A Study of Primary Productivity of *Thalassia testudinum* in the Northeast Region of Dominica Using CARICOMP Methodology

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Abstract:

CARICOMP methodology was used to measure the primary productivity of *Thalassia testudinum* seagrass beds in the Commonwealth of Dominica, using water quality measurements, taking core samples, laying out quadrats, taking growth measurements, and biomass calculations were used to collect this data. The data are compared to other CARICOMP studies to determine the productivity and health of the seagrass bed. The study showed that the site had ideal conditions to support a productive seagrass community.

Introduction:

Caribbean Coastal Marine Productivity (CARICOMP) is a regional scientific program and a network of marine laboratories, parks, and reserves that focuses on understanding and comparing the structure and function of mangroves, seagrasses, and coral reefs (CARICOMP, Vol. 3). We chose to center our project around the CARICOMP method because the data collected will be beneficial and relevant to the CARICOMP database, as no prior research has been conducted in the Commonwealth of Dominica. Due to time constraints and limited accessibility to all three habitats, we chose to focus solely on the seagrass portion of the project.

Throughout the Caribbean there are several species of seagrass, however CARICOMP focuses primarily on *Thalassia testudinum,* commonly known as turtle grass. Characterized by its broad leaves and shallow distribution, it plays a key role in the primary productivity in coastal zones in the tropics, and is one of the more dominant species in the region. Productivity of *T. testudinum* varies between seasons, reaching its maximum during summer months and its low during colder months. It can sustain environmental stresses to an extent, however distribution is limited by temperature, pH, salinity, and turbidity (Dineen 2001).

Site Characterization:

Dominica is in of the Windward Islands in the Lesser Antilles volcanic arc, located at 15.25 N, 61.20 W. The Atlantic Ocean lies to the east, while the Caribbean Sea is located to the west. At 750 km^2 in total land area, Dominica is 29 km at its maximum width and stretches 47 km from north to south (Meditz and Hanratty 2009).

With a coastline of 148 km, the waters around Dominica are very diverse. *T. testudinum* beds are located along the north and east coasts of the island in areas that are sheltered from disturbances such as bays and back reef areas. Seagrass beds in Dominica are generally small compared to other areas due to a steep and narrow shelf that limits light and doesn't provide protection from disturbances such as waves and storms (ITME).

Our study site is located at 15.59290 N, 61.35436 W on the northeast side of the island near the town of Calibishie. It is located in a shallow bay called Porte-la-Fin and is protected on the left by steep cliffs. Roughly 100 meters off shore there are two large rock outcroppings,

together named “Angel Rock”, that partially shield incoming disturbances from the north. Because our site is located on the Atlantic side of the island, northeast trade winds have a significant effect on current patterns, which bring energy into the bay. However the presence of a fringing reef and Angel Rock limit the extent to which the currents influence the seagrass beds (Appendix 1, Figure 4). From the shoreline out to Angel Rock water depths range from zero to three meters. These depths are ideal for T. testudinum growth because they allow ample light for photosynthesis (ITME). The sediment in the area is characterized by sand, small pebbles, rocks, and calcified materials.

Vegetation in the bay consists of sea moss, *Thalassia,* and another type of seagrass, *Syringodium filiforme*. Marine animals at the site include: brittlestars, sea urchins, a variety of small fishes, coral, anemones, and occasionally turtles.

Methods and Materials:

On May 27, 2009, we began the initial portion of our project on primary productivity of seagrass beds in Dominica. Our team of four students took a variety of measurements to assess the productivity of *Thalassia testudinum* located in Porte-la-Fin bay, near the town of Calibishie.

Two areas of dense *Thalassia testudinum* beds that were representative of the entire area were selected as our two station sites. These stations were approximately 28m apart with a depth no greater than 0.5m. Within each station, three 10cm x 20cm quadrats were set at random, and each was given a name pertaining to its station number and quadrat number (e.g. S1Q1, S2Q4). Each corner of the quadrats were marked by a thin metal rod and flagging tape. Once the corners were marked, the total number of *Thalassia* shoots were counted in each quadrat to determine density.

Next, eight live shoots within each quadrat were randomly chosen to be hole-punched at sediment level. When multiple leaves were stemming from one shoot, the leaves were aligned and marked with a single punch. This method was used to measure the rate of growth when the hole-punched shoots were collected at a later date. This will be done by measuring the distance from the base of the leaf to the marked hole.

Adjacent to each quadrat, five shoots were arbitrarily plucked from the base of the bundle sheath, and placed in plastic bags labeled with the site and quadrat numbers. In cases where the

sheaths were buried, we dug through the sediment in order to collect a complete sample. A total of thirty shoots were collected.

Three core samples were taken at each station, one for each quadrat. The corer used was made from a PVC pipe that was 11cm in diameter and 60cm in length. The pipe was fitted with rebar to serve as handles. The base of the corer was cut with a hacksaw into varying sized, tooth-like, serrated edges (Appendix 2, Figure 5). The corer was pushed and rotated as deep into the sediment as the rocky soil would allow, to collect samples of both above ground and below ground plant material. The average depth of each cut was 35cm. Once the corer reached its final depth, we capped the top with a plastic plug to create suction. We then pulled the corer out quickly, removed the plug, and emptied its contents into a bucket. Using large strainers, we removed the rock, sediment, and unnecessary species so that only *Thalassia* materials remained. The plant matter was then separated into Ziplocs labeled by site and quadrat numbers.

Next we secured the HOBO data logger in the bay. We situated the HOBO approximately 9m west of our second site at 15.59302 N, 61.35464 W. We attached the device with rope to a submerged boulder and used a red plastic float to denote the site. The HOBO data logger recorded the varying water temperature every 30 minutes for the next six days.

We used a water quality monitoring system developed by Hydrolab to take measurements of water parameters at the site. With this system, we took ten sets of measurements along the seagrass beds. All readings were taken at 0.5 meters. Each reading contained measurements of time, depth, temperature, salinity, dissolved oxygen, dissolved oxygen percentage, specific conductivity, pH, and turbidity. All readings were saved and recorded.

In the laboratory, we made weigh boats of varying sizes out of aluminum foil, numbered each one, and took their empty weights. These weights were to be subtracted later from the final weights of the boats when combined with biomass. To ensure that the boat weights were not affected by any outside moisture, we placed them all in the laboratory's drying oven for three hours and weighed them again, noting any changes.

Next, we separated each core sample into two groups: Above (shoots and leaves) and Below (rhizomes and roots). We then subdivided those groups into alive-above, alive-below, dead-above, and dead-below plant matter, resulting in a total of 24 groups. Each of the six alive-above groups were soaked in a bath of 10% hydrochloric acid to remove epiphytes and calcified materials. These six groups were then washed thoroughly with freshwater to remove excess acid.

Each of the 24 groups were then placed in individual pre-dried weigh boats. Then, all of the boats were loaded into the electric drying oven for 10 hours at 80°C. In the morning, we reweighed a cluster of boats every 30 minutes for 2.5 hours to determine whether or not their weights had stabilized. The weigh boats remained in the oven because the heavier boats were still displaying changes in weight. After a total of 24 hours, all of the boats were removed from the drying oven and final weights were recorded.

The samples that were collected adjacent to the quadrats and stored in plastic bags, were washed off with freshwater in the laboratory. After being rinsed, each shoot was separated into individual leaves from youngest to oldest. Age was determined by length of leaf, shortest being the youngest, and longest being the oldest. We then measured the length and width of each leaf and recorded the data. This procedure was repeated six times for each of the quadrat samples. This information will be used to determine a leaf area index.

On June 2, we returned to the Porte-la-Fin site to follow up with the second part of the project. The first thing we did was performed a site characterization. To do this we took several photos of the surrounding area, including photos from the top of the cliff located to the west of our site. We also recorded the movement of the currents through the area as best we could by visual observation. Species diversity and sediment type was also recorded at this time.

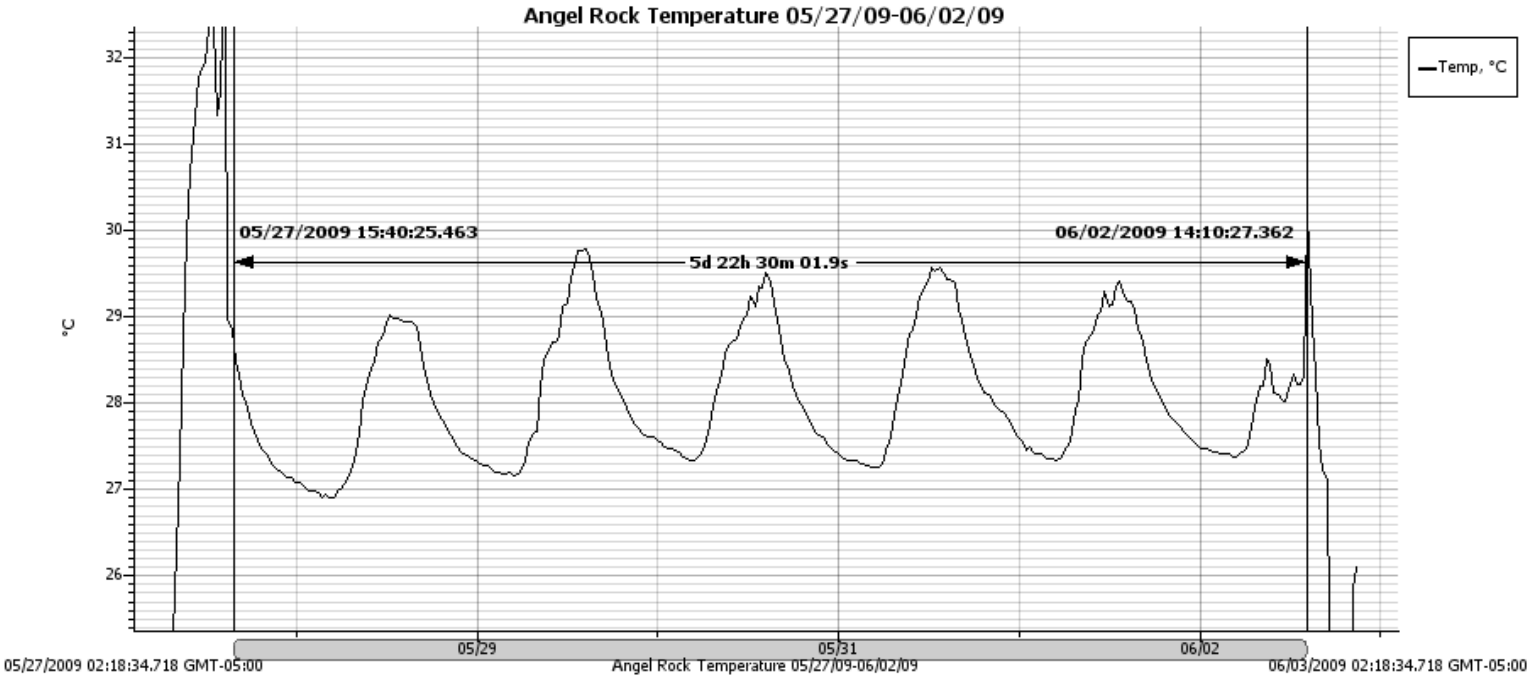
After the site characterization we took ten more sets of measurements along the seagrass beds with the same water quality monitoring system, to compare with the previous measurements. We then returned to our marked quadrats to remove the hole-punched blades of *Thalassia.* The shoots were once again removed at sediment level and placed in labeled bags. Unfortunately, one of our quadrats, S1Q1, was no longer intact due to unknown factors, thus we were not able to retrieve any hole-punched samples from this quadrat. Once all of the hole-punched samples were collected and bagged, we removed all of our flag markers.

Finally, we removed the data logger. We took the logger back to the station where we downloaded the stored temperatures in a computer and created a graph.

Back at the lab, we separated the old and the new growth to formulate the growth of the seagrass. All samples from site one were placed in a single group, as were the samples from site two. Then, using a razor, we cut each seagrass blade at the hole-punch mark. Cut portions were further separated into old standing growth (OSG), and new growth (OG). New growth describes the part of the leaf from the hole down to the base, and old growth is from the hole to the top of

the blade. Additionally, any new leaves (NL) growing from the base that didn't have a hole in them were placed into a separate group. Next, each group was soaked in a 10% HCl solution to remove epiphytes and calcified particles. After washing them off in freshwater we put them into pre-weighed foil weighing boats and placed them in the drying oven set at 73^{o}C. After 24 hours, we removed the weighing boats and took and recorded final weights of the dried plant material.

Results:



.Figure 1. HOBO Data Logger temperature readings from 5/27/2009 to 6/2/2009

Growth Measurement of *Thalassia testudinum*			
Country & Institution			
Dominica, West Indies		Areal Productivity (g dry weight m^{-2} d^{-1})	Turnover (% per day)
Site	**Duration (days)**	**Mean**	**Mean**
Porte-la-Fin Bay S1	6	3.50	3.48
Porte-la-Fin Bay S2	6	5.50	4.70

Table 1. The average measurements in areal productivity and turnover of *Thalassia testudinum* at stations 1 and 2, from 27-May-09 to 2-June-09. (Areal productivity is the number of grams of plant material produced per m^2 per day. Turnover is the % of the plant present that is replaced each day.)

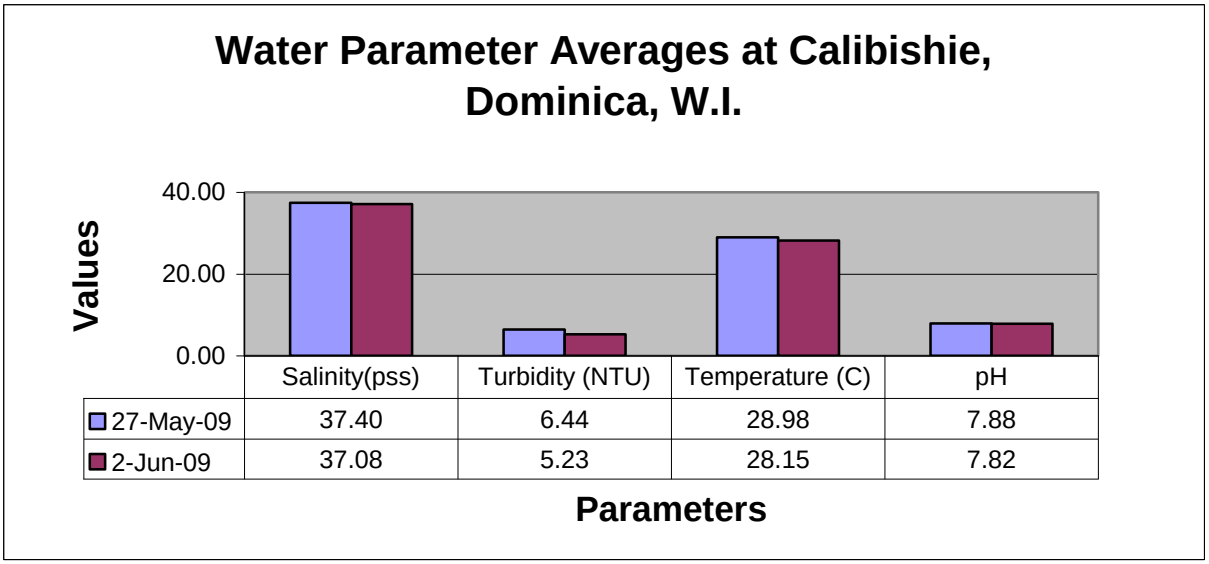


Figure 2. Hydrolab Water Quality Monitoring System measurement averages from Calibishie.

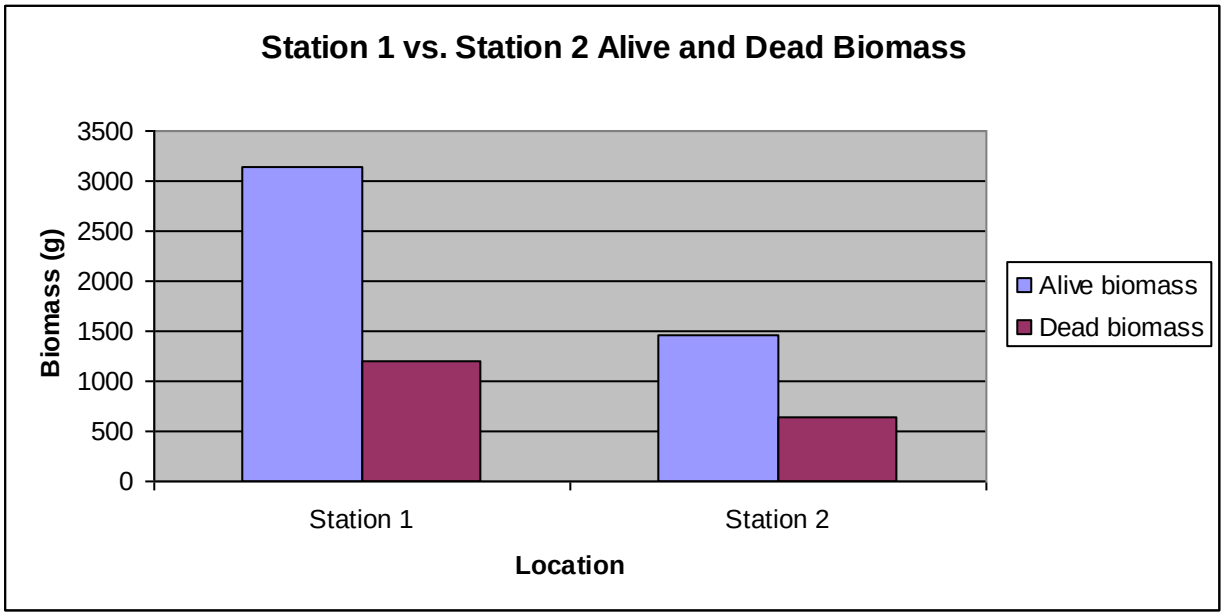


Figure 3. A comparison between the biomass found at each station per m^2.

Discussion:

The water quality results returned by the Hydrolab system indicated that the conditions in Porte-la-Fine Bay were ideal for *T. testudinum*'s growth and productivity. It has been estimated that a temperature range of 20-30 ^{o}C is best for *Thalassia* growth (Dineen 2009). Our data showed fluctuating temperatures of 28.9 ^{o}C and 28.15^{o}C. *T. testudinum's* growth and

productivity is also dependent on salinity levels. Deleterious effects on the seagrass may occur when salinity drops below 20 pss or rises above 45 pss (Dineen). The results from our data collection showed salinity averages of 37.40 pss on May 27 and 37.08 pss on June 2. These values are higher than optimal conditions, but below the deleterious level. *Thalassia* is not known to grow at depths greater than ten meters (ITME). Our seagrass did not exceed depths greater than one meter. Our turbidity levels were low at the average of 6.44 NTU and 5.23 NTU. It is essential that turbidity and depths are low to allow ample light for efficient photosynthesis. Our pH levels provided the optimum conditions while being slightly basic with averages of 7.88 and 7.82.

Static measurements were taken to provide information on the condition of the seagrass. Using the six core samples, we calculated the overall biomass of the living and dead plant material. At station 1, the living biomass was more than double the amount of the dead matter. This would be expected of a healthy and growing seagrass bed. The same pattern of results occurred at station 2 but on a smaller scale. This may have happened because the rockier sediment prevented the corer from penetrating as deeply. Therefore, the root system in its entirety may not have been fully sampled. Furthermore, *Syringodium* was more prevalent at station 2. Therefore the biomass would decrease from discarding the unwanted *Syringodium*.

The dynamic measurements we took were used to examine the health and growth rates of Thalassia. Our areal productivity measurements determined the individual growth rate of each plant, m^2 per day. After six days, we calculated that the mean growth rate for station 1 was 3.5 m^2 per day . When compared with areal productivity from other CARICOMP sites such as Trinidad and Tobago, where the areal growth rates over a three-year period averaged 2.60, 1.09, and 1.97 m^2 per day, this is relatively high (UNESCO.org). Station 2 had an even higher areal productivity rate of 5.50 m^2 per day . This suggests that the *Thalassia* at station two is growing faster than those plants found in station 1. If this is correct then *Thalassia* may be on the way to increasing its dominance over *Syringodium* in that area. This adds conclusive evidence that the *Thalassia* bed is in a very healthy state. However, a longer duration would produce a more accurate assessment. The turnover rate is the percentage of plant present that is replaced each day. The turnover rates that we calculated had average percentages of 3.48 and 4.70. When compared with turnover rates from other CARICOMP sites, our numbers were in a normal range,

but on the higher end. For example, in Trinidad and Tobago, the turnover rates over the course of three years averaged 3.69, 2.41, and 3.74 (UNESCO.org).

Most CARICOMP studies were conducted over several months or years rather than weeks. Having less than three weeks critically altered our collection process and the outcome of our results. With more time, we would have increased the number of stations and the number of quadrats set at each station. This would have offered more samples per station, increasing the accuracy of the results. Increased access to the site would have been helpful in relieving much of the time constraint. Having such equipment as a boat or raft would have allowed our time at the site to be used much more efficiently.

In hindsight, we realize that a few tasks could have been carried out differently. Most importantly, we should have focused solely on *Thalassia* from the beginning. Originally, our intention was to perform a full CARICOMP study by analyzing mangroves, coral reefs, and seagrass beds. Initially, our time was used attempting to evaluate the productivity of Champagne Reef and searching for seagrass in areas that were barren. The presence of *Thalassia* was not discovered until halfway through our stay in Dominica.

Our study evaluated a *Thalassia* bed using the CARICOMP methodology. Both our static and dynamic data depicts a healthy seagrass bed at Pointe-la-Fin. Our study may be useful for a variety of future marine studies. Furthermore, our project can be expended upon to produce a full CARICOMP analyses of the marine productivity of Dominica. Subsequent studies in the area could focus on the variation of *Thalassia* beds through out Dominica, or could analyze the effects on *Thalassia* in the presence of *Syringodium*.

The importance of *Thalassia* cannot be overstated. These beds are host to many fish and sessile invertebrates. *Thalassia* beds are places of primary production that offer foraging opportunities and protection to many fish including several economically important species. One of the most significant contributions of this habitat is its ability to filter nutrient loads. Consequently, the dynamics of *Thalassia* beds need to be fully understood to insure the balance of the marine ecosystem of Dominica.

Acknowledgements:

We wish to acknowledge Dr. William Heyman for helping us come up with the initial idea to study seagrass productivity in Dominica using the CARICOMP method, and for providing continual guidance and support as we conducted our research. We would also like to

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Appendix 1:

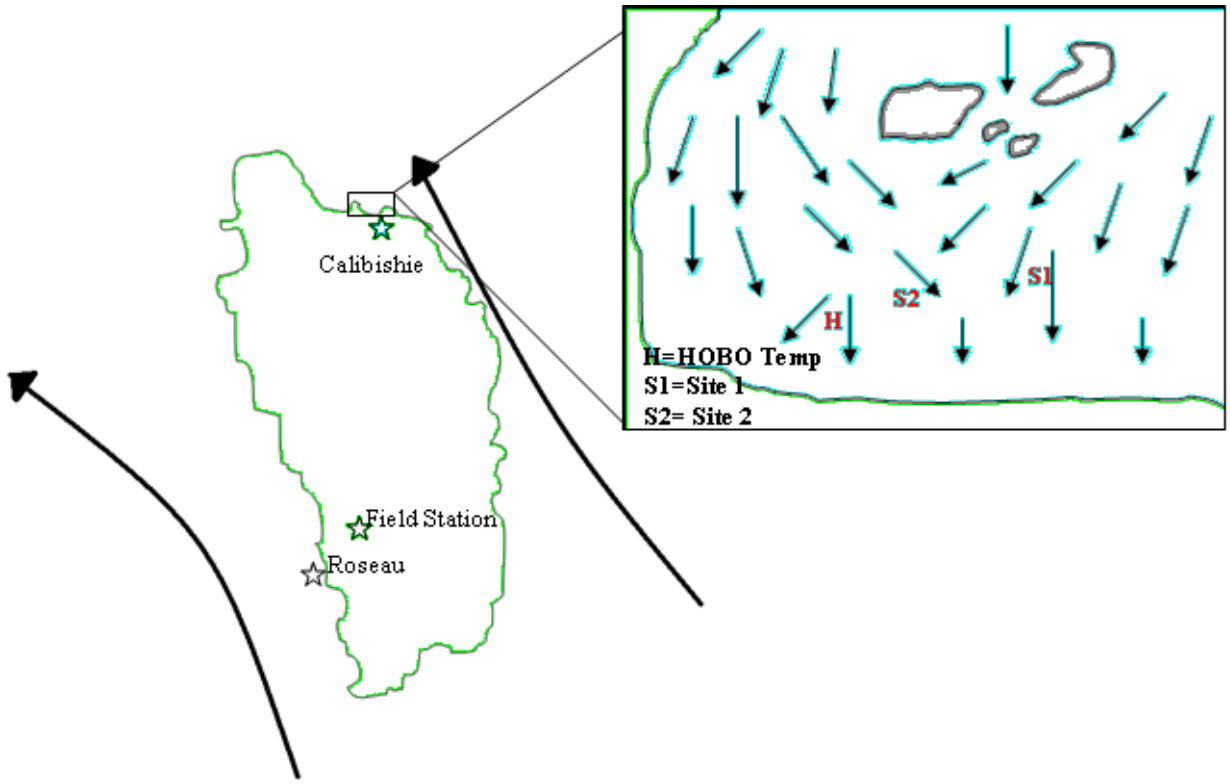

Figure 4. This diagram depicts the major currents around Dominica as well as an enhanced map of the currents at our site.

Appendix 2:

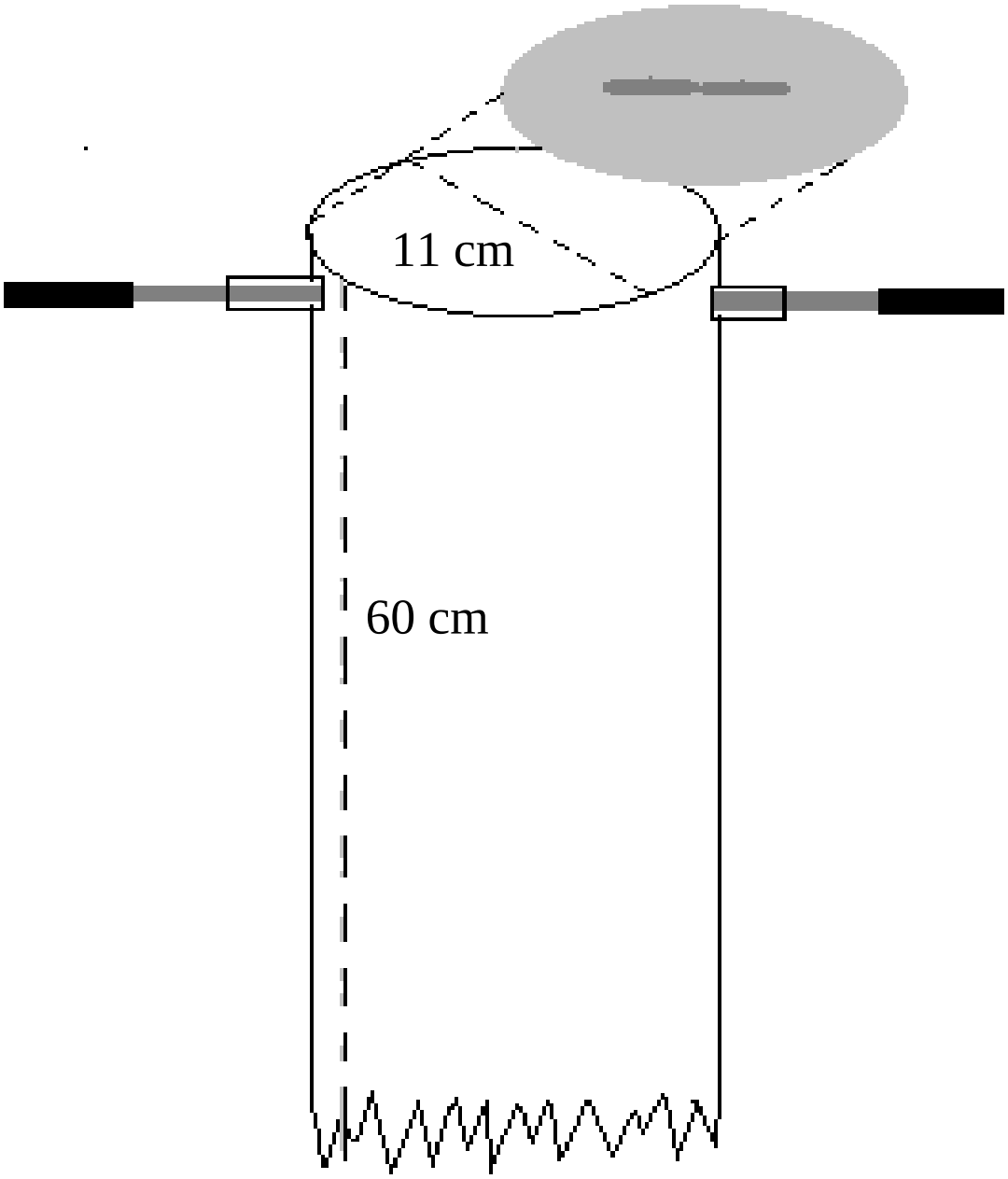

Figure 5. A graphic illustration of the corer model that we constructed and used.

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