Growth of Benthic Communities in the Indian River Lagoon

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Abstract

Benthic organisms are organisms that grow in, on, or near the sea-floor. They are extremely important to the ecosystems in which they live due to the fact that a large number of them filter particulates from the surrounding water, and make up large parts of lower levels of the food chain. Particulates can be biotic or abiotic, and can potentially be harmful. Turbidity is a measure of how clear water is, and clean water tends to be less turbid. The goal of this study is to quantify the effect our organisms have on turbidity of the surrounding water. Through the deployment of man-made oyster mats and attaching them to dock pilings, benthic organisms will settle and filter the water in areas affected by overdevelopment.

Introduction

Growing quantities of pollutants in the Indian River Lagoon (IRL), located on the east coast of Florida, are extremely problematic. The IRL has changed drastically over the last 40 years. The Living Docks program proposes a solution to this problem. This program, founded by Dr. Robert J. Weaver and Dr. Kelli Hunsucker, uses oyster mats to increase the amount of benthic organisms that are present in the IRL. The Living Docks program revolves around the placement of oyster mats on pilings at docks along the coast of the IRL. The preferred method for facilitating the growth of benthic organisms is the oyster mat. Oyster mats are squares of plastic mesh with a width and length of two feet which have approximately 60 to 80 dried oyster shells zip tied to them. Participants add the dried oyster shells to the mats because the benthic community is largely composed of sessile organisms, which prefer to grow on a calcareous substrate (Weaver et al., 2018). The main benthic organisms that are the focus of the research are: barnacles, *Balanus amphitrite* and *Balanus eburneus*, and encrusting bryozoan, *Hippoporina Verrilli*. The purpose of this study was to investigate the relationships between water quality data and settlement of oysters, encrusting bryozoans, and barnacles.

Methods

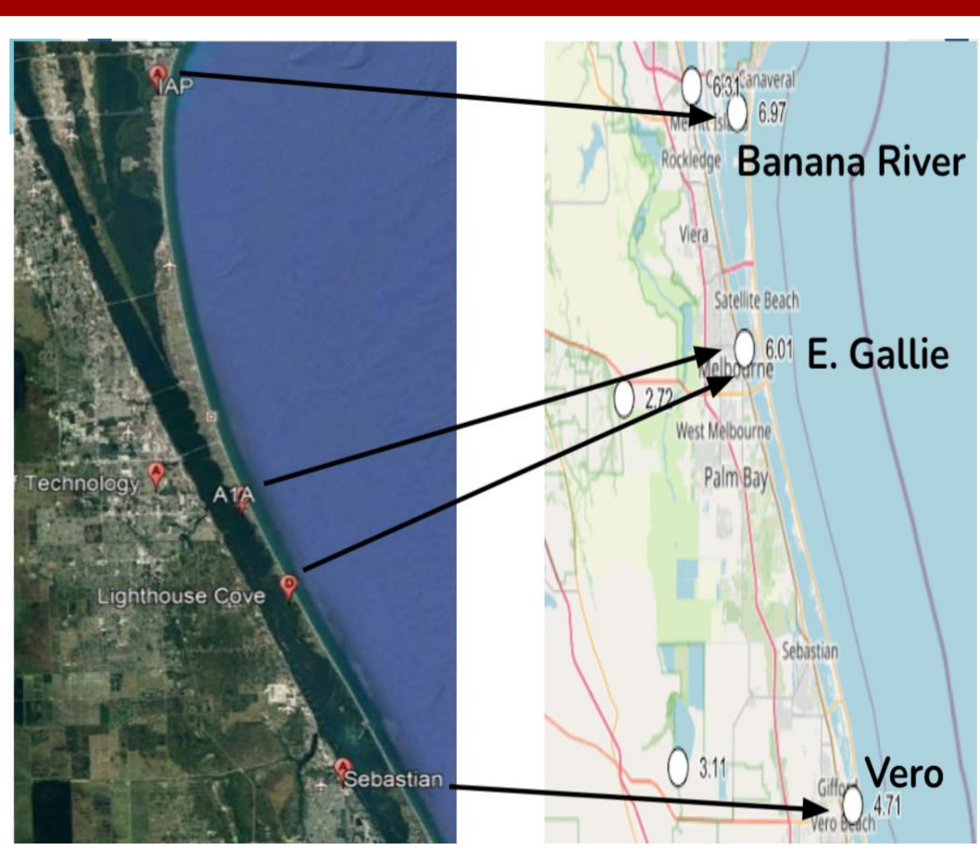

Figure 1. A map of the Living Dock locations and their corresponding water quality stations.

The water stations and their corresponding docks are represented by *Figure 3*. The water quality attributes taken from each station and used in regression were turbidity, water temperature, salinity, and pH. The researchers used the betareg package in R. Due to the nature of the Living Docks 2020 to 2021 percent cover data, linear regression was not applicable. Researchers used two types of link functions in modeling, the log link function and the logit link function. *Figure 2* illustrates the factors used in the beta regression model.

Over the course of the summer the research team conducted 4 assessments of the spread of the benthic community at 4 separate docks. The dock locations were A1A, IAP, Lighthouse Cove, and Sebastian. During the assessments, research participants used schematics of the docks to locate 6 oyster mats. The percent cover of organisms growing on the shells was recorded to represent settlement. Water quality data used to model settlement was collected from St. Johns River Water Management. Three locations were chosen corresponding to the locations of the four docks; these include Banana River, Eau Gallie, and Vero.

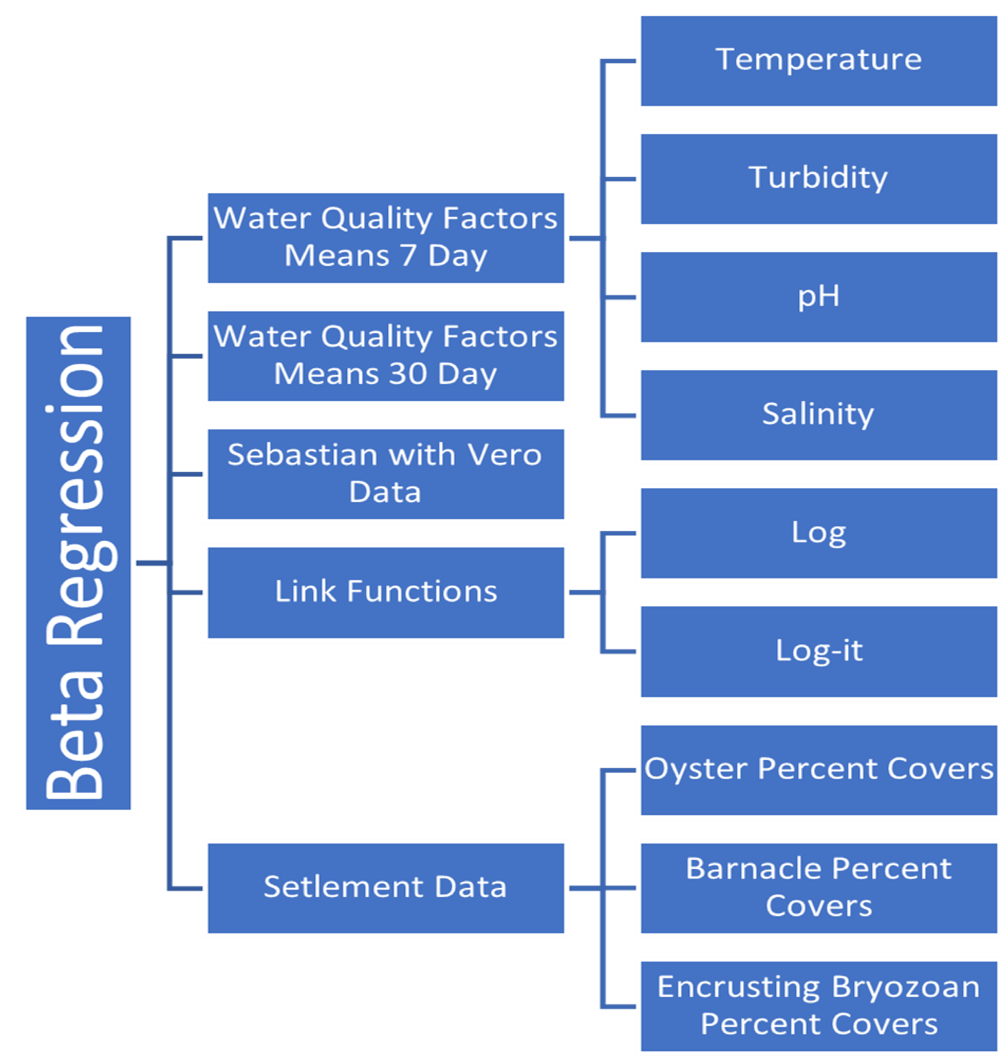

Figure 2. Flowchart describing beta regression performed

Barnacle Growth Best Models

Model	Pseudo r^2	AIC	p-value (phi coefficient)	Significant Observations
Barnacles ~ Dock + Season + pH + Salinity + Temperature + Turbidity, Log-link Function, 7-Day Means	0.2941	-602.9704	<2e-16	Dock, salinity, turbidity, almost season almost temperature
Barnacles ~ Dock + Season + pH + Salinity + Temperature + Turbidity, Logit-link Function, 30-Day Means	0.3098	-595.731	<2e-16	Dock, salinity, turbidity

Table 1. Barnacle growth Models with highest pseudo r^2 and lowest AIC

Oyster Growth Best Models

Model	Pseudo r^2	AIC	p-value (phi coefficient)	Significant Observations
Oysters ~ Dock + Season + pH + Salinity + Temperature + Turbidity, Log-link Function, 7-Day Means, Vero data for Sebastian	0.3555	-3032.185	<2e-16	Only dock and season significant
Oysters ~ Dock Log-link Function, 7-Day Means	0.352	-3039.451	<2e-16	Dock

Table 2. Oyster growth Models with highest pseudo r^2 and lowest AIC

Encrusting Bryozoan Growth Best Models

Model	Pseudo r^2	AIC	p-value (phi coefficient)	Significant Observations
Encrusting Bryozoans ~ Dock + Season + pH + Salinity + Temperature + Turbidity, Logit-link Function, 7-Day Means	0.3189	-2264.38	<2e-16	Dock, season, pH, salinity, almost temp almost turbidity
Encrusting Bryozoans ~ Dock + Season + pH + Salinity + Temperature + Turbidity, Log-link Function, 7-Day Means Vero data used for Sebastian	0.2997	-2265.164	<2e-16	Dock, season, pH and temperature significant

Table 3. Encrusting bryozoan growth models with highest pseudo r^2 and lowest AIC

Results

Tables 1-3 illustrate the organism settlement models with the best AIC or pseudo r^2 values. Pseudo r^2 explains variability within the data while the AIC values represent the best-fitting model. It is generally accepted that a good pseudo r^2 falls on the interval from (0.2,0.4). A good AIC value is generally accepted to be lower. The beta regression model with the best pseudo r^2 for modeling barnacle growth found that the most significant factors were dock location and the means for 7 days prior to the assessment of salinity and turbidity. These were also the most important factors in all models predicting barnacle growth. For modeling oyster settlement, all of the models suggested that dock location was the most significant factor. When modeling the growth of encrusting bryozoans, dock location, the mean for 7 days prior to the assessment of pH, season, and the mean for 7 days prior to the assessment of temperature were found to be significant. Encrusting bryozoans were found to be the only species sensitive to pH.

Conclusions and Discussions

Each of these models represent relationships which have biological significance. Dock location was the factor which had the greatest impact on the settlement of oysters. Based on settlement data collected within the IRL, the central and southernmost parts of the lagoon seem to foster more oyster settlement. For example, dock location IAP near Port Canaveral continue to produce less oysters on oyster mats through the duration of the assessments and is the northernmost location (Weaver et al, 2018). Acidity, measured in pH, was the factor which had the greatest impact on the settlement of encrusting bryozoans. Because encrusting bryozoan species *H. Verrilli* is a calcareous organism, the acidity of the water will greatly impact the growth. Increasing sea temperatures will result in increasing metabolic rates for these organisms, but ocean acidity associated with climate change can lead to the dissolution of this organisms' calcareous structured (Smith, 2014). These organisms also prefer cooler water temperatures to form their skeletons, and have seasonal preferences (Winston, 1995). Barnacle growth was significantly impacted by dock location, salinity, and turbidity. Barnacle feeding rates are dependent on the amount of total suspended solids in the water column. Barnacles also have preferred ranges of both salinity and temperature, which vary due to dock location. They can survive in temperatures as low as 12 degrees Celsius, but in order to breed they require water temperatures of at least 18 degrees Celsius (Vaas, 1978). This leads to barnacle populations having periods of recession and growth dependent on seasons. By modeling the settlement of these three organisms in the Indian River Lagoon, we were able to draw conclusions on how water quality factors affect organism growth and ultimately filtration.

References

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