The significant and rapid effect of human activities such as urbanization, pollution, and overfishing on biodiversity in aquatic macroinvertebrate ecosystems

1: Massapequa Ames High School

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Abstract

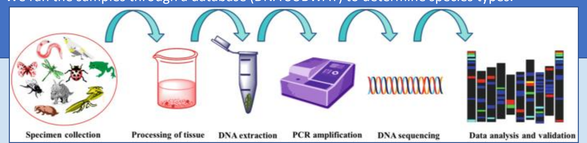
Through this scientific investigation, the amount of biodiversity in Massapequa Preserve, a temperate deciduous forest with shallow freshwater bodies of water, will be found to show the effect of human activity on their environment, specifically, aquatic invertebrates that reside within the creeks and ponds. Shovels, nets, and sifters were used to collect the specimens which were then drowned in alcohol to preserve their natural state. These findings are significant because they will prove the future of biodiversity differences and weaknesses due to unnatural outside activity like urbanization. In all, macroinvertebrate specimens from the water will be collected to obtain data on the effect of urbanization on levels of biodiversity---and that biodiversity may be scarce.

Introduction

The plan for collecting diverse and unique aquatic invertebrate specimens is to ultimately obtain a variety of them to observe and determine the biodiversity of the organisms within the Massapequa Preserve. Biodiversity relates to the variety of organisms within a particular habitat or environment. The level of biodiversity in specific areas and ecosystems will inform observers of the potential changes to the ecosystem caused by urbanization and be compared to historic sampling to see if any changes in biodiversity occurred.DNA barcoding is a vital method for finding biodiversity within the specimens. Finding DNA differences between already known species and the collected samples will help prove how biodiversity has changed and been affected by human activities like urbanization, overfishing, pollution, and land extraction such as mining in once-diverse ecosystems (Lamb, 2024). Extraction and degradation activities like this on the land also help contribute to global climate change, which is a further factor that affects biodiversity (Eastwood, 2023). Climate change then causes eutrophication in marine habitats which can lead to excess growth of plants and deteriorating growth of other organisms (Deng, 2024). Keeping biodiversity stable is vital to other organisms' health and if it continued to decline, human health would also be affected greatly (Marsell, 2021). A highly urbanized area such as Long Island, NY would have low levels of biodiversity which will most likely continue in trend.

Procedure

- On the side of the creek, nets were used to collect samples in the water.
- looked through the collected mud with small shovels to find organisms.
- GPS coordinates and photographic data collected.
- Organisms were put into alcohol-filled test tubes to preserve their DNA.
- Repeat procedure for collection sites 2 and 3.
- Used a small sifter to collect the organisms in the creek (second site)
- Samples were measured and photographed using handheld digital microscopes and cell phone cameras.
- Samples were stored at -20C until DNA extraction was to be performed.
- Use PCR (Polymerase Chain Reaction) to replicate and focus on small sections of DNA (CO1 gene).
- Run a gel electrophoresis experiment to validate the PCR method on the DNA strands.
- Used Sanger Sequencing to determine the nucleotide positions.
- We ran the samples through a database (DNA SUBWAY) to determine species types.



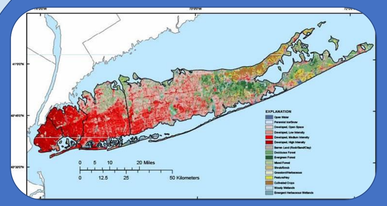
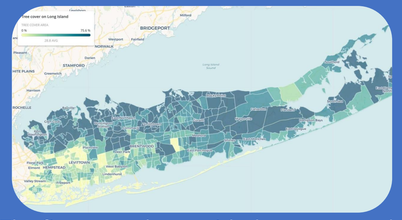
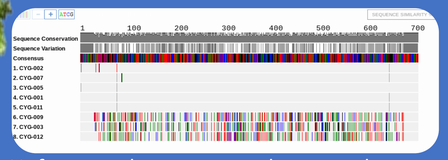


Fig. 1- Biodiversity on Long Island (Top: Urbanization) (Bottom: Tree cover)



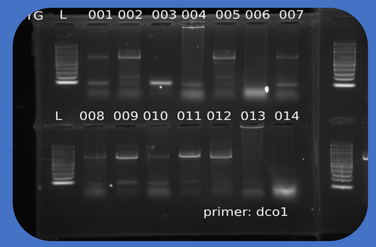
The first map above with the warmer colors represent the levels of urbanization on long island, and they directly correlate with the levels of tree cover in the area. In the massapequa region near Levittown, Freeport, etcetera, there are very low levels of tree cover compared to other regions and can display high levels of pollution and urbanization---which can degrade biodiversity of organisms.

Fig. 2- DNA barcode



Unfortunately, many samples were shown inconclusive when they were put into processing for barcoding and gel electrophoresis. However, of the samples that made it through, 4 of the 8 samples were the same species. In addition it could be said that 5 of the 8 samples were extremely similar, if not the same species.

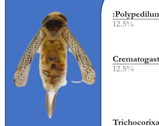
Fig 3. - Gel Electrophoresis test

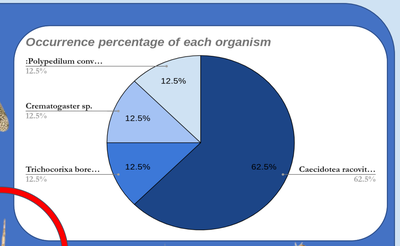


As shown in the gel that was run, samples 1, 02, 05, 07, and 11 belong to the Proasellus group and ⅘ have the specific *Caecidotea* species and *racovitzai genus.* The remaining 3 organisms have very different DNA from one another in both barcoding and gel electrophoresis (03, 09, 12). For more specification, 03: *Trichocorixa borealis*, 09: *Crematogaster cerasi/lineolata*, 12: *Polypedilum convictum.*

-1: Proasellus sp., *Caecidotea racovitzai*
-2: Proasellus sp., *Caecidotea racovitzai*
-3: Trichocorixa borealis
-4: Inconclusive
-5: Proasellus sp., *Caecidotea racovitzai*
-6: Inconclusive
-7:Proasellus sp
-8: Inconclusive

-9: Crematogaster sp., *Crematogaster cerasi*, *Crematogaster lineolata*
-10: Inconclusive
-11: Proasellus sp., *Caecidotea racovitzai*
-12:*Polypedilum convictum*
-13: Inconclusive
-14: Inconclusive
-15: Inconclusive
-16: Inconclusive

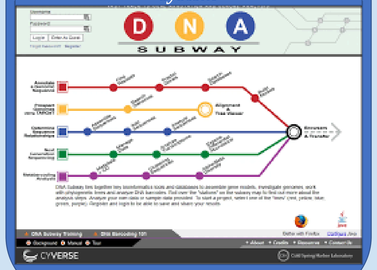




Discussion

As concluded in this experimental investigation, 5 out of 8 of the samples gathered and shown conclusive, shared extremely similar traits and are most likely the same species. This is an example of less biodiversity showing up in the preserves around Long Island. A lack of biodiversity can result in various negative environmental effects such as an imbalance in the food chain or food web, a vacancy in a niche, environmental instability, and increased risk of extinction for these macroinvertebrates. Even though small aquatic invertebrates are seen as insignificant in the large scale, a decrease in their populations over time can cause major problems for species to live healthily and fully. Large levels of biodiversity are essential for the continued life of these organisms and if we continue to urbanize without smart growth planning, we will also face challenges towards health and livability as well. DNA barcoding is an important tool for discovering how lack of biodiversity can threaten life in the future

DNA SUBWAY digital barcoding system



References

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