Examining edge effects in a living shoreline; Is predation of transplanted ribbed mussels, *Geukensia demissa*, higher at the marsh edge or interior?

• Abiola Saibu • Muntahi Mowla •
Mentors: Amanda Flores & Chester Zarnoch

R.I.P Britney the mussel you will be missed dearly

Introduction

- Salt marshes in Jamaica Bay are degrading due sea-level rise, sediment starvation, erosion, and excess nitrogen loading
- Restoration efforts include the construction of living shorelines to mitigate salt marsh loss
- Living shorelines rely on the recruitment of invertebrates and other organisms to meet reference ecosystem functions
- Cordgrass (*Spartina alterniflora*) and ribbed mussels (*Geukensia demissa*) share a mutualistic relationship where cordgrass provides protective shelter and mussels provide nutrients through biodeposition
- Ribbed mussels tend to live between the marsh edge and the marsh interior at varying densities
- Previous research has demonstrated that predation pressure is higher when prey live at habitat edges
- This study focused on the survivorship of transplanted ribbed mussels in different marsh zones within a living shoreline

Objectives

- Evaluate how edge effects influence mussel presence & survivorship
- Investigate the effect of fencing on transplanted ribbed mussel survivorship
- Determine the types of predators more likely to consume ribbed mussels

Study Site

- The living shoreline is located next to the West Pond at the Jamaica Bay Wildlife Refuge
- The experimental plots were situated between a wide mudflat and a dense forest
  - Thus, mussels have the potential to be exposed to both terrestrial predators (i.e. raccoons) & aquatic predators (i.e. blue crabs & mud crabs)

Figure 1: Map of the JB Wildlife Refuge; study site is framed in red

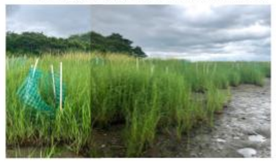

Figure 2: Position of plots within the Living Shoreline

Methods

Set-up

- 16- 0.25 m^2 plots were established in the marsh
  - 8 placed at the marsh edge; 4 with fencing & 4 open
  - 8 placed within the marsh interior; 4 with fencing & 4 open

Site Characteristics

- Stem density and maximum stem height were quantified to contextualize survivorship based on site characteristics
- Quantified the number of mussels present in each plot

Tethering Experiment

- Tethered mussels assembled with fishing line, electrical tape, and cyanoacrylate glue
  - Untethered mussels were painted with nail polish to track their location
- Placed 10 mussels (15-35 mm) per plot

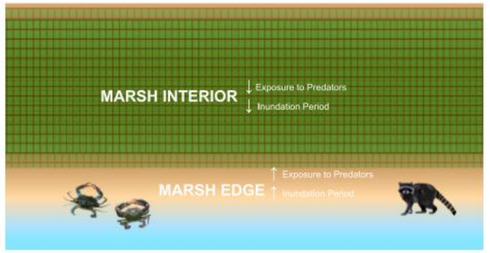

Figure 3: Conceptual diagrams demonstrating how edge effects influence predator-prey dynamics

Figure 4: Experimental plots at the West Pond Living Shoreline

Figure 5: Tethered mussels attached to landscape pins prior to deployment

Results & Discussion

Site Characteristics

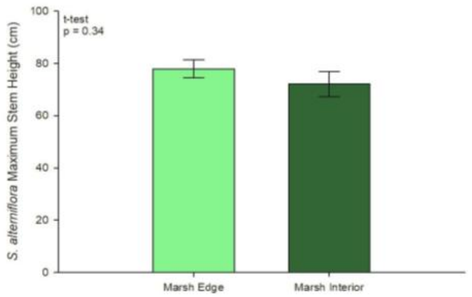

Figure 6: Maximum stem heights of *S. alterniflora* within experimental plots

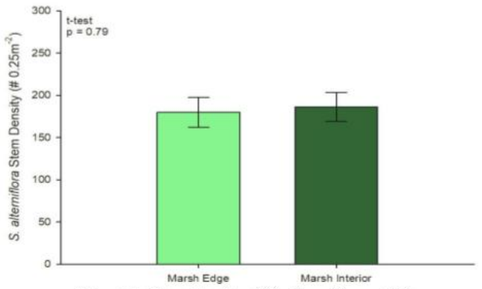

Figure 7: Stem density of *S. alterniflora* within experimental plots

- There were no significant differences between the maximum stem height (Fig. 6) nor the stem density (Fig. 7) at the marsh edge and marsh interior
- Despite this, the densities of ribbed mussels were significantly greater ($p = 0.04$) at the marsh edge as compared to the marsh interior (Fig. 8)
  - This is corroborated by past research, where highest densities of ribbed mussels are found at marsh edges in dense aggregations in natural marshes

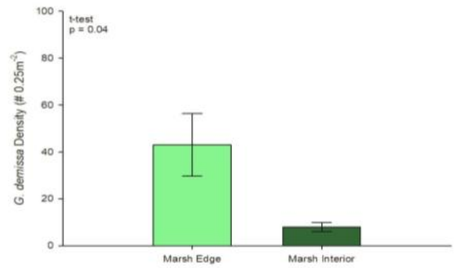

Figure 8: Ribbed mussel densities within experimental plots prior to tethering experiment

Results & Discussion

Tethering Experiment

- Upon retrieval, most shells were found in fragmented, crushed pieces within or around plots
  - Untethered mussel survival was highly variable among the plots with no significant effect of fencing nor habitat
    - Survival was higher in open interior plots (37%) as compared to edge plots (24%)

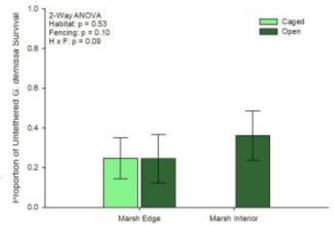

Figure 9: Surviving proportion of untethered ribbed mussels

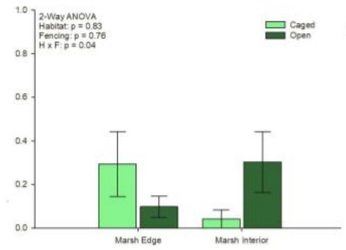

Figure 10: Surviving proportion of tethered ribbed mussels

- Tethered mussels survived best in two scenarios;
  - 29% survival in caged, marsh edge plots, &
  - 30% survival in open, marsh interior plots

- The mean size of recovered mussels was 28.5 mm
  - Coupled with the pattern of survival, these results suggest that the types of predators at the marsh edge may be different than those within the marsh interior

Summary

- Ribbed mussels transplanted to a living shoreline experience high risk of predation regardless of position within the marsh
- Fencing increases survivorship at the marsh edge but not within the marsh interior
  - Plant characteristics at the marsh edge and interior were similar and do not explain differences in survival
  - It is possible that the marsh edge has greater predation pressure and/or types of predators than the marsh interior
- Future experiments will employ different exclusionary material and trail cameras to identify specific predators

References

Bertness, M. D., & Grosholz, E. (1985). Population dynamics of the ribbed mussel, Geukensia demissa: The costs and benefits of an aggregated distribution. *Oecologia*, *67*(2), 192–204. https://doi.org/10.1007/BF00384283

Bilkovic, D. M., Mitchell, M. M., Isdell, R. E., Schliep, M., & Smyth, A. R. (2017). Mutualism between ribbed mussels and cordgrass enhances salt marsh nitrogen removal. *Ecosphere*, *8*(4), e01795. https://doi.org/10.1002/ecs2.1795

Carroll, J. M., Tettelbach, S. T., Jackson, L. L., Kulp, R. E., McCoy, E., & Peterson, B. J. (2022). Variability in site characteristics linked to bay scallop abundance but not tethered survival: Implications for restoration. *Journal of Experimental Marine Biology and Ecology*, *546*, 151663. https://doi.org/10.1016/j.jembe.2021.151663