Interpreting marine and terrestrial landscape effects on Atlantic horseshoe crab (*Limulus polyphemus*) nurseries

Cole Castillo
University of North Carolina at Chapel Hill, UNC Institute of Marine Science
ntcast@email.unc.edu

Abstract

This study investigates the impact of environmental conditions on the development of juvenile Atlantic horseshoe crabs (HSCs) in nurseries. By comparing protected and unprotected nurseries, the research examines how predator access affects juvenile growth and survival. Additionally, the influence of terrestrial landscape on nursery functionality is explored. The project combines aerial imagery and field measurements to analyze eight nurseries on Shackleford Banks, North Carolina. Using Geographic Information System (GIS) tools, the research aims to uncover patterns that affect nursery dynamics. The study addresses gaps in early-life HSC research, with implications for habitat conservation and the state of ecosystems.

Objectives

I aim to analyze the landscape effects on the functionality of juvenile Atlantic horseshoe crab (HSC; *Limulus polyphemus*) nurseries. By comparing intertidal, sandflat nurseries with and without adjacent, seaward oyster reefs (i.e., protected and unprotected nurseries, respectively), I hypothesize that protected nurseries will improve juvenile growth and survival by limiting predator access. I will also determine whether the terrestrial landscape affects nursery functionality. I hypothesize that nurseries with landward, sandy beaches (versus landward marshes and other habitats) will also have greater juvenile density because this habitat-type likely provides better spawning grounds for adult HSCs. To test these hypotheses, I will utilize a combination of aerial imagery and *in situ* measurements of each nursery.

Methods

During June to August 2023, I was stationed at UNC-CH's Institute of Marine Sciences in Morehead City, NC. We surveyed 8 nurseries on Shackleford Banks, NC, which comprised 4 protected and 4 unprotected sites, utilizing a paired/block design (Fig.1). Paired nurseries were strategically selected to be spatially close to each other to control for site-specific characteristics. The survey methodology involved placing 10m wide transects parallel to the shore. We then conducted juvenile size and number surveys within each transect using clam rakes, while also tracking the distinctive tracks left by horseshoe crabs (HSCs), which appear as three parallel lines in the sand. Additionally, we recorded the abundance of aquatic predators such as whelks, rays, and blue crabs within each transect. Mapping work was completed using ArcGIS Pro to generate map layers. The NC OneMap data served as a base map from which I created layers of point, line, and polygon information concerning juvenile population numbers, movement, and nursery areas. Furthermore, I had access to GIS shapefiles from a PhD student containing data on the 4 oyster reefs.

Results

For the first part of the project, I completed the preliminary mapping of all the sites on ArcGIS Pro. There are currently four reef sites mapped. The control sites have been unspecified on the map but exist next to their corresponding reef. Sites 3 and 4 are comprised of many more reef patches and occur at locations in which there is (visually) greater sandy shoreline, which is preferred for HSC spawning. Based on HSC survey data collected by Alexis Longmire (E3P PhD Student) during the summer of 2022, there was not a significant difference between the number of predators present at the unprotected sites vs. the protected sites. There was, however, more of a difference in HSC density when looking at the location of the sites, with sites 3 and 4 showing a greater density of HSCs. The next part of the project will look more closely at how the terrestrial environment may have more of an effect on HSC density than predator presence.

Figure 1. Map of Reef 1. The

Figure 2. Map of Reef 2.

Figure 3. Map of Reef 3.

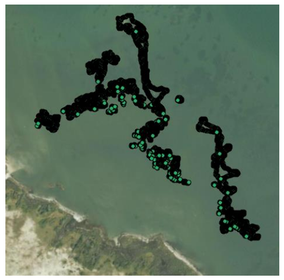

Figure 4. Map of Reef 4.

Conclusion

These results are important for site selection for scholars choosing to study similar marine invertebrates living on intertidal sand flats. When considering sites for study, the composition of the surrounding terrestrial landscape should be accounted for as I hope to prove (or disprove) with my ongoing analysis. Additionally, this portion of the project along with the investigations that follow could be beneficial for resource allocation relating to conservation. Some sites are better suited for conservation based on the density of HSCs and mapping allows for an easier visualization of the size and spread of the oyster reef sites.

These results are important for the general audience as it tells us where one might find a greater number of HSCs. Whether you are an invertebrate enthusiast or a fisherman with your sights set on these critters, mapping information is necessary for finding the sites and again for figuring out the size and spread of the reefs. For a greater chance at encountering HSCs, one would be advised to visit sites 3 or 4, rather than sites 1 or 2.

The next steps for the project would be to create a classification guide to categorize the different land types surrounding each of the reefs and their controls. Additionally, satellite or drone imagery would be ideal to acquire as the a more accurate classification could be done using such imagery.

References and Acknowledgements

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