An Examination of Hurricane Joaquin’s Impact on the Red Mangrove Prop Root Biota of Oyster Pond in San Salvador Bahamas

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Hurricane Joaquin’s Impact on Oyster Pond

Abstract

Our research was conducted in Oyster Pond on San Salvador Island, Bahamas, to study Hurricane Joaquin’s impact on the biota of red mangrove (*Rhizophora mangle*) prop roots, with a focus on macro algae and invertebrates. We hypothesized that there would be a decrease in the number and variety of organisms attached to the mangrove prop roots. Two transect lines were used to observe 16 samples using a 0.25 meters-squared quadrat to study the biota. Surface water grab samples were also collected to analyze water chemistry. Previous data for pH, salinity, and nutrients (nitrate, nitrite, and ammonia) showed little to no change in water chemistry 6 months after the hurricane. The dominant invertebrate species found on the prop roots was the black mangrove oyster (*Isognomonzen alatus*) which contrasts with previous studies reporting the burnt mussel (*Brachiodontes exastas*) as the dominant species. Dominant macro algae on the prop roots were *Batophora oerstedii* and *Acetabularia* (*crenulata* and *calyculus*), and previous studies reported a larger variety of macro algae with a more even distribution. This study provides evidence that the red mangrove prop root biota is recovering, and is currently less diverse and less abundant than pre-hurricane conditions.
Introduction

Hurricane damage provides a solid foundation when it comes to research due to the fact that it physically initiates a change. San Salvador, Bahamas, was devastated by Hurricane Joaquin in October 2015 and allowed our research group the chance to study the effects of the island and its ponds pre and post hurricane. Although there has been little research done on the island of San Salvador itself, especially concerning its ponds, there has been some research about hurricanes affecting other bodies of water in the Caribbean. It is hard to compare hurricane damage accurately between locations since the extent of the aftermath of hurricanes depends on the duration, intensity, and velocity among other factors; however, generally, the effects are highly similar since hurricanes are consistently one of the most physically disruptive forces on environments (Skip et al., 2005; Beltran-Torres et al., 2003).

One of the most common indirect effects concerning bodies of water comes from all the rainfall associated with a hurricane which lowers the salinity levels of the water resulting in an increase in species diversity and water chemistry change (Beltran-Torres et al., 2003; Park et al., 2009). In Salt Pond on San Salvador, bivalves, seeds, forams, and gastropods are all among the species that have the potential to be swept into other bodies of water during a hurricane which plays into the species increase post-hurricane (Park et al., 2009). Furthermore, macro-algae cover increases as more disturbances in the water occur since hurricanes have the ability to alter the functions and compositions of communities, at least in patch reef communities (Beltran-Torres et al., 2003; Park et al., 2009). Previous research shows just how difficult it is to generalize results from one hurricane to another, and the closest study mimicking Oyster Pond was done by Peirels et al. (2003). This study concluded that water chemistry would return to normal after the hurricanes passed through as well as the fact that there were changes within the composition of
algal species which is consistent with our hypothesis (Peirels et al., 2003). A plethora of other effects arise from hurricanes as well, but these are the effects that concern our research.

Interior ponds are an excellent spot for research due to the fact that they contain a variety of information in one spot. Despite the fact that they are physically isolated from the ocean, they contain conduits which allow for ocean water to run directly into the ponds. Conduits provide salinity to the interior ponds contributing to species richness within the ponds. Common species in saline inland ponds include different algae, mussels, gastropods, small fish, bivalves, and multiple plants (see Figure 4 for some visuals). Of these common species, our species was on the red mangrove prop roots along the coast of the pond. Mangroves are a type of tree that provides food and shelter to different species as well as catching sediment for land building. The abundance of information found in interior ponds assisted our studies as we began to research.

Concerning interior ponds, we focused on the biota of the mangrove prop roots in Oyster Pond in San Salvador pre versus post Hurricane Joaquin. Due to the fact that little research has been conducted in San Salvador Ponds gave our group the chance to begin filling that gap in the research. Doyle et al. (1992) is one source that has found studies concerning hurricane effects on other islands and land masses that relate specifically to mangroves. It concluded that mangrove species are susceptible and vulnerable to hurricane disturbances, so this allowed a small reference point for our studies (Doyle et al., 1992). We believed that there would be a decrease in the number of species surrounding the red mangrove prop root biota in Oyster Pond and were looking for evidence to support or disclaim this hypothesis.
Methods

Initially, our group hiked the entire loop south of the Gerace Research Center, formerly known as the Bahamian Field Station (view Figure 1). After this initial visual survey of the surrounding environment, we returned to Oyster Pond traveling from the west trail (towards the Lucayan Route 2). Once we arrived on March 14th in 2016, we did a visual snorkel of the pond to get a feel for the lay out as well as the environment. We returned the next day (March 15th) and began to collect our first batch of data. At first, we measured 25 meters south of the pond entrance with a Lufkin 100m measuring tape and tagged the red mangrove prop roots at every five-meter interval. We repeated this process for the North side of the pond entrance. Once finished, the tape was placed aside, and we retrieved dive slates and Ziploc bags to begin sampling and surveying the prop roots.

As slowly as possible, as not to disturb the flock, we approached each root or set of roots at the five-meter intervals. We placed a 0.25 meters-squared quadrat against the roots beneath the water’s surface. One member would give a verbal estimate of the percent coverage of each visible species of algae and invertebrates while two others would right down the information on separate dive slates. After the visual survey, another group member would collect a sample of each algae species visible on the root and place them in a Ziploc bag to be examined under a microscope later. This process could take up to five minutes as the visual surveyor would have to wait for the flock to settle before giving an accurate estimate. This process was repeated for every five-meter interval north and south of the pond entrance. After a quick lunch break, our group made a secondary trip to collect more data. For this portion, we added 15 meters to both the North and South sides of the entrance for a total of 80 meters measured from the entrance (40
on each side of the entrance). We replicated the visual survey and sampling process from the previous trip. To view a visual representation of this process, see figure 2 below.

Once all data was collected we returned to the Gerace Research Center to examine the samples collected and review the visual survey information gathered. Alex Schwartz used a pH meter, a salinity refractometer, and marine water testing kit to determine the chemistry of water samples gathered by Dr. Dawn Ford, Jalana Abernathy, and Sabrina Novak while we were doing our visual survey. A pluggable USB microscope connected to a laptop was utilized to view and photograph the algae samples, and excel was utilized to summarize and analyze the data collected from the visual survey. The biggest limitation to our survey was time. We were unable to do this data collection process for the entire circumference of the pond, and we were unable to repeat the process multiple times to affirm that our data was free of error. It was also incredibly difficult to obtain a large sample of the bushy algae species covering most of the prop roots as the layer was thin, fragile, and covered in floc.
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(Figure 1; this map demonstrates the trail most used by our group; the red star marks the trail to the entrance of Oyster Pond. Map courtesy of R. Laurence Davis et al. from the University of New Haven, 1994)
(FIGURE 2; the above visual demonstrates the sections we sampled, the order they were sampled in, and the direction traveled from the entrance; visual created by group member Ashlyn Pack, 2016)
Results

Using the above methods, the group collected data on the visual percent coverage of each species as well as a count of every observable species connected to or nearby the red mangrove prop roots the group observed. The group also collected multiple water samples to test if there was a drastic change in water chemistry. Sample one collected had a pH of 7.45, a salinity of 35 ppt (parts-per-thousand), and 0 known nutrients. Sample two collected had a pH of 7.63, a salinity of 36ppt, and 0 known nutrients. Table 1 summarizes the majority of the visual survey data by marking ‘X’ in each cell where the species was observed and leaving a blank cell if the species was not observed. The data determined that in 2014-2015 prior to the hurricane there were fourteen observable species, and in 2016 there were only eight observable species. *Batillaria minima* and ‘eggsacks’ were two species not found in 2014-2015; while in 2016, there were eight species missing or unobservable. The final column reports the average percent coverage of each species from the post-hurricane observations. Verbal communication with Dr. Dawn Ford determined that the overall percent coverage of each species was less than what was observed in 2014-2015. The percent coverage from our 2016 observations can be seen in the bar chart labeled Figure 3. The dominant invertebrate species were *Isognomen alatus* and *pinctada longiquamosa* (pictured in Figure 4). Both known species of *Actabularia* were found in the pond, and microscope photographs of each can be seen in Figure 3 to show the distinct difference in the shape of each species. The overall coverage of each observed root (or set of roots) was lower than the previous observations recounted to us by Ford and Abernethy (2014, 2015), and the species richness of the observed areas had significantly dropped since Hurricane Joaquin.
<table>
<thead>
<tr>
<th>Observed Species</th>
<th>Pre Hurricane Ford and Abernathy 2014-15</th>
<th>Post Hurricane Group Observations 2016</th>
<th>Average Percent Coverage Post Hurricane 2016</th>
</tr>
</thead>
<tbody>
<tr>
<td>Batillaria minima (snail)</td>
<td>X</td>
<td>X</td>
<td>2.5%</td>
</tr>
<tr>
<td>Eggsocks</td>
<td>X</td>
<td>X</td>
<td>10%</td>
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<tr>
<td>Isognomon olatus (black mangrove oyster)</td>
<td>X</td>
<td>X</td>
<td>9%</td>
</tr>
<tr>
<td>Pinctada longisquamosa (scaly pearl oyster)</td>
<td></td>
<td>X</td>
<td>10.3%</td>
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<tr>
<td>Unknown hydroid</td>
<td>X</td>
<td>X</td>
<td>12.5%</td>
</tr>
<tr>
<td>Acetabularia calyculus (green algae)</td>
<td>X</td>
<td>X</td>
<td>48.7%</td>
</tr>
<tr>
<td>Acetabularia crenulata (green algae)</td>
<td>X</td>
<td>X</td>
<td>48.7%</td>
</tr>
<tr>
<td>Anadyomene stellate (green algae)</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Batophora oerstedtii (green algae)</td>
<td>X</td>
<td>X</td>
<td>60.7%</td>
</tr>
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<td>Cladophoropsis macromeres (green algae)</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dasys crovaniana (red algae)</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dictyosphaeria ocellata (green algae)</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Microdictyon marinum (green algae)</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pedobesta lamourouxii (red algae)</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Polysiphonia subtilissima (red algae)</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spyridia spp. (red algae)</td>
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<td></td>
<td></td>
</tr>
<tr>
<td><strong>Species Richness</strong></td>
<td><strong>14</strong></td>
<td><strong>8</strong></td>
<td></td>
</tr>
</tbody>
</table>

(TABLE 1; the above table is a visual comparison between the observation of Dr. Ford and Jalana Abernathy with the observations of our group in 2016 as well as the percent coverage of the species our group observed, 2015-2016)
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Average Percent Coverage
Post Hurricane 2016

2.50% 10% 9% 10.30% 12.50% 48.70% 60.70%
Batillaria Eggsacks Isognomon Pinctada Hydroid Aceabularia Batophora

(FIGURE 3; this bar chart visually demonstrates the percent coverage of each species observed post-hurricane; this was created via Microsoft Excel by group member Ashlyn Pack, 2016)
(FIGURE 4, side by side comparison of black mangrove oysters (*Isognomen alatus*) and scaly pearl oysters (*Pinctada longiquamosa*); side by side comparison of *Acetabularia calyculus* and *Acetabularia crenulata*, 2016)

Discussion/Conclusion

Our observations determined major changes in the number of species observed. We also found that there was a significant change in the bivalve species as black mangrove oysters heavily dominated while no burnt mussels were observed. This contrasts with data found in 2005-2007 by Cole et al. where Oyster Pond was dominated by burnt mussels. Our data shows some parallels with the observations of Cole et al. (2005-2007) where they found some changes in the biota of Oyster Pond post-hurricane and compared to the massive changes in other interior ponds like Little Granny Pond. It was also observed that compared to Rothfus (2008-2010) and Cole, Hoft, and Campion (2005) there was no drastic change in water chemistry. It is hypothesized that Oyster Pond has some natural protection from the hurricane’s damaging effects, and more research could be done in the future on the biota of other sections of prop-roots in the pond. Pictured below are some photographs of the visual changes of the pond (Figure 4).
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(FIGURE 4, side by side visual of the pond’s prop roots before and after the hurricane; before photos provided by Dr. Ford and Jalana Abernathy, and after photos taken by Alex Schwartz, 2014-2016)
References


Tanner, E. V. et al. 1991. “Hurricane Effects on Forest Ecosystems in the Caribbean.” *Biotropica*