Assessing Invertebrate Abundance in NYC Wetlands

Emily Casper, Raquel Castromonte, Tafari Loyd, Suzanna Yates, Tina Zhou, Carol Henger, Lily Mleczko

Fordham University, Project TRUE

Introduction

Wetlands play a significant role on Earth, acting as storm buffers, animal nurseries, and water filters. Wetlands are especially important in urban areas like New York City (NYC) in which 460 CSO (Combined Sewage Overflow) discharge sites release raw sewage and stormwater into local waterways when treatment plants are overwhelmed.1 This, along with other aspects of urbanization, influences the many symbiotic relationships that play a vital role in maintaining the structure and productivity of wetland ecosystems.

For example, fiddler crab (Uca spp.) burrows encourage vegetative growth by increasing soil oxygen content. Similarly, Atlantic ribbed mussels (Geukensia demissa) serve as a buffer for plants, protecting them from severe weather conditions and erosion while providing nutrients to the soil.2 In return, salt marsh vegetation provides protective coverage from predators, food sources, and a stable environment for the invertebrates to form habitats. The goal of this study is to determine what environmental factors may influence the abundance of these invertebrate species, so that we can further understand urban wetlands.

Research Questions

Question: What is the difference in abundance of Uca spp. burrows and Geukensia demissa in CSO and non-CSO sites?

Hypothesis: There will be a lower abundance of Uca spp. burrows and Geukensia demissa in CSO sites, while there will be higher abundances at the non-CSO site.

Question: How does vegetative coverage affect the abundance of Uca spp. burrows?

Hypothesis: As vegetative coverage decreases, Uca spp. burrow abundance will increase.

Question: How does water quality affect the abundance of Uca spp. burrows and Ge. demissa?

Hypothesis: Uca spp. burrow and Ge. demissa abundances will increase with higher water quality.

Methods

We studied three different sites: Hutchinson River (HR), Spring Creek (SC) and Udall’s Cove (UC). SC and HR are associated with CSO discharge sites, while UC is not.

Quadrat Sampling

- We sampled 1m² quadrats at 5m intervals along a 50m transect that was placed along the intertidal shoreline.
- Total quadrates 31 (about 30 per site)
- We labeled and photographed each quadrat and plotted their GPS coordinates using “Easy GPS” app and Google Earth (Images 6-8).
- Within each quadrat, we recorded the abundance of Uca spp. burrows and G. demissa, and estimated percent cover of vegetation, water and litter.

Water Quality Testing

- We recorded abiotic factors (time, air temperature, luminosity and cloud cover) before testing water quality.
- We used a DO 6+ probe to measure salinity, water temperature and dissolved oxygen.
- We used a refractometer to measure salinity.
- We also used a LaMotte water quality kit to measure pH levels, carbon dioxide, nitrates and phosphates found in the water.
- Parameters were measured 3 times per site.

Results

Figure 1: Mean Uca spp. Burrow Abundance Across Sites

A one-way ANOVA was conducted to determine if there was a statistically significant difference in mean Uca spp. burrow abundance between sites (F(2,88)=3.66, p<0.05). Tukey’s post hoc test revealed that there was a statistically significantly higher burrow abundance at Spring Creek compared to Udall’s Cove (p<0.05). All other differences between sites were nonsignificant.

Figure 2: Mean G. demissa Abundance vs. Site

A one-way ANOVA was conducted to determine if there was a statistically significant difference in mean G. demissa burrow abundance between sites (F(2,88)=21.05, p<0.0001). A Tukey’s post hoc test revealed that there was a statistically significantly higher burrow abundance at Spring Creek compared to both Udall’s Cove and Hutchinson River (p<0.0001).

Figure 3: Uca spp. Burrow Abundance vs. Vegetation Cover Across Sites

A Pearson’s r value was calculated to assess the relationship between the average amount of Uca spp. burrows and the average amount of vegetation cover at each site. A parabolic trendline indicates higher burrow abundance at medium vegetation cover, although the low R² value implies a weak trend.

Figure 4: Average G. demissa Burrow Abundance at Spring Creek

The parabolic trendline indicates higher burrow abundance at medium vegetation cover. The 0.29 R² value indicates a strong trend in Spring Creek compared to all three sites combined.

Figure 5: Average G. demissa Abundance at Average Dissolved Oxygen

A Pearson’s r value was calculated to assess the relationship between the average amount of G. demissa and the average amount of dissolved oxygen. The R² value was reported as -0.3773 indicating a weak negative correlation.

Figure 6: Average Uca spp. Burrows at Average Dissolved Oxygen

A Pearson’s r value was calculated to assess the relationship between the average amount of Uca spp. burrows and the average amount of dissolved oxygen. The R² value was reported as 0.9599 indicating strong positive correlation.

Figure 7: Mean Uca spp. Burrow Abundance vs. Shoreline Loss

A Pearson’s r value of -0.9599 indicates strong negative correlation between Uca spp. burrow abundance and shoreline loss.

Discussion/Conclusions

Our results led us to reject our hypothesis. We hypothesized that there would be a higher abundance of Uca spp. burrows and G. demissa at UDall’s Cove compared to Hutchinson River and Spring Creek. However, our results indicate the opposite outcome. It is possible that the increased levels of nutrients coming from CSO sites like Spring Creek and Hutchinson River benefit the two species by increasing levels of food sources like algae. This is especially relevant for G. demissa which filters nitrogen, bacteria, and other suspended organic particles as it feeds.

Vegetative Coverage

In regards to the relationship between Uca spp. burrows and the vegetative coverage, we suggest that Uca spp. burrows are more abundant when there is medium plant cover (Figures 3 and 4). Therefore, our results indicate that burrow abundance increases with decreased vegetation. Vegetation, such as Spartina alterniflora and Spartina patens allow Uca spp. to make burrows in soft sediments, obtain a denitral food source, and have protection from predators. Medium cover might be favorable because lower vegetative coverage could risk exposure to predators, while higher coverage with thick root density would not produce adequate substrate for burrows.

Water Quality

Our results indicate that there was no strong correlation between the amount of dissolved oxygen and Uca spp. burrows (Figure 5) and between the amount of dissolved oxygen and G. demissa (Figure 6). Although studies generally show that marine life typically thrives under conditions where the dissolved oxygen is higher, our results contradict this. Our inability to find a relationship could potentially be caused by an insufficient number of data entries, varied locations of dissolved oxygen tests (within sites), and fluctuating tidal rhythms. In addition, both Uca spp. and G. demissa demonstrate a large tolerance for different levels of salinity, water temperature, and dissolved oxygen. Therefore, other factors such as erosion could have impacted these species more than water quality.

Future Studies

The lack of correlations between water quality parameters, vegetative coverage, and invertebrate abundance led to the conclusion that other environmental factors may be influencing our results. Erosion data supplied by NYC Parks Department indicates that Udall’s Cove is eroding at a faster rate (0.68 ft/year) than both Spring Creek (0.56 ft/year) and Hutchinson River (1.33 ft/year). Using our abundance data, we found that the average abundance of both Uca spp. and G. demissa negatively correlated with each site’s shoreline loss per year (Figures 7 and 8). Further research could help determine if erosion is influencing the invertebrate populations more than the factors we initially studied.

Acknowledgements

We would like to thank WCS, Project TRUE, and Fordham University for their partnership. We would also like to thank our site leaders, Lily Mleczko and Carol Henger, for their mentorship and guidance.

References