Water Chemistry Reflects Health of Ocean Shoreline and Marsh of Fripp Island Through Bivalve Diversity

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Abstract

It is well known that bivalves are a great bioindicator to determine the quality of water in specific areas. Marine bivalves are also important to our economy, bringing in a total of 20.6 billion US dollars per year. Due to recent observations on Fripp Island's ocean shoreline and saltwater marsh, I proposed that the water chemistry of Fripp Island's ocean shoreline and marsh are affecting the diversity and richness of bivalves on the island. My hypothesis is that the pH of the water's chemistry is affecting bivalves' health along the ocean shoreline and marsh of Fripp Island. I collected sixteen samples from four quadrants of the marsh and four accesses along the ocean shoreline. Eight samples were taken knee/elbow deep in the water and eight taken along the shorelines. These samples were to determine the water's chemistry including pH, ammonia, nitrate, and nitrite at two different spots. By collecting these results, I was able to determine the pH of the water may be affecting the richness and diversity of bivalves in these areas.

Introduction

Fripp Island is a barrier island and is the outermost island of South Carolina. The island is estimated to be about 3,000 acres and is a very popular tourist destination. Fripp Island has one of the most drastic tidal changes that average at about six to nine feet. These qualities allow many different species to live on and around Fripp along with creating an adequate habitat for bivalves to thrive. According to fossil evidence, molluscs originated in the sea, and most of them have remained there. Only bivalves and gastropods moved into brackish and freshwater habitats but remained close to the shorelines where food was abundant and habitats varied (Hickman et al. 2001). Also known as pelecypods, there are approximately 15,000 species of this taxon found in marine and freshwater habitats throughout the world today (ADW 2001). Bivalves are filter feeders which limit them from moving onto land but their feeding habits allow them to filter out pollutants, such as heavy metals and microplastics, from the water. Bivalves hold an important role in the environment; they are considered an indicator species. If something were to change (e.g. water chemistry), they would be the first species to be affected by the change indicating that habitat is suffering.

Bivalve molluscs have been used to assess the levels of contamination in marine ecosystems, and certain genera and species, notably mussels and oysters, have been extensively studied in temperate waters (Paez-Osuna et al., 1993). Mussels, in particular, are very effective at removing an overload of nutrients. They have been used to re-establish particularly bad areas that are heavily polluted (Featherstone 2011). Unfortunately because bivalves are filter feeders and consume pollutants, humans are no longer able to eat them. This has raised concern for the fishing industry due to supply and demand. Demand for more protein packed foods has caused bivalve populations to suffer. Climate change and pollution have had major impacts on bivalve supply. Ocean acidification and filtration of pollutants such as heavy

metals and microplastics have made it hard for the fishing industries to keep production up to meet these demands.

Having a healthy and thriving bivalve population is crucial to our economy and ecosystems. In order to sustain these populations we need to maintain and create healthy water systems, including fresh and saltwater. The proposal is that the water chemistry of Fripp Island's ocean shoreline and marsh are affecting the diversity and richness of bivalves on the island. Increased amount of CO2 in the atmosphere initiates a set of chemical reactions in the oceans that lowers pH. As the ocean becomes more acidic, levels of biologically available calcium decreases, which is crucial for healthy mollusc shells. Clams, oysters, mussels, and scallops produce thinner and weaker shells when reared in low pH. Larval survivorship for oysters is reduced when ocean acidity increases (Hickman et al. 2001). My prediction is that the marsh has a neutral pH which in turn would support species richness among oysters and other bivalves typically found in saltwater marshes. My second prediction is that there will be more species diversity in the ocean than in the marsh around the island. These predictions, if proven wrong, would support the null hypothesis being that the water's chemistry is not the only factor affecting the diversity and species richness in these areas. The hypothesis was tested because Fripp Island is a heavily touristed area and we wanted to know if pollution is affecting the island's bivalve richness and species diversity.

Methods and Materials

To test the hypothesis, the ocean shoreline and marsh were divided into four quadrants each. Beach accesses 1A, 15, 19, and the end of Tarpon were used because it covered popular areas of Fripp Island's ocean shorelines (Fig.1). The marsh at the marina boat dock, two inlets at the farthest points of the marsh and the middle of the marsh were sampled (Fig 2). In each quadrant water chemistry was tested at the shoreline and at knee/elbow deep. In total sixteen samples were obtained; eight at the shoreline of the marsh and ocean and the other eight knee/elbow deep in the marsh and ocean. When sampling the ocean shoreline, the packing list included a ziplock baggie, pen, sharpie, field guides, waterproof booklet, and containers with lids to collect samples of water. In addition to these items, a kayak, paddles, and lifejacket was needed to collect from the marsh. The ziplock bag was for collecting different bivalve shells along the shorelines and the ones that were still alive were cataloged in a booklet. Each water sample was labeled with the correct quadrant and water depth to avoid confusion. Once at the Activity Center, water samples were arranged according to their proper quadrant and a chemistry test kit was used. The kit utilizes approximately 5mL per test tube for accurate readings. The test kit allowed readings for the ammonia, nitrate, nitrite, and pH of the water. Once these tests were completed they were put in an Excel spreadsheet for later comparison.

Fig. 1: Map of Fripp Island Ocean Shoreline with the different accesses used for testing.

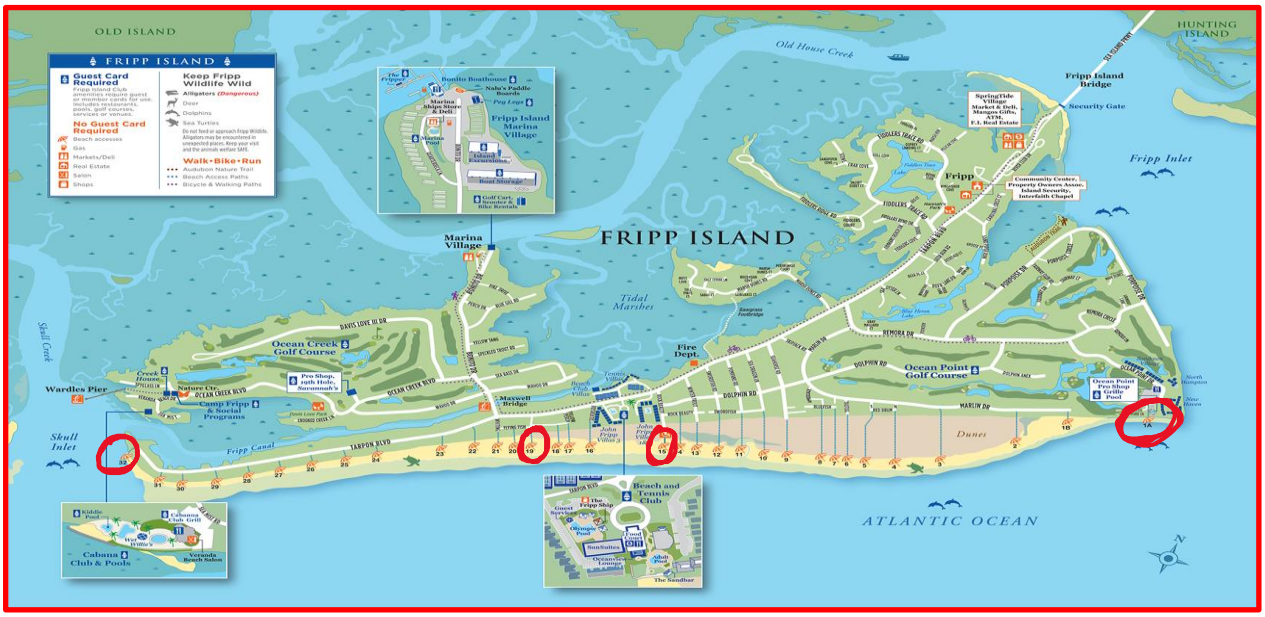
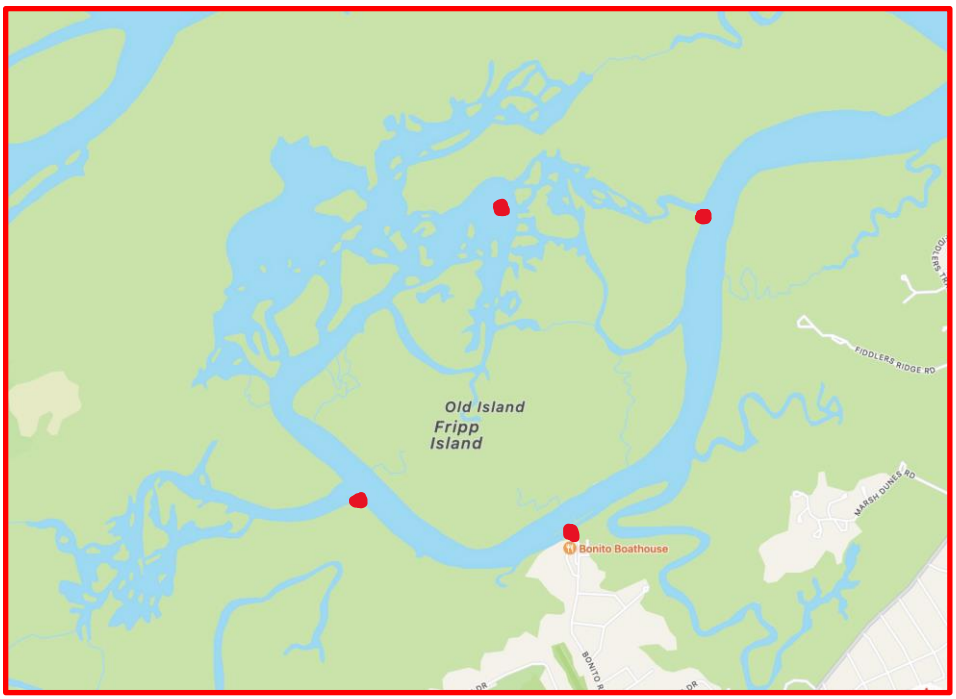
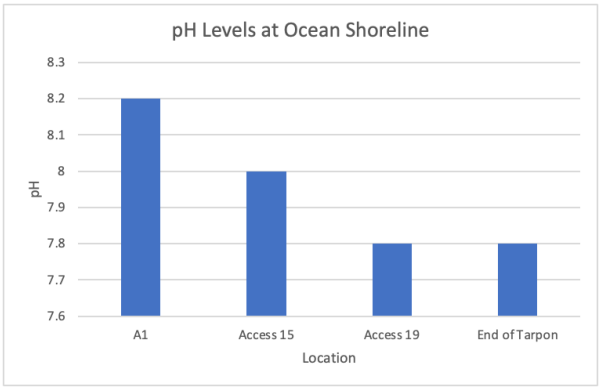


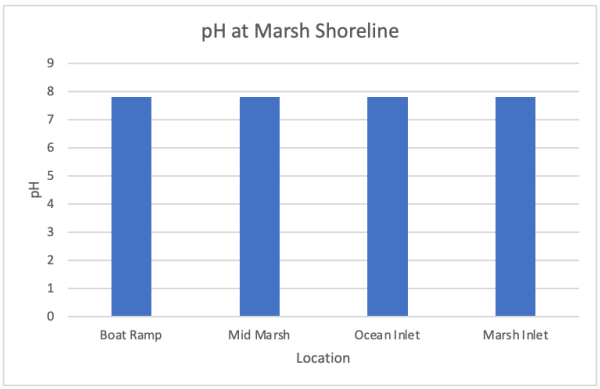
Fig. 2: Map of Fripp Island Marsh with the four points where samples were collected marked in red.

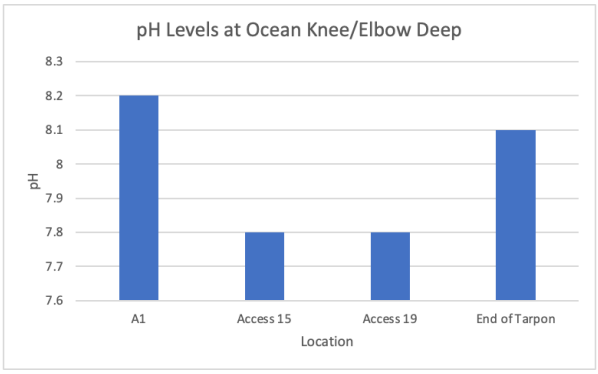


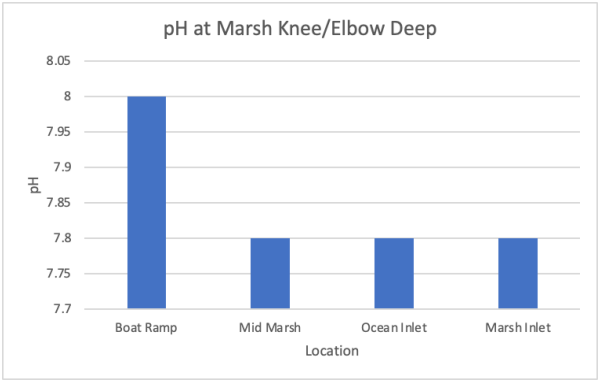
Results

Once all of the tests were completed and data was put into an Excel spreadsheet it was determined that the ocean's pH had a higher frequency of being neutral than the marsh. This being said, the first prediction of the marsh having a neutral pH compared to the ocean shoreline of Fripp is inaccurate. When comparing the shorelines and the knee/elbow deep samples to one another it can be concluded that the marsh has a slightly higher number of basic samples in regards to pH. The second prediction however was supported due to the collection of different species of bivalve shells found along the ocean shoreline. The marsh mainly inhabited oysters that could be seen mainly during low tide.









Discussions

After examining the results from the samples, it was concluded that the pH is not affecting the species richness and diversity of bivalves in the ocean and marsh ecosystems around Fripp Island. This means that our null hypothesis is proven to be true and other factors are also affecting the species richness and diversity in these areas. A limitation that could have affected the results of the study was the type of water chemistry test kit used. The test kit used is specifically designed to test water chemistry of fish tanks. A proper tool to use that could have picked up better on chemistry levels in the marsh and ocean is a spectrophotometer This device allows you to pick up on smaller molecules and allows for a more accurate reading in a larger body of water. This piece of equipment, however, is very costly and budgets put a limitation to

this. For someone who wants to continue this study in the future, another component that could benefit is finding a way to test the water's calcium levels. Calcium is a very important component for growth and directly affects the trochophore stage of the bivalves lifecycle. Overall, the study brought attention to the importance of bivalves in our ecosystems and their susceptibility to human impacts such as pollution and climate change. It would be interesting to see if the calcium levels are at proper levels and if there's a difference between the ocean and marsh. This would help determine if that is another variable that may be affecting the diversity and species richness in these areas.

Citations

1.) Boening, D.W. An Evaluation of Bivalves as Biomonitors of Heavy Metals Pollution in Marine Waters.

2.) Hickman Jr, Cleveland P., Hickman, Frances M., Kats, Lee B.. (2001). *Integrated principles of zoology* (Ed.10). New York: McGraw-Hill.

3.) Paez-Osuna, F., Osuna-Lopez, J.I., Izaguirre-Fierro, G. *et al.* Heavy metals in clams from a subtropical coastal lagoon associated with an agricultural drainage basin.

4.) Kellogg, D., & Faultin, D. G. (n.d.). *Bivalvia*. Animal Diversity Web. Retrieved July 2022, from https://animaldiversity.org/accounts/Bivalvia/

5.) Featherstone, A., & Taylor, A. (2011, October 3). *Bivalves as a way to improve water quality - conservation articles & blogs - CJ*. Conservation Jobs.