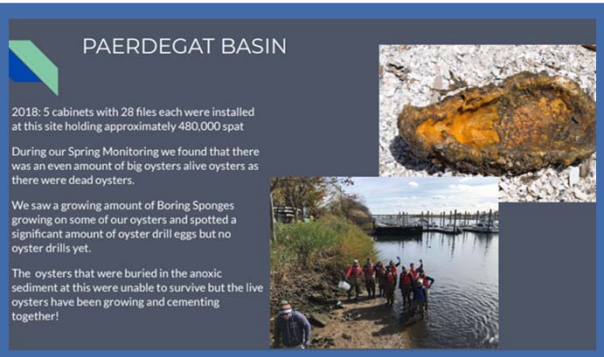

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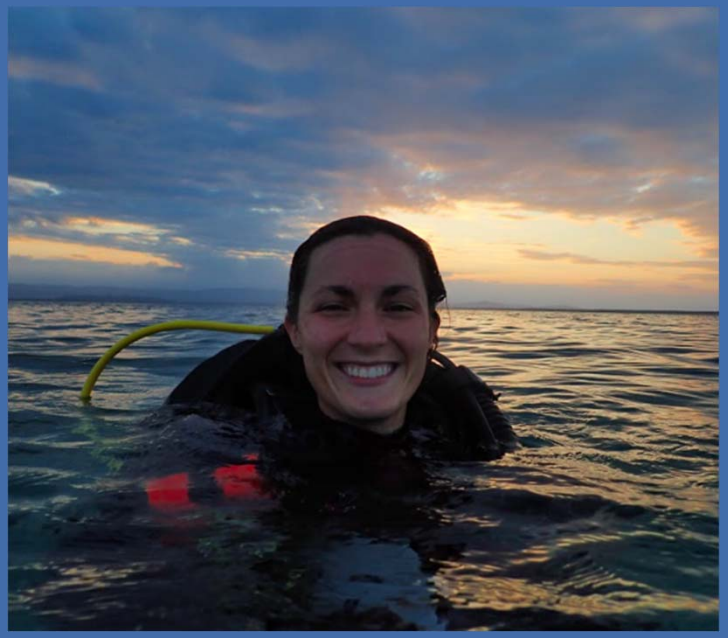

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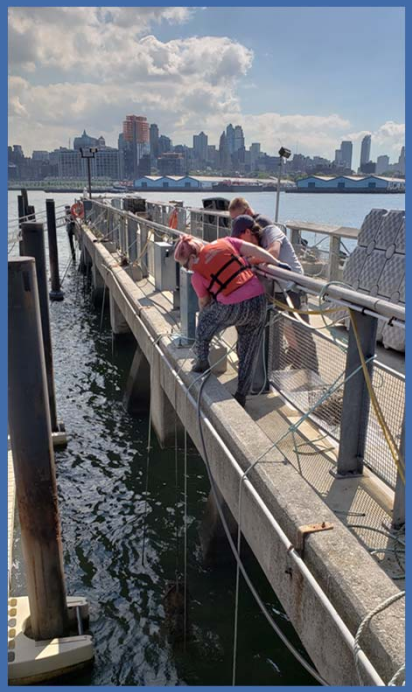

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