Oyster Substrate Identification in the Little Hell Gate Bridge Shoreline

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WATERFRONT STEWARDSHIP

Purpose

Oysters were the original ecosystem engineers of New York City Harbor. They once assisted the region's ecosystem by filtering water, providing habitat for other marine species, and attenuating wave energy. However, oysters are nearly extinct in the harbor due to overexploitation, dredging, and pollution.(Billion Oyster Project)[1] Based on oysters' physiology and their life cycle, oysters can most likely be found on hard substrates such as concrete, limestone, river rock, and oyster shell substrate. Oyster larvae live in the water column two weeks after they hatch, and, mature through different stages. Larvae drift in the currents in order to follow phytoplankton, their primary source of food. Larvae are not capable of swimming horizontally, but they can move vertically to some extent. Once the larvae are approximately two weeks old and on the pediveliger stage (larva with a foot), they begin to concentrate at the bottom of the river system to search for a hard substrate. In the case of oysters, the substrate can be natural material such as oyster shell, mangrove roots, or limestone[2]. Oyster larvae can detect calcium carbonate. The larvae utilize an appendage that they grow called a foot. This foot helps them crawl around on the bottom to find a suitable substrate on which to attach. Once they have successfully determined a suitable location, usually an oyster shell, they begin to attach to the shell by secreting glue. The larvae then undergo a complete metamorphosis of internal anatomy and become what we call a spat. The oyster spat will start to feed and put all of their energy into shell growth by sequestering calcium carbonate from the water column.

The goal of the experiment is to determine types of substrates on Randall's Island, specifically the area around the Little Hell Gate Bridge, that provide habitat for oysters. The oyster shell is the preferred substrate to use in restoration because it most closely matches natural reef habitat, it is often expensive and in limited supply[3]. With this experiment, in the future, this data could be used in alleviating usage of hard substrate such as *Crassostrea virginica* oyster shell in an urban reef restoration effort.

The specific goal is to determine:

1. Types of substrate oysters are habiting (classification of rock, composition)
2. Number of oysters live on substrate
3. Number of oysters dead on substrate
4. Size of oysters on substrate
5. Organisms or plants that coexist with oysters on substrate

[1] (2013). Billion Oyster Project. Retrieved August 30, 2016, from http://www.billionoysterproject.org/.
[2] (2015). Oysters Life Cycle | Horn Point Lab Oyster Hatchery. Retrieved August 30, 2016, from http://hatchery.hpl.umces.edu/oysters/oysters-life-cycle/.
[3] (2016). https://tamucc-ir.tdl.org/tamucc-ir/handle/1969.6/1 https://tamucc-ir.tdl ... Retrieved August 30, 2016, from https://tamucc-ir.tdl.org/tamucc-ir/sitemap?map=0.

Materials

1. pickaxe
2. ruler
3. marker, pen
4. numbered zip lock bag (#1-#-18)
5. notebook
6. calipers
7. salt marsh map
8. spreadsheet for data entry
9. vest and boots

Procedures

1. Mark the starting area within the Little Hell Gate Bridge on the map.
2. Check for tide level and temperature in the area and record it in the spreadsheet.
3. From the starting point, walk along the shoreline to examine each and every rock for oysters.
4. Identify each and every rock that is in the intertidal zone.
5. Survey to see how many oysters are on the rocks, how many are alive and how many are dead.
6. Identify the size of the oyster using calipers.
7. Identify other coexisting species and plants on the rock and record them in a spreadsheet.
8. Step 3-6 should be repeated for all the rocks that are examined along the shoreline.
9. Survey to see oysters that are not attached to hard substrate, and identify an environment they are in. Fully grown oysters or spat could be carried by the tide to shore. These oysters used to be on hard substrate, but ended up on the shoreline environment with no hard substrate.
10. Collect rock sample and separate it into bag labeled unknown#1, 2, 3...etc for each rock that oysters appeared on.
11. On shore, identify rock samples in labeled bags that are collected.

Date: 7/12/16

Labeled Rock	Mortality Rate	Oyster size(cm)	Coexisting Species/Plants	Substrate Type
Unknown #1	Live:0; Dead:4	-	*Fucus vesiculosus*	Limestone
Unknown #2	Live:0; Dead1	-	*Fucus vesiculosus*	Limestone
Unknown #3	Live:0; Dead:4	-	*Fucus vesiculosus*	Schist
Unknown #4	Live:0; Dead:10	-	*Fucus vesiculosus,* Arthropod	Schist
Unknown #5	Live:4; Dead:6	2.9,3.4,2.9,2.5	*Fucus vesiculosus,* Arthropod	Schist
Unknown #6	Live:1; Dead:3	3.9	*Fucus vesiculosus,* Arthropod	Schist
Unknown #7	Live:13; Dead:9	3-4	*Fucus vesiculosus,* Arthropod	Schist
Unknown #8	Live:1; Dead:3	3-4	*Fucus vesiculosus,* Arthropod	Schist
Unknown #9	Live:1; Dead:5	3-4	*Fucus vesiculosus*, Arthropod	Schist
Unknown #10	Live:4; Dead:4	2.7,2.5,1.9, 2.4	*Fucus vesiculosus,* Arthropod	Schist
Unknown #11	Live:0; Dead:4	-	*Fucus vesiculosus*, Arthropod	Schist
Unknown #12	Live:1; Dead:4	4.7	*Fucus vesiculosus,* Arthropod	Schist
Unknown #13	Live:1; Dead:1	3	*Fucus vesiculosus*, Arthropod	Schist
Unknown #14	Live:3; Dead:7	3-4	*Fucus vesiculosus,* Mud Snail, Arthropod	Schist
Unknown #15	Live:1; Dead:3	3-4	*Fucus vesiculosus,* Mud Snail*,* Arthropod	Schist
Unknown #16	Live:2; Dead:3	3-4	*Fucus vesiculosus,* Mud Snail*,* Arthropod	Schist
Unknown #17	Live:2; Dead:2	3-4	*Fucus vesiculosus,* Mud Snail*,* Arthropod	Schist
Unknown #18	Live: 2, Dead:1	3.5, 3.2	-	Concrete
Unknown #19	Live:2, Dead: 0	2.6, 2.9	-	Concrete

Table1: Recorded data of mortality rate, oyster size, coexisting species, and substrate type.

Figure 1: Map of Little Hell Gate Bridge, red line indicates the area that substrates are identified; Red Circle marks the starting area: 40*47’27.5’N 73*55’39.9’W, Red Line marks the surveying area.

Figure 2: Substrate locations along the Little Hell Gate Bridge shoreline

Observation

It was observed that oysters appear in the same type of rock along the shoreline of Little Hell Gate Bridge. While most oysters found were dead, there were live oysters with a minimum size of 2.4 inches to a maximum size of 4 inches. Most oysters appear on larger rocks and appear to be growing beneath the side of submerged rock. Oysters also appear to be growing in difficult-to-reach areas along the shoreline. There are coexisting species on the same substrate, mainly *Fucus vesiculosus* and Arthropods.

Analysis

Oyster mortality rate is the lowest in Unknown Substrates 1 and 2. There were 4 dead oysters and 0 live oysters on substrate#1 and 1 dead oyster and 0 live oysters on substrate#2. Coexisting species of seaweed, Fucus Vesiculosus exit along with oysters on the substrates.

After identification, substrate#1 and substrate#2 are limestone, which is an organic sedimentary rock form from accumulation of plant or animal debris. The particular limestone, Oolitic limestone is composed mainly of calcium carbonate oolites (small sphere formed by the precipitation of calcium carbonate on a small shell or shell fragment). Oolitic limestone is an ideal substrate for oyster larvae. The reason oyster mortality is low because there is a low quantity of limestone available compared to other types of substrate in surveyed area. At the same time, location of the substrate could affect oysters' growth. Limestone is located along the shoreline but situated inward of the shoreline. Limestone in the site surveyed is not native to Randall's Island and could have been brought in for shoreline restoration of the salt marsh.

Substrates Unknown #3 to Unknown #17 are located along the shoreline of the Little Hell Gate Bridge. Mortality rate of oysters continues to be low; however, live oysters also exist on the schist. There were 3 dead oysters on Unknown #3 and there are 10 dead oysters on Unknown #4. Unknown #5 has 4 live oysters with size of 2.5 cm, 2.9 cm, 2.9 cm, and 3.4 cm and has 6 dead oysters. Unknown#6 has 1 live oyster of 3.9 cm and 3 dead oysters. Species of *Fucus vesiculosus*, *Ilyanassa obsoleta*, and arthropods coexist on the same substrate. After identification, substrates are metamorphic origin, specifically schist. Schist is a type of metamorphic rock that formed under lowest temperatures and pressures of 570-840 (F) and 14500-5800 (psi). Schist is foliated and has medium to coarse grained texture. It has mostly visible sparkling crystals of chlorite. Protolite of schist depends on the degree of metamorphism. Schist is formed by regional metamorphism of mafic igneous rocks, usually basaltic rocks. Because oysters have ability to detect calcium carbonate, oyster larvae look for calcium carbonate based substrate and in this case attached onto schist, thus mineral composition of schist in the Little Hell Gate Bridge could be a carbonatic protolith which includes calcite ± dolomite ± quartz ± micas, scapolite, wollastonite, and could be specifically identified as green schist[4]. Although Randall's Island is part of Manhattan Schist strata, it is likely that schist and other rocks along the shore are brought from remote locations.

Unknown Substrate #18, and Unknown Substrate #19, after identification, appears to be small concrete rocks. Unknown Substrate #18 has 2 live oysters of size 3.2 cm, and 3.5 cm and has 1 dead oyster. Unknown Substrate #19 has 2 live oysters of size 2.6 and 2.9 cm, and has no dead oyster. However, oyster count is small due to small substrate size as well as scarcity of substrate. Some data are missing in table 1 because we were unable to measure these oysters or gather substrate samples due to oysters growing within rock cracks.

Conclusion

The experiment is adequate however, it is not without flaws. Due to time constraints and a small, low tide window, the experiment has to be completed within a day. There were some unforeseen events as we discovered some oysters submerged underwater, beneath the substrates. It is difficult to examine without proper equipment. Underwater inspection cameras would be a great tool to examine submerged oysters. The experiment could be done more efficiently if there are more members working on the project. We would set up the project with a group of five people. Two members can set out to look for oysters and mark substrates and other two members can collect samples and measure oysters' size. The last member can input data. Another way the experiment could be improved is solving the issue of tide level. It would be best not to hasten through the experiment to

[4] (2013). ALEX STREKEISEN-Greenschist-. Retrieved August 30, 2016, from http://www.alexstrekeisen.it/english/meta/greenschist.php.

accommodate for rising tide level; instead we would spend more time on the experiment and expand it to two to three days.

If oyster farming and restoration were to be conducted in the area of Little Hell Gate salt marsh, it could be done without acquiring much of the additional oyster substrate such as *Crassostrea virginica* oyster shells. Little Hell Gate shoreline already has optimal substrates necessary for oyster farming, however, necessary monitoring is still needed for oyster growth in schist and concrete substrate environment to see how much oysters can grow along the shoreline. Now that we know what kind of substrates exists in the Little Hell Gate Bridge area, more experiments could be done on the relationship between oyster mortality on specific substrate in a different season.

Works Cited

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