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Testing for Dissolved Oxygen Concentrations in Water Surrounding Pine Island, Florida

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Abstract

An investigation was performed in the waters surrounding Pine Island, Florida to determine the levels of dissolved oxygen (DO) present in the water. It was suspected that areas with high human contact would have reduced levels of dissolved oxygen. Six test areas were selected for water testing and analysis through a colorimetric test procedure. The levels of dissolved oxygen would allow us to assess the general health of the water and evaluate the impact human activity had on water quality. Dissolved oxygen was found to be statistically stable and at acceptable, healthy levels throughout the Pine Island areas tested. Oxygen is a critical building block for healthy aquatic environments. It was believed that human activity would have a detrimental impact on level of DO in the waters around Pine Island. It is important to understand how the human activity on Pine Island is impacting the quality of the water and therefore the natural organisms in the immediate area. The study results did not support our original expectations; the levels of dissolved oxygen in areas of heavy human activity were similar to those in area of low on no-human activity and both areas had healthy levels of dissolved oxygen.

Introduction

Pine Island, Florida is the largest island in Florida (See Appendix A for topical representation of island) and supports a high number of pristine natural preserves while also sustaining concentrated areas of human habitation and activity. This study defined search areas that had heavy human contact and low or no-human contact and then measured the amount of dissolved oxygen present in the associated segments of water. Oxygen is essential for all aquatic life forms (Ping & Chuanxue, 2014). The level of dissolved oxygen in natural waters is one indication of water quality. Oxygen is naturally introduced by atmospheric activity like wind activity and waves (Verma & Singh, 2013) and is also as a byproduct of photosynthesis from aquatic plants and algae. Healthy aquatic environments require levels of DO higher than 5 parts per million (ppm) (Water Properties, 2014). Stress begins around 3ppm; levels below that have very limited ability to support aquatic life (Avant, 2013, Ping & Chuanxue, 2014). Fish and crustaceans require oxygen for respiration through their gills. Fungi and bacteria also require oxygen to decompose organic matter which is important for nutrient recycling (Schurmann & Steffensen, 1992).

Oxygen is a critical chemical element required for most organisms to exist (Ping & Chuanxue, 2014). This project was a study to determine if human activity had a negative impact on local water quality in relation to local marine ecosystem around Pine Island, Florida. It was expected that levels of dissolved oxygen in the water would be impacted negatively by human actions. This study investigated oxygen levels in two distinct areas of the island. Area I had dense human housing development as well as a high concentration of boat related activity. Area II had areas that were in a predominantly natural state with little or no human activity (refer to Appendix B for visual representation of the two different areas tested). The benefit would be to know if human's physical presence and activities have had a negative impact of the environment and health of animals near shore in this marine habitat. Pine Island has unique characteristics not found in many other areas of Florida. It is the largest island in the state with a lot of protection by barrier islands. In addition, Pine Island has significant proportions of land set aside and managed as natural habitats. The island area has distinct areas of heavy human density and activity which abut areas where native animals and fauna live in natural, undisturbed habitat. Comparing the levels of dissolved oxygen between the two areas could show the effect human presence and activity have on local water quality.

This study defined two distinct zones on Pine Island that represented areas of heavy human density and activity (Area I) and areas of low human or no-human density and activity (Area II). Three water samples were drawn at each area and measured for dissolved oxygen. The measurement method was performed with a Salifert O_2 Profi Test. This was a rhodazine D test method to determine levels of oxygen concentrations in parts per million. Liquid reagents would react with dissolved oxygen and display themselves in a rose-colored hue based on concentration. This type of test is referred to as a colorimetric test and is not affected by salinity in the water sample. Increased salinity and increased temperature can negatively impact the ability of water to dissolve oxygen. This test is also time-dependent in that testing must occur closely to the time the sample is taken. A primary testing decision after determining the study subject and scope was to select a method of water testing.

Method

The hypothesis was that there is less dissolved oxygen in the areas with heavy human contact than in the areas of low or no-human contact (Garg & Bhatnagar, 1996). In order to assess the levels of DO water samples would be taken and measured according to test instructions. We employed a basic method in which water samples were taken and then subjected to a colorimetric method of analysis with a Salifert O_2 Profi Test kit. This process takes a water sample and adds different reagents at various intervals which color the water; then the water sample is compared to a color chart (Appendix C). Three water samples in each area were collected and immediately tested for DO. Salinity was also to be tested at each site with a Pond Care chemical reagent salt level test kit. This kit was unable to detect any salt in the first three samples and was determined to be defective; no further salinity testing was performed. Temperature was also defined as a valuable parameter and testing was performed with a digital thermometer. This device failed to function when Area II was tested; therefore this parameter was omitted for the scope of the report.

Area I and Area II sample points (Appendix A) were accessed by kayak (Appendix D) at mid-tide. This was determined to be the best representative time for water current as tides were ebbing toward open waters and all test locations were accessible by boat. Three water samples were collected at each of the six main sites (Table 1) to promote an accurate average DO measurement (Javid, Yaghmaeian, & Roudbari, 2014).

Table 1: *Labels designating test site locations on Appendix A map.*

Test Area I:	1: Henley Canal
	2: Date Street Canal
	3: Monroe Canal
Test Area II:	4: Pineland Research Pier
	5: Bokeelia Canal
	6: Jug Creek Pier

The Salifert test process requires collecting 5ml of water and placing it in the test vial. Our collection was performed with a graduated syringe and placed into the test vial. Five drops of O2-1 were added and gently swirled for 20 seconds. Five drops of O2-2 were added and swirled for fifteen seconds. The sample was left undisturbed for three minutes. Then five drops of O2-3 were added with gentle swirling with each drop. The vial was then undisturbed for one minute. At this time the test vile was placed on the white surface of the test card and color matching between the test water result and the color chart provided by the manufacturer was performed. The chart shows incremental dissolved oxygen values from two to fifteen parts per million (PPM) in two ppm increments. All sample collection materials were then flushed with salt water to remove any existing chemical residue before the next test.

Results

The summarized results from the six data collection points are presented in Table 2. Initial observation of the raw data revealed a possible decrease in the measured amount of DO in the heavy human contact areas. It appeared that the numbers and averages in these areas were lower than in low or no-human contact areas of the study.

Table 2: *Test results averaged from each location*

Site	Dissolved Oxygen (ppm)
1 Henley Canal	6
2 Date Street Canal	6
3 Monroe Canal	8
4 Pineland Research Pier	15
5 Bokeelia Pier	8
6 Jug Creek	8

Table 3: *Raw collection data from multiple samples at each site*

Area I		Site	Sample 1	2	3		Average	
		1	6	6	6		6	
		2	6	6	6		6	
		3	6	8	8		8	
Area II		4	15	15	12		15	
		5	8	8	8		8	
		6	8	8	8		8	

The raw data in Table 3 would be used to validate our hypotheses. The author's hypothesis was that there would be a difference in the measured amount of DO in areas designated by heavy human contact and areas of low or no-human contact. The null hypothesis would be that there was no statistical difference in DO between the areas of heavy human activity and the areas of low or no-human activity. A T-Test was used to determine if there was a statistical difference between the two data sets. The result of the T-Test calculations (Table 4) confirmed that there was no statistical difference between the two data sets. The P-value of the two tail category of 0.270 is greater than 0.050. This allowed us to accept our null hypothesis and reject the hypothesis that human contact would have an effect on the level of DO in our test areas.

Table 4: *T-test computations of raw collection data to validate hypothesis.*

T-Test: Two-Sample Assuming Unequal Variances		
	Variable 1	*Variable 2*
Mean	6.666667	10.33333
Variance	1.333333	16.33333
Observations	3	3
Hypothesized Mean Difference	0	
df	2	
t Stat	-1.51097	
P(T<=t) one-tail	0.134952	
t Critical one-tail	2.919986	
P(T<=t) two-tail	0.269904	

Discussion

Dissolved oxygen is the amount of oxygen that is in the water and available for organisms to use. The amount of dissolved oxygen present in water can be affected by salinity, temperature, water flow, and biological activity (Verma & Singh, 2013). Below a certain point life is not supportable (Water properties, 2014). The null hypothesis stated there would be no difference in the level of dissolved oxygen between the area designations of heavy human contact and low or no-human contact. It would seem logical that natural areas would be healthier than areas that were subjected to biological impacts from fertilizer, automotive runoff, and human water based activities (Pihl, Baden & Diaz, 1991). The data collected so far does not support that theory. We expected to confirm the hypothesis of this study that there would be a difference.

The value of the data is highly dependent of the accuracy and consistency of the test procedure. The colorimetric test process employed for this study allowed highly subjective decisions in determining the color value of the test sample. Multiple observers were enlisted to test water following the directions from the manufacturer. Interpretations of how to perform the test and evaluate the resulting color were not consistent. The water samples from Area I taken at the Monroe Canal (3) had higher levels of oxygen very similar to the sample locations in Area II and unlike the levels of the other Area I canals. Here are a few possible reasons for this disparity. Testing on those samples may have been performed improperly or the water sample may have been excessively agitated during the test. Another possibility is the test was interpreted incorrectly as discussed previously. A third possibility could be that the water patterns in this area carry waters from Area II into Area I and it has not yet been depleted of oxygen by area activity (Touchart, Bartout & Azaroul, 2012).

Water collection and testing was a difficult process. The kayak provided a very good means to access remote areas for testing but it was a less than desirable platform for the actual test procedure. It was hard to maintain position in the water and manage the test. The kayak was also a very unstable platform in the presence of other water craft. Boat traffic would regularly rock the kayak making it more difficult to handle the test vials and reagents while bobbing around in the water and working within the narrow confines of the kayak cabin space.

Action and Reflection

A noticeable difference in the levels of DO was expected between the defined areas of heavy and low human contact. We would expect many of the activities people exercise in this area to alter DO levels (Schurmann & Steffensen, 1992). Motor boat contaminates in the water, fertilizer discharge into watersheds and canals, habitat disturbance, and septic leakage are some examples (Water Properties, 2014). Based on the results of this study, the impact human activity currently exerts on the area of Pine Island is not cause for concern to the health of the marine environment in relation to levels of dissolved oxygen. This is a welcome outcome.

This study would benefit from retesting the locations with a more accurate instrument like a digital DO meter. This study would also benefit from testing the water at different times of the year (Pihl, Baden & Diaz, 1991). Water levels, weather action and human activity all vary greatly throughout the year (Haider & Ali, 2013). Performing this test throughout the year would provide a truer representation of the DO levels and the health of the environment (Manivanan, Sinha & Kanetkar, 2013, Javid, et al., 2014).

It is also recommended that testing be performed in a more stable platform like a motorboat and with a partner. There were a number of safety issues and testing procedural issues that would be improved by having a more stable and visible vessel. Safe control of the kayak was not possible while measuring and timing water samples. Approaching water craft in the heavily traveled canals made it difficult for one person to execute the testing. This study determined that human contact is not measurably detrimental as was expected based on the results of one test period. This offers encouragement that oversight and regulations are working to protect this marine environment. It was expected that in areas of heavy human activity the level of dissolved oxygen would be lower than in areas in which the area remained natural and untouched. Dissolved oxygen levels in areas impacted by human activity should be monitored. For healthy coexistence it is important to understand the impact human activity places on natural environments.

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Appendix A

Topical representation of Pine Island, Florida showing test site locations numbered 1 through 6.

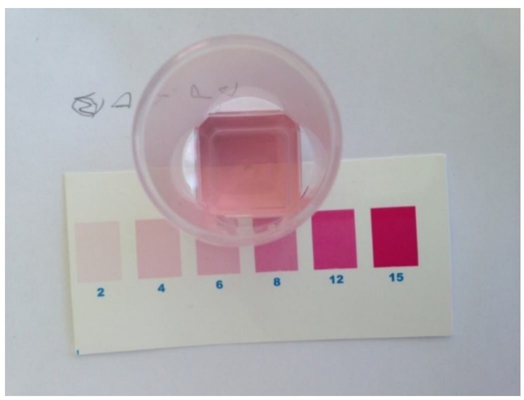
Appendix B

(1) Two photographs of Area I, dense human habitation and activity on Pine Island

(2) Two photographs of Area II, low or no-human impact

Appendix C

Test vial containing complete water test alongside color matching sheet.



Appendix D

Kayak was the access method used to collect and test water samples.