Evaluating the combined influence of sediment and bivalve addition on microbial community composition and salt marsh resilience in New Hampshire

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Introduction

Salt marshes are resilient habitats yet are at risk of widespread loss from climate change. As sea level rise outpaces marsh accretion, restoration techniques that maintain elevation and preserve native vegetation are needed[1]. Sediment addition addresses this need via deposition of thin sediment layers on top of deteriorating marsh habitat. This method has been increasingly used throughout the U.S., but pilot studies are limited within New England.

Ribbed mussels (*Geukensia demissa*, **Fig. 1**) facilitate native vegetation growth and stabilize salt marsh sediments[2]. This suggests they may be useful in sediment addition projects, but this technique has yet to be studied. Sediment addition studies also have not yet incorporated analyses of soil microbial community composition throughout the restoration process.

Figure 1. Ribbed mussels and smooth cordgrass *(Spartina alterniflora).*

I will evaluate salt marsh response to sediment and mussel addition through a study in Great Bay.

- H_1: Sediment addition will initially disturb marsh vegetation, fauna, and microbes, but similarity to reference habitat will increase over time.
- H_2: Pairing sediment addition with mussels will reduce erosion and have a positive effect on plant biomass.

Methods

Five blocks of five experimental treatments (**Fig. 2**) were replicated in three marsh locations with distinct hydrologic regimes (**Fig. 3**).

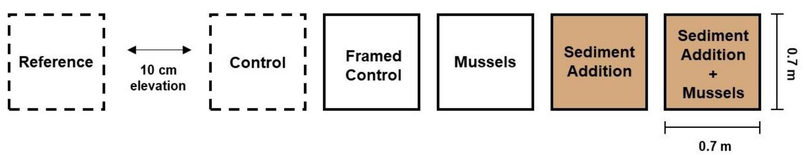

Figure 2. Experimental treatments (order randomized) by block.

Restoration took place in summer 2023. 14cm of quarried sediment was added to each sediment addition plot, consistent with prior research[3]. Ten mussels were collected from the marsh edge and added to mussel plots (**Fig. 4**).

This project has a Before-After-Control-Impact design, comparing pre- and post-restoration conditions in restored and reference marsh.

Figure 3. Block locations at Adams Point.

Figure 4. Ribbed mussel placement within a sediment addition plot.

Monitoring parameters include:

- **Elevation** (RTK GPS)
- **Hydrology** (water level recorders)
- **Vegetation** (percent cover)
- **Porewater chemistry** (pH, sulfides, salinity, redox potential)
- **Macroinvertebrate community composition**
- **Soil microbiome**

Pre-restoration data were collected in June 2023. Sediment samples for soil microbial community analysis were collected in October 2023. Post-restoration data will be collected annually and used to calculate the Restoration Performance Index[4].

Preliminary Results

Pre-restoration vegetation community composition (**Fig. 5**) was consistent between treatments; low marsh plots were dominated by smooth cordgrass and pool plots were dominated by bare ground. Reference plot reflected species composition expected at higher elevations.

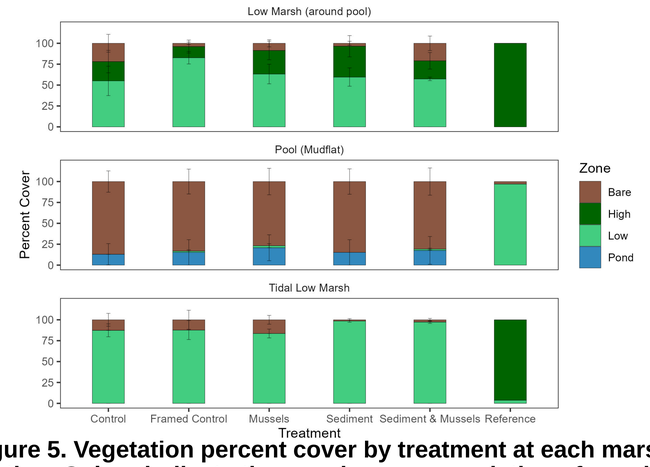

Figure 5. Vegetation percent cover by treatment at each marsh location. Colors indicate the marsh zone association of species.

Following restoration, sediment addition plots were significantly higher in elevation than controls and consistent with reference plot elevations (**Fig. 6**).

No significant differences were found in porewater chemistry among treatment plots pre-restoration, though a block effect was consistently noted.

Mussel survivorship from Aug. to Nov. 2023 was highest in paired sediment and mussel treatments within pool habitat and in mussel-only treatments within low marsh.

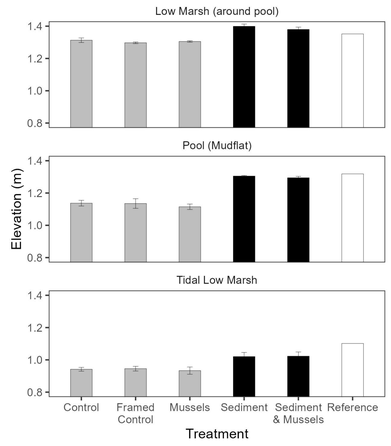

Figure 6. Post-restoration elevation by treatment.

Discussion and Next Steps

DNA extractions for October 2023 soil microbiome samples took place in fall 2023 through spring 2024. Additional sediment samples will be collected in spring 2024, and at one- and two-year timepoints post-restoration along with other monitoring parameters. DNA will be amplified using PCR and sequenced prior to community composition analysis. Mussel survivorship will be monitored monthly. The results of this study will provide data to the regulatory community that can be used to determine whether sediment and mussel addition can improve ecosystem services and should be used on larger scales to enhance coastal resilience.

Acknowledgements

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