Will we see different organisms living in and around the Brooklyn Bridge Park oyster garden after a large rainstorm due to combined sewage overflow?

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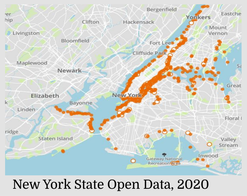
Abstract

This project addresses how large rain storms affect biodiversity in the Brooklyn Bridge Park oyster garden, concerning combined sewage overflow (CSO) into the East River. CSO occurs when heavy rainfall overwhelms New York City's combined sewer system, releasing sewage and stormwater full of bacteria and harmful chemicals into local waterways, which disrupt the ecological health of an oyster garden. By collecting organisms before and after a storm event, extracting and sequencing their DNA, and comparing the results, we aim to identify whether there is a connection between rainfall and CSO shifts in species composition. Our central research question asks whether we will observe different organisms living in and around the oyster garden.

Introduction

Biodiversity monitoring is common in aquatic ecosystems and is crucial in providing insight into the presence of different species, restoration efforts, and potential invasive species. Biodiversity is an essential factor in the health and stability of an ecosystem. Environmental factors, namely pollution, can threaten an ecosystem's biodiversity. Combined Sewer Overflows (CSOs) are a known source of pollution in NYC waterways, especially during heavy rainfall. CSOs occur when untreated human and industrial waste is released into nearby waterways, such as streams, rivers, and other bodies of water (Wang, 2014). The discharge of the untreated waste into aquatic ecosystems can introduce a variety of bacteria and pathogens into the environment (Tondera et al., 2016). Sewer overflows affect aquatic systems, such as the water quality and fish consumption safety, impacting the health of our waters and ecosystems (Odilov et al., 2024). Once called the Big Oyster, NYC's oyster population experienced a dramatic decline due to pollution, overharvesting, and habitat destruction, effectively ending its status as an oyster capital in the early 1900s. Oyster reefs play a crucial role in the health of aquatic ecosystems as they are natural filter feeders and provide habitat for other organisms in the ecosystem. Excess waste, toxins, and nutrients in the water can greatly reduce the effectiveness of the oysters' filtering, resulting in poorer water quality (NOAA, 2025). Oyster gardens can prove to be vital to aquatic habitats as they support a diverse community of organisms and aquaculture (Bishop et al., 2023). In this project, we tested the prevalence of organisms to answer our hypothesis: There will be a reduced biodiversity after the rainy collection day.



New York State Open Data, 2020

Figure 1: This map showcases the locations of combined sewer overflow outfalls in NYC.

Experimental Questions

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Procedures

Collection Procedure

- We retrieved oyster cage, poured water through to flush out organisms within, and sifted through the water and sediment containing the organisms to pick out visible organisms, obtaining > 10 samples
- We placed these organisms in ethanol tubes to extract DNA to be sequenced.
- Organisms were gathered on 2 different days: once on 4/1, after a large rainstorm, once on 4/21 when there hadn't been rain for 5 days.

Chelex Extraction

- 1. Obtain tissue ~10 mg or ⅛- to ¼-inch diameter in size by removing a piece of the tissue with a razor blade, clean tweezers, scissors, or back of a 10-µL pipette tip to enable efficient lysis. Some organisms or samples will be small enough where the entire specimen should be used. If you are working with more than one sample, be careful not to cross-contaminate specimens. Be sure to preserve remainder of the organism, as well as additional collected specimens at -20°C, in 95%+ EtOH, or both.
- 2. Gently tap 10% Chelex solution tube on a hard surface to ensure the solution is at the bottom. Place tissue into Chelex tube and label tube with a sample identification number.
- 3. Twist a clean plastic pestle against the inner surface of Chelex tube to forcefully grind the tissue for at least 2 minutes. Use a clean pestle for any additional samples. Ensure the sample is ground into fine particles. Securely close the cap of the tube.
- 4. Incubate tubes at 98° for 10 minutes.
- 5.. The Chelex tube (or the tube containing the transferred supernatant) can be stored at 4°C temporarily or frozen at -20°C for long-term storage until ready to begin Part III. Alternatively, 2 µL of the supernatant from the tube can be used directly for PCR reactions. Do not transfer any of the white Chelex resin along with the supernatant (if you are pulling directly from the Chelex tube). This is a crude DNA extract and contains nucleases that will eventually fragment the DNA at room temperature. Keep the sample cold to limit this activity.

Data

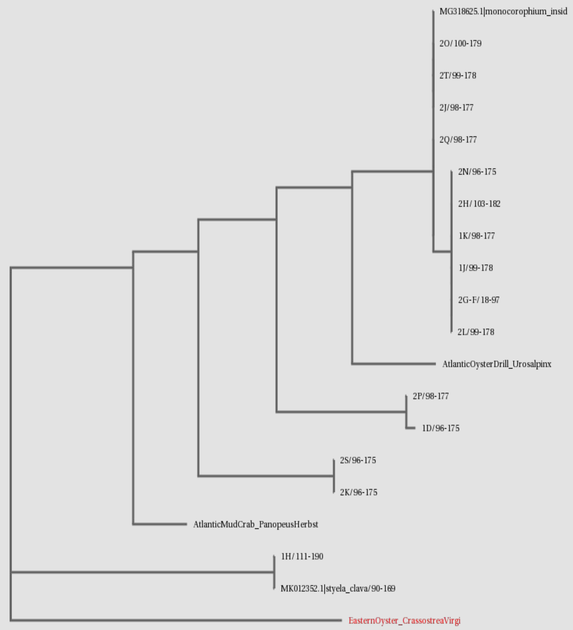

Figure 2: Cladogram of collection days 1 & 2, including some known ocean species to compare relatedness. Collection day 1 begins with a 1 and represents the species present after a rainy day. Collection day 2 begins with a 2 and represents the species present after 5 days of no rain.

Figure 3: A picture of a monocorophium insidiosum. The monocorophium insidiosum is an amphipod crustacean that plays a crucial role in ocean ecosystems, serving as food for fish and shrimp alike.

Conclusion

Our hypothesis was mainly supported that the biodiversity of the oyster gardens decreased after a stormy day. There was an overall decreased number of total organisms we discovered in our oyster garden during the rainy day (16 vs 10). Viewing our cladogram, we also discovered that most of the 2nd collection day species were on the same clade with a related species, monocorophium insidiosum (common name: insidious corophiidae) (see figure 2). This could indicate that higher trophic level species rely on this clade for as an energy source in ocean ecosystems. During the rainy day, a lack of any spotted organisms in this clade could indicate that higher organisms struggle to find food sources as a result of the combined sewage overflow poisoning related populations.

Potential Sources of Error

- The Chelex extraction method has varying success with marine invertebrates of different clades.
- There was only enough time for two collection days, potentially skewing data to selection bias since we only had 1 trial per collection day type.

Further Research

- Additional trials are necessary to accurately assess the effects of sewage overflow on the biodiversity and prevalence of marine organisms.
- Water quality testing is necessary to rule out the possibility of extraneous factors, such as competitive exclusion or other toxins unrelated to combined sewage overflows.

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