Holey Crab! Assessing the Presence of Purple Marsh Crabs (*Sesarma reticulatum*) in NYC Wetlands

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Introduction

New York City is developing at a rapid rate, often at the expense of its coastal wetlands. Marshes act as the kidneys of our waterways, filtering pollutants brought by runoff, factories, and 460 CSO's (Combined Sewage Overflow). In addition to filtration, wetlands serve to shield the land from hurricanes, saving us about $23 billion in damage annually.[1] Wetlands are also some of the most productive ecosystems in the world and are inhabited by hundreds of species, many of which use it as a nursery.[2]

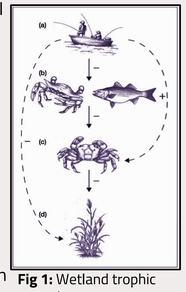

Fig 1: Wetland trophic cascade

One organism that lives in NYC wetlands is *Sesarma reticulatum*, the purple marsh crab, a nocturnal, herbivorous crab that feeds on smooth cordgrass, *Spartina alterniflora*. Recently, New England wetlands, such as those in Cape Cod, have seen significant amounts of their wetlands damaged due to *S. reticulatum* herbivory.[3] This damage is attributed to greater abundance of the crabs as a result of overfishing of *S. reticulatum*'s predators. Human disruption of the trophic cascade is causing damage to our coastal wetlands. However, not much is known about the presence and the effect of *S. reticulatum* on New York City wetlands. Therefore, this study set out to assess 4 different NYC wetlands for these organisms, test a new method of catching them, and analyze the effects of different environmental factors (invertebrate abundance, predator abundance, and DO levels) on their presence and abundance.

Research Questions

Question: Is *S. reticulatum* present at our four New York City wetland sites?
Hypothesis: *S. reticulatum* will be present at Pelham Bay Cove and Pelham Hutchinson River, where it has been well-documented. Udalls Cove and Spring Creek will not have *S. reticulatum* present.

Question: Which type of pitfall traps, funneled (2-Liter bottle) or non-funneled (tennis ball container) is better at catching crabs?
Hypothesis: The funneled (2-Liter bottle) pitfall trap will be more successful at catching crabs than the non-funneled (tennis container) pitfall trap.

Question: How does the presence of other invertebrates–fiddler crab (*Uca spp.*) and Atlantic ribbed mussels (*Geukensia demissa*)–affect the abundance of *Sesarma reticulatum*?
Hypothesis: As the abundance of *Uca spp.* increases, the abundance of *S. reticulatum* increases to a certain point, before declining. A similar trend would occur as *G. demissa* abundance increased.

Question: How does the presence of predators affect the abundance of *Sesarma reticulatum*?
Hypothesis: As the abundance of predators increases, the abundance of *S. reticulatum* decreases.

Question: How does the DO level affect the abundance of *Sesarma reticulatum*?
Hypothesis: The higher the levels of DO, the lesser the abundance of *S. reticulatum*.

Question: What is the effect of *S. reticulatum* abundance on the marsh grass (*Sp. alterniflora*)?
Hypothesis: The greater *S. reticulatum* abundance, the greater the percentage of predated *Sp. alterniflora*.

Methods

Quadrat Sampling
- 1m^2 quadrats areas were randomly sampled along the edge of the *Spartina alterniflora*, 360 in total across sites.
- Within each quadrat, we recorded the abundance of *Sp. alterniflora*, ribbed mussels (*G. demissa*), any visible crab species and predation on the *Sp. alterniflora*.

Water Quality Testing
- We used a DO 6+ probe to measure dissolved oxygen.

Predator Surveys - Birds & Crabs
- We used a 15m wide seine net to sample Atlantic Blue Crabs (*Callinectes sapidus*)
- We observed avian species using the point-count method: 2 people stood in the center of a 50m radius for ten minutes and used reference books and apps for identification purposes.

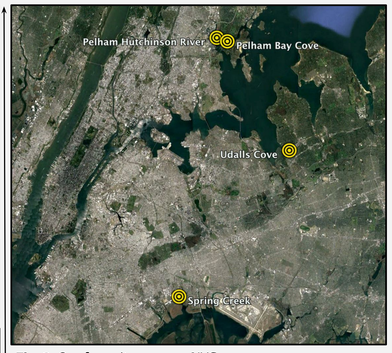

Fig. 2: Our four sites across NYC.

Pitfall Traps
- We randomly placed 20 pitfall traps at each site using both tennis ball containers and two-liter bottles and left them for 24 hours.
- We recorded the abundance of purple marsh crab/fiddler crab

Results

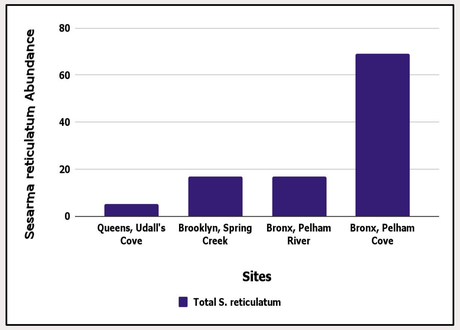

Figure 3: *S. reticulatum* Abundance Across Sites
The results show the differences in *S. reticulatum* abundance across sites.

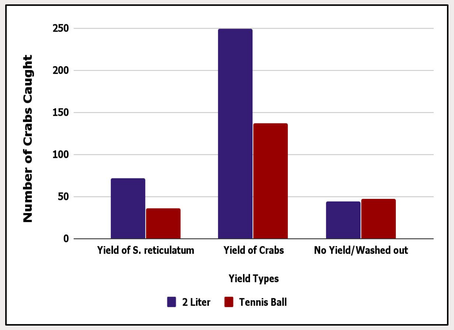

Figure 4: Comparison of the Two-Liter and Tennis Ball Traps
This graph shows the difference in crab catching success between the two-liter (funneled) and the tennis ball traps.

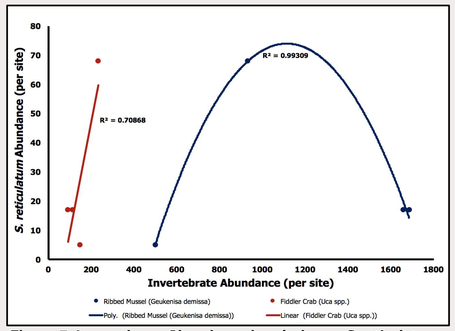

Figure 5: Invertebrate Abundance in relation to *S. reticulatum* Abundance
The trendline indicates a parabolic relationship between *S. reticulatum* and *G. demissa* abundance with an R^2 value of 0.9931, indicating a strong correlation. *S. reticulatum* and *Uca spp.* show a linear trend with an r value of 0.8418, indicating a strong direct relationship between the two abundances.

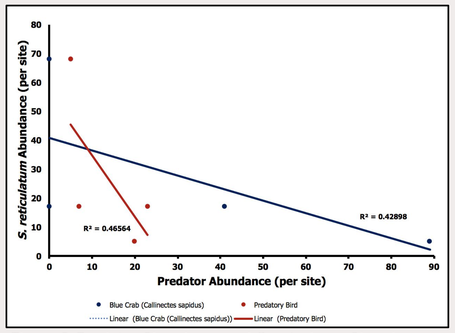

Figure 6: Predator Abundance and *S. reticulatum* Abundance
A Pearson's r value was calculated for the relationships between predatory bird abundance (*N. nycticorax, E. thula, A. herodias*) and *S. reticulatum* abundance & between blue crab (*C. sapidus*) abundance and that of *S. reticulatum*. The r value for predatory birds was -0.6823 and the r value for *C. sapidus* was -0.6549. Both values indicate a moderate inverse relationship.

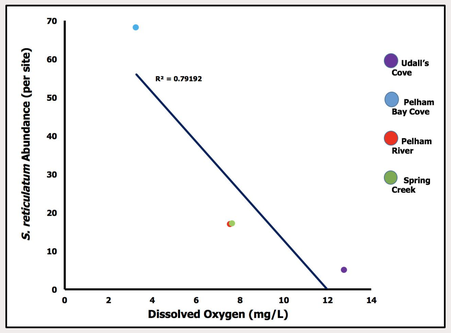

Figure 7: Average Dissolved Oxygen and Abundance of *S. reticulatum*
A Pearson's r value was calculated to assess the relationship between the average amount of dissolved oxygen and the total number of *Sesarma reticulatum*. The r value of - 0.8906 indicates a strong negative relationship.

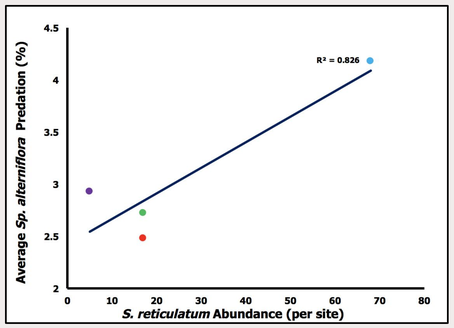

Figure 8: *S. reticulatum* Abundance and Average *Sp. alterniflora* Predation (%)
A Pearson's r value was calculated to analyze the relationship between *S. reticulatum* abundance and average spartina predation (%). The r value of .9088 indicate a strong positive correlation.

Discussion/Conclusions

***Sesarma Reticulatum* Presence**
Contrary to our hypothesis, *S. reticulatum* was found at all of our sites, even at Udalls Cove and Spring Creek. Furthermore, these less-researched sites had comparable quantities of purple marsh crabs to well-documented ones. At Spring Creek we caught 17 crabs, which is similar to what we caught at Pelham Hutchinson River.

Fig 9: Researchers emptying a 2L pitfall trap.

Funneled Pitfall Trap vs. Non-Funneled Pitfall Trap
The hypothesis that the funneled pitfall trap would be more successful than the prevailing non-funneled pitfall trap at catching crabs was supported by our data. Analysis reveals that the two-liter bottle yielded thirty-five more *Sesarma reticulatum* and seventy-seven more *Uca spp.* across all sites. However, the larger opening provided by the 2-liter trap may have skewed the results in its favor.

Invertebrate Abundance and *S. reticulatum* Abundance
We hypothesized that *S. reticulatum* and *G. demissa* would have a parabolic relationship. With less ribbed mussels, the ground is less stable for crab burrows, resulting in a decrease in *S. reticulatum* abundance. However, if there are too many ribbed mussels, there is less room for crab burrows, resulting in a decrease in abundance. We thought that there would also be a parabolic relationship between *S. reticulatum* and *Uca spp.* because of similar space-restraints; however, our results showed a direct linear trend. This implies a non-competitive relationship between the *S. reticulatum* and *Uca spp.*. This could be due to the fact that fiddler crab holes are more temporary and can easily be co-opted by purple marsh crabs. However, further research, with more variation in fiddler crab abundance, may show a more parabolic trend.

Predator Abundance and *S. reticulatum* Abundance
Our results support the hypothesis that as predator abundance increases, *S. reticulatum* populations decrease. This was seen at Udalls Cove, where we noted an increased number of predators, such as *C. sapidus* and predatory birds (*N. nycticorax, E. thula, A. herodias*), which was reflected in the scarcity of *S. reticulatum*. As we were able to catch blue crabs at only two of our sites, further research may show a stronger relationship between the two variables. Overall, without predator populations continually maintaining *S. reticulatum* abundance, *S. reticulatum* can devastate the *Sp. alterniflora*.

Fig 10: Purple marsh crab with 2 male fiddler crabs.

Water Quality and *S. reticulatum* Abundance
We hypothesized that there would be an indirect relationship between dissolved oxygen levels and the abundance of *S. reticulatum*. This hypothesis was based on research that points to the inability of their marine predators, such as striped bass (*M. saxatilis*), to thrive in environments low in dissolved oxygen. We found that our results support the hypothesis: the data shows that with increased dissolved oxygen, there are less *S. reticulatum*.

***Sp. alterniflora* Predation and *S. reticulatum* Abundance**
Analysis of the effect of *S. reticulatum* abundance on *Sp. alterniflora*, shows that as abundance of *Sp. reticulatum* increases, the average percentage of spartina predation also increases. This supports our hypothesis and merits future study.

Future Studies

S. reticulatum was observed at all 4 sites (UC, PC, HR, SC), providing an opportunity to observe the effect of *S. reticulatum* on the wetland itself. We began this process by recording crab predation evidence of *Sp. alterniflora* in our study sites. Our data shows that as the abundance of *S. reticulatum* increases, the presence of predated *Sp. alterniflora* also increases **(Figure 8)**. However, more thorough research is necessary to determine the extent of *S. reticulatum*'s effect on NYC marshes.

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References

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