The Effect of Restoration of Marshes on Shrimp Abundance

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Abstract

Shrimp are central to the food chains of numerous marine ecosystems. In salt marshes, they serve as detritivores, keeping the ecosystem running. Marsh restoration is the process of rebuilding marshes that have been destroyed/degraded by human intervention or natural events; this is done by restoring their natural tidal flow, re-planting native plant life, and removing invasive species. To assess the efficacy of restoration efforts, we compared the abundance and diversity of shrimp species in Randall's Island restored marsh and unrestored sandy shore. Samples were collected from the restored marsh and unrestored shoreline, and their DNA was sequenced to determine all present species. There was no detected difference in biodiversity between the areas, however, a greater abundance of shrimp was found in the restored marsh.

Introduction

Shrimp are diverse organisms with a wide variety of characteristics; most share several determining characteristics, making it hard to differentiate species without sequencing their DNA (Britannica, 2023). Shrimp are omnivorous scavengers, eating small crustaceans/marine invertebrates. They also rely on seaweed, grasses, and other debris for protection from predators (Britannica, 2023).

Randall's Island is located on the East side of Manhattan and contains a number of fields and parks. Within the park, there exists a restored salt marsh and an unrestored sandy beach. Restored salt marshes are productive ecosystems with a great abundance of tall grass (*Spartina alterniflora*). Such areas provide protection and food for a multitude of species (Waterfront & Natural Areas, 2023). The unrestored area lacks abundant plant life and rather contains debris/pilings, stones, and seaweed.

We wondered how Randall's Island recent restoration efforts would affect animal life in its bodies of water. We selected shrimp as our organism of interest as they -- particularly the *Palaemon vulgaris*, *Palaemon pugio, and Crangon septemspinosa*-- are traditionally found in abundance in salt marshes. We also conducted a visual phenotypic analysis to determine any defining characteristics, namely whether or not the shrimp had pincers.

Materials & Methods

- 45 shrimp were collected using seining nets
  - 16 were from Randall's Island unrestored shoreline and 29 from its restored marsh
- 15 samples from each group were randomly selected for visual phenotypic analysis (sorted into pincer and non-pincer) and amplification.
- Samples were taken from the abdominal segments on the dorsal side, or from brain, right above the stomach.
- Using a centrifuge, lysis solution, silica resin, and wash buffer, DNA was isolated
- DNA was amplified and through gel electrophoresis and products were analyzed
- In 19 samples DNA were detected /sequenced by Genewiz, and assessed using the BLAST program on the Cyverse DNA Subway database
- The identified sequences were then aligned using the MUSCLE program and entered into PHYLIP ML

Figure 1: Map of the Little Hell Gate Salt Marsh on Randall's Island indicating the locations of the collected samples. 16 samples were collected from the unrestored marsh, and 29 were collected from the restored.

Results

	# Shrimp Collected Unrestored	# Shrimp Collected Restored
Round 1	5	12
Round 2	4	8
Round 3	7	9
Total	16	29

Table 1. Shrimp Abundance Data. Shrimp were collected in the restored and restored sections of Randall's Island's Little Hell Gate Salt Marsh using a seining net. 29 shrimp were collected in the restored marsh and 16 in the unrestored.

Sample Number	Unrestored vs Restored	Forward/ Reverse/ Both	Aln Length	Bit Score	Species
KSQ-005	Unrestored	Both	651	1159	*Palaemon vulgaris*
KSQ-009	Unrestored	Forward	350	620	*Palaemon vulgaris*
KSQ-010	Unrestored	Forward	347	593	*Palaemon vulgaris*
KSQ-012	Unrestored	Reverse	40	73.4	*Eukrohnia hamata*
KSQ-016	Restored	Reverse	475	832	*Palaemon vulgaris*
KSQ-020	Restored	Reverse	379	648	*Palaemon vulgaris*

Table 3. Sequencing Data. Data shows the samples' places of origin, whether they were fully sequenced, alignment lengths, bit scores, and determined species. n=6

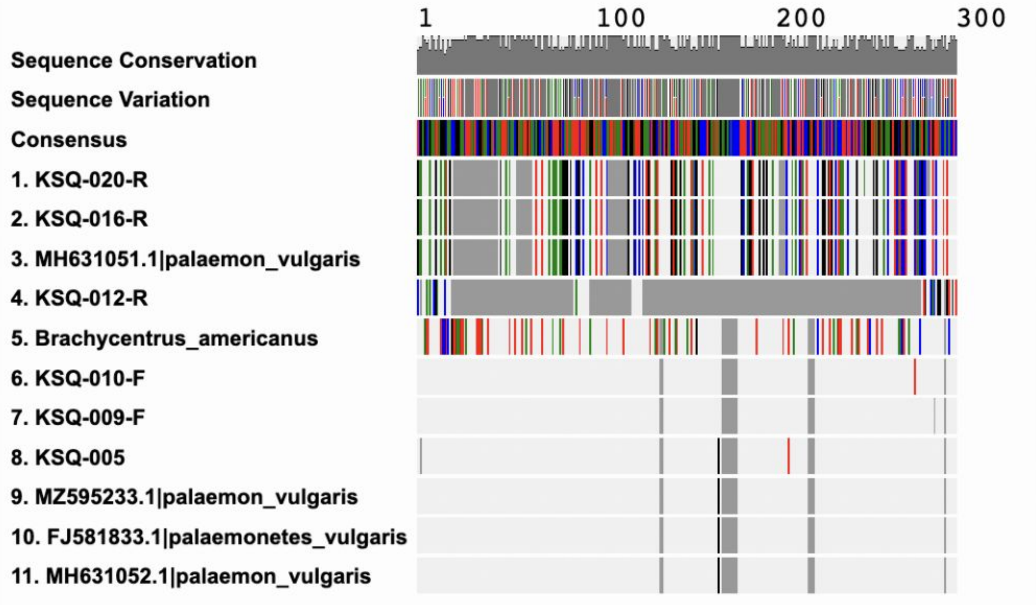

Figure 2: Trimmed Multiple Alignment Created By MUSCLE. This image shows 300 bp of sequence conservation, with the colors representing different nucleotides. Conservation is represented by gray and variation by white. Sequenced samples have high alignment with each other and reference sequences of *Palaemon vulgaris*, suggesting that this is the identity of the samples.

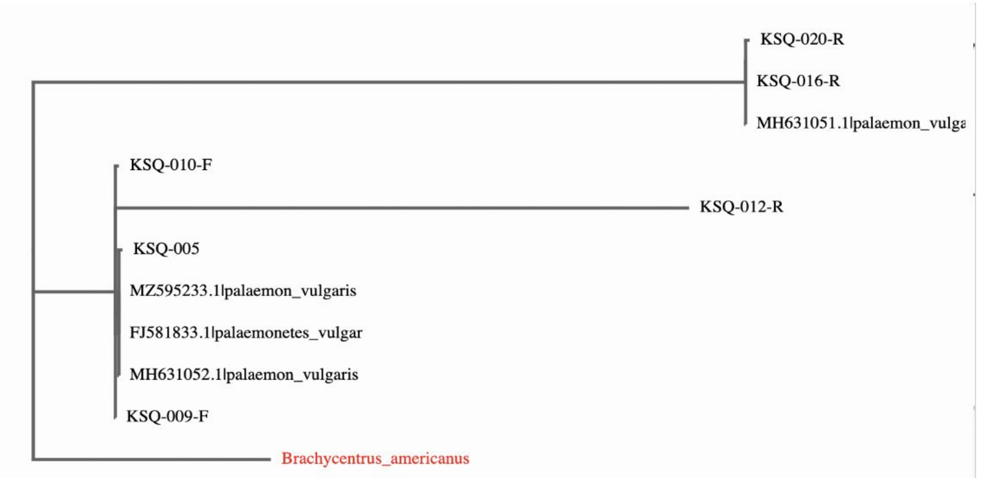

Figure 3: Phylogenetic Tree of Sequencing Results. Maximum likelihood phylogenetic tree displaying the evolutionary relationships between the identified species. The samples notably share similar evolutionary origins with *Palaemon vulgaris,* with the exception of KSQ-012, which was identified as *Eukrohnia hamata.* The species highlighted in red has the least genetic commonalities with the rest, functioning as the outgroup.

Discussion

- **We hypothesized that the restored marsh would have greater shrimp abundance and species diversity than the unrestored area. Our hypothesis was partially supported.**
  - Of 45 samples, 29 came from restored marsh, 16 from unrestored area
  - Only *Palaemon vulgaris* was identified
- The restored marsh = abundant plant life = more suitable living conditions for its organisms (food, protection from predators, etc).
  - *Palaemon vulgaris* prefer habitats with *Spartina alterniflora,* a common marsh grass
- The unrestored area = lack of vegetation = less suitable habitat = leading to lower abundance.
- In unrestored area: low-moderate certainty that a *Eukrohnia hamata* was present.
- Shrimp are known to eat small invertebrates like these; one may have been in shrimp's stomach and was accidentally detected in the DNA sequencing
- Potential Errors:
  - KSQ 001-KSQ 020 left outside of the freezer for two weeks. However, two of these samples were re-tested using gel electrophoresis and maintained positive results.
  - Labels of the samples were written in Sharpie; however, wore off in processing, so some were rewritten without complete confidence in their identity
  - Potential cross-contamination occurred en route to lab for sequencing
    - only obtained forward/reverse sequences for 1 sample
- Future Studies:
  - How an abundance of *palaemon vulgaris* affects the ecosystem
  - Role of *palaemon vulgaris* in both marshes ecosystems
- Significance:
  - Results indicate the importance of plant life in supporting shrimp life
  - Efforts to increase diversity = better conditions for both shrimp and other aquatic organisms.

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