SARGASSUM EARLY ADVISORY SYSTEM (SEAS): DEVELOPING THE STANDARD OPERATING PROCEDURE OF INVESTIGATING THE HOURLY GROWTH RATE OF SARGASSUM WHILE SUSPENDED IN THE NERITIC COASTAL WATERS OFF OF GALVESTON, TEXAS

An Undergraduate Research Scholars Thesis

by

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ABSTRACT

Sargassum Early Advisory System (SEAS): Developing the Standard Operating Procedure of Investigating the Hourly Growth Rate of Sargassum While Suspended in the Neritic Coastal waters off of Galveston, Texas. (May 2014)

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Sargassum, a pelagic brown alga, is a vital part of marine and coastal ecosystems. It serves as shelter for fish, turtles, and other hatchlings and juveniles. Sargassum acts as a source of food, as it reaches closer to the shorelines, birds will feed on the abundant life that grows throughout its mats. It serves a fundamental role once on the beaches; providing organic material to sustain dune vegetation. Sargassum, while vital to beach health, can become a significant burden to coastal communities if too much washes onto a beach at one time. Prior to making landfall it experiences an extreme spike in biomass increase, and overwhelms the system as it is suspended just off the surf zone. Pelagic brown alga, such as Sargassum, grows in a vegetative manner, absorbing nutrients located within the surface waters through the outer membrane. The nutrient rich coastal Gulf of Mexico waters provide access to such growth-spurring nutrients and serve to accelerate the Sargassum's growth. This research is addressing the means of attaining an accurate measurement of the growth rate within the depth of closure of Texas coastal beaches. This area is targeted due to the increased mixing of nutrients as predicted by the Hallermeier-equation (Hallermeier 1981).The Sargassum Early Advisory System (SEAS) has the ability to forecast Sargassum events through the observation of the Sargassum within its loop system. In

order to increase volumetric accuracy of the forecasts the attainment of an expected rate of growth will be pursued(Webster and Linton 2013). Knowing the expected rate of Sargassum's growth once entering neritic waters is vital for forecast accuracy in the SEAS project. This information gives researchers the ability to compute the amount of Sargassum projected to make landing with greater volumetric accuracy. This Standard Operating Procedure (SOP) detailing proper measurement attainment methods has been constructed and field tested in the collection of Sargassum's hourly growth rate data. The preliminary data collected while in this testing phase has indicated a much higher Sargassum growth rate than originally anticipated, as well as revealing some fascinating idiosyncrasies.

ACKNOWLEDGEMENTS

Through funding provided by the Texas Institute of Oceanography and the Undergraduate Research Scholars Program this research has brought to light the intricacies of Sargassum's growth cycle within the depth of closure.

My Coauthors Captain Robert Webster, Jeff Frazier, and Dr. Thomas Linton have been invaluable in this work and I cannot express how necessary they are and have been in my scientific endeavors.

Two individuals who were great help during the field work were Kaylee Hatfield and Jesse Smith. Both of these Texas A&M at Galveston students worked very hard during the testing of the Floatation Suspension Units.

NOMENCLATURE

SEAS	Sargassum Early Advisory System
NASA	National Aeronautical and Space Administration
NOAA	National Oceanic and Atmospheric Administration
USGS	United States Geological Survey
SOP	Standard Operating Procedure
Landsat	Land Satellite

CHAPTER I

INTRODUCTION

The SEAS Program has unearthed a large amount of information about the algae but much more is left unknown. One of the pivotal questions yet to be explored is how quickly does it grow while suspended in the near coast nutrient rich (neritic) waters of the Golf Coast? The Sargassum Early Advisory System uses Landsat satellite imagery from the National Aeronautics and Space Administration (NASA) and the United States Geological Survey (USGS) to form its advisories. The volume of Sargassum seen approaching the coast through the neritic waters, versus what the Galveston Park Board and other Texas beach managers' report making landfall seem to be at odds. At some point during its movement from the Gulf of Mexico waters to the beach, a large bloom of growth occurs. It is theorized that the Sargassum experiences its maximum growth rate while in the surf zone due to the concentrated mixing of neritic waters.

As of now, the specific rate of growth displayed by Sargassum in Texas coastal waters is unknown. It is understood from observations, however, that the macro algae grows rapidly in nutrient laden waters. If the SEAS program were able to pinpoint the average growth rate of Sargassum, it would allow for the more accurate forecasting of Sargassum landings and inundating events. Increasing the information held about Sargassum will also serve to benefit more than the SEAS project. Knowing the variable amounts of Sargassum that could make landfall on a beach during a specific time period will help beach managers in assessing and adjusting their management practices. Historically, beach managers had to rely on having staff and resources in a standby mode in the possibility of having Sargassum make landfall on the beaches that may never have arrived. The SEAS Program has since given the beach managers the ability to know what to expect and to staff the beaches with the correct amount of force required in order to properly relocate the Sargassum. The identified growth rate of Sargassum will also serve as a base measurement for future research concerning the macro algae.

Through several methods the SEAS Team attempted to collect accurate growth measurements. A total of six successful measurement collection attempts were taken during the months of June and July of 2013. These attempts were successful in allowing for the development of a best method of collection and providing measurements that will serve as preliminary data. Biomass increase was measured by weight every hour and weather, surf, and surroundings were notated for later comparison.

CHAPTER II

OBJECTIVE

The goal of this experimental effort is to come up with a first-of-its-kind data set. There has not been a study done on the amount of growth that occurs in Sargassum as it drifts within the depth of closure off the Texas coast. Measuring the growth on such a scientific scale will provide a model to apply in similar growth measuring situations. It often occurs that Sargassum enters a suspended period moving parallel to the coast for an extended period of time. This allows for a pod of Sargassum to roll within the surf zone and quickly grow to a substantially sized mat (A pod is a football sized clump of Sargassum independent of a large windrow system or a mat).It is when these thick mats of Sargassum make landfall that the beach maintenance system is overwhelmed and Sargassum cannot be dealt with effectively.

CHAPTER III

METHODOLOGY

The steps that were taken to begin this investigation were largely trial and error. The basic attempt of this research has been to collect a sample of Sargassum with a known weight. This sample would then be suspended in natural conditions, open to its surroundings but contained, allowing it to be measured multiple times. The suspension unit must not allow for contamination yet allow as natural conditions as possible. This means that wind, sun, water, and nutrients must be able to reach the sample, but the sample cannot lose biomass through the unit nor can biomass be added. The suspension unit also needed to be rugged enough to sustain repeated surf swells and withstand immense wear.

Image 1.1
The Sargassum Coral Suspension Unit deployed, seen here tethered with nylon rope and 300 pound rated carabineers on to two fence posts.

The suspension unit took several shapes as designs and methods were attempted. The first was referred to as the corral. The corral was made by floating the external shell of a crab trap in the surf while keeping it tethered to a fence post secured within the waters. The trap was connected to the fence posts via floating nylon rope and also had a buoy at each corner for increased flotation. This method was supposed to have allowed for a stable and sturdy environment to work around and within.

The trap was measured wet, to form a baseline, and then a healthy pod of Sargassum was placed inside and monitored for a period of 32 hours. The corral was hoisted out of the water to be weighed, when the Sargassum had been allowed to drain for a full minute, on an hourly basis. A hanging fish scale was used to procure the measurements. During the night experiment a light was fixed to the top of the corral, allowing it to be monitored. It was not measured hourly due to the lack of manpower, however it was monitored, evaluated hourly as well as relocated as needed. Due to the fixed design, the corral had to be relocated as the tide moved in and out.

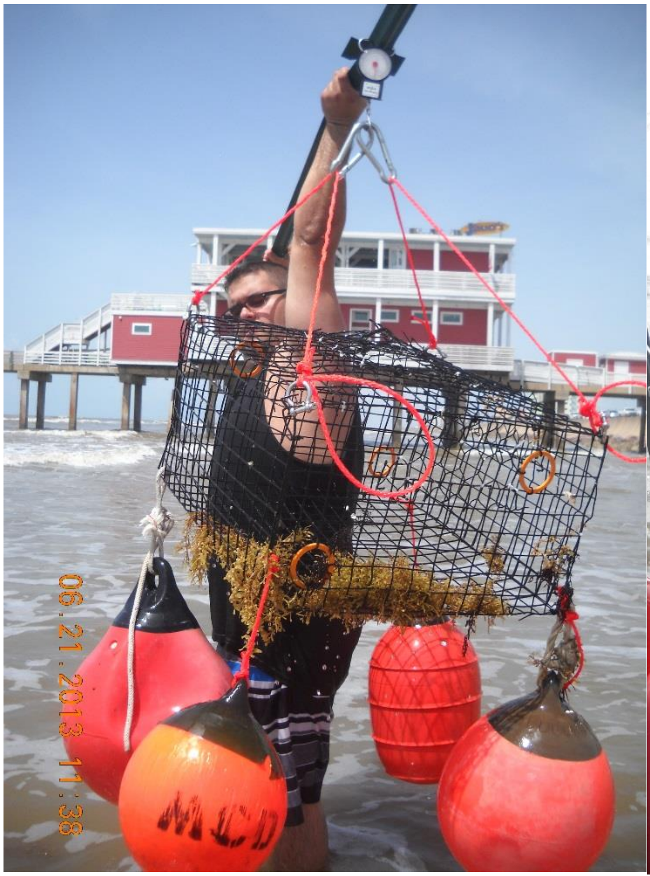

Image 1.2
This image depicts the means of measuring the Corral Suspension Unit.

Image 1.3
This shows the increased efficiency gained by adding the fine metal mesh.

Several issues in this design were observed. The spacing between the metal grid was simply too large, allowing the biomass to fluctuate. In one instance, a significant spike in weight was seen because of the infiltration of a good-sized fish. Due to this, all data collected up to that point was null. This was fixed by covering the corral with a fine metal mesh that decreased the likelihood of Sargassum entering or leaving. Another problematic design was that the fence posts were not robust enough to withstand the energy of the surf. By the end of the field work, every fence post that had initially purchased was broke or contorted beyond use. The most obvious design flaw was the sheer mass of the corral. It was simply too cumbersome to use properly. The weight of it made measurements very strenuous, the relocations took a minimum of three people to perform safely, and its building materials made the chance of getting cut very likely.

Image 1.4
The “Rocket” Suspension Unit

The second suspension unit designed and used became known as the “rocket”. This name was coined due to its likeness to a space shuttle rocket, with booster rockets strapped to the side. The unit was comprised of a large water cooler jug, with two round juice jugs attached on either side. The water cooler jug had holes strategically drilled into it, allowing for the flow of water and nutrients, replicating natural conditions. The “booster rocket” jugs served to increase flotation, allowing the water cooler jug to remain only half submerged. The top half was exposed to the atmosphere, this allowed for wind and temperature to remain as open to the environment as possible while also allowing the sample to swash back and forth as it would naturally if suspended in the surf. Once the sample was inserted into the water cooler jug through the bore, this orifice was closed up using high grade adhesive tape. This made the small holes the only means of entering and exiting the rocket. The rocket was tethered to a pier, both heavy fishing line and deep sea pole as well as simple nylon rope was tested. Nylon rope was found to be the most reliable and easy to use. Every hour the rocket was hauled up onto the pier and measured using an electronic hand held fish scale.

This "rocket" design was found to be a great platform to use in the collection of this data. The only major modification that should be made is that a clear jug rather than a light blue plastic should be used. While unconfirmed, it is hypothesized that the blue plastic may interfere with the light as it passes through to the Sargassum. In an effort to increase the repeatability of the methods found to work this Standard Operating Procedure (SOP) has been developed in the process of the testing. The procedure addresses not only how to repeat the previous experiment but also suggestions for additional measurements to be conducted using holding structures further offshore, or research vessels for a stable platform.

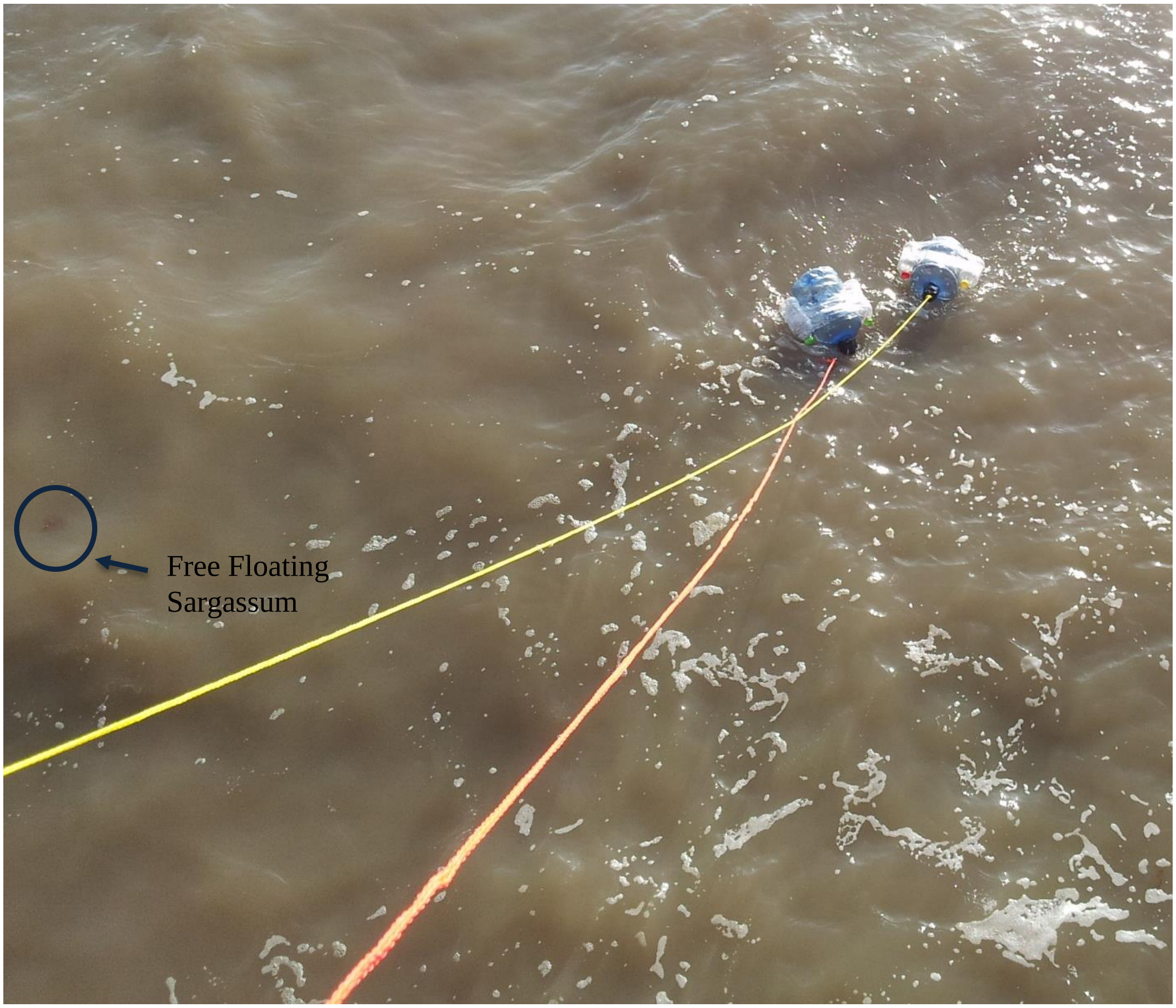

Image 1.5
This picture shows the two “rocket” suspension units deployed off of the pier within the surf zone.

CHAPTER IV

RESULTS

A set of standard operating procedures in attaining this type of measurements was designed in this research. The “rocket” suspension unit proved itself a stable, easy to use, and precise piece of equipment. With the sturdy and yet easily built design the “rocket” unit takes away the need to have something that can take the abuse of the surf. Its floating design allows it to glide up and over the large swells. When measuring on a pier, the ability to tether the rocket to the pier is invaluable. This method allows the suspension unit to not take the abusive battering that the corral did. When deployed in the deeper water the “rocket” will need to be anchored rather than tethered. The anchor will need to be attached using the high strength nylon rope. This will present a challenge due to the need for slack, to keep it from becoming submerged should large swells arise. The location of the “rocket” should be recorded accurately using GPS, this will allow for the timely retrieval and measurement of the unit.

The “rocket” is a sturdy, cheap and versatile means of collecting this data. While the data must be considered only preliminary it is quite telling of what should be found with further research. The trends seen in the testing performed present a predictable growth rate. The data also suggests that Sargassum has certain idiosyncrasies about its growth and conditions that affect it.

This trial was performed for a period of seven hours beginning at 8:41 am, temperature averaged 88.1°F outside, and increasing as the day went on. The humidity decreased throughout the day, and it remained fairly clear with only scattered clouds throughout the day. The winds maintained a southern origin occasionally turning from the SSE and maintained an average wind speed of 9.2 mph during the trial. The use of the now outdated corral resulted in some visible fluctuations thus a mean line has been applied to represent the average growth rate observed. On 6/22/13 a 13.64% biomass increase by weight per hour was observed.

Graph 1.1

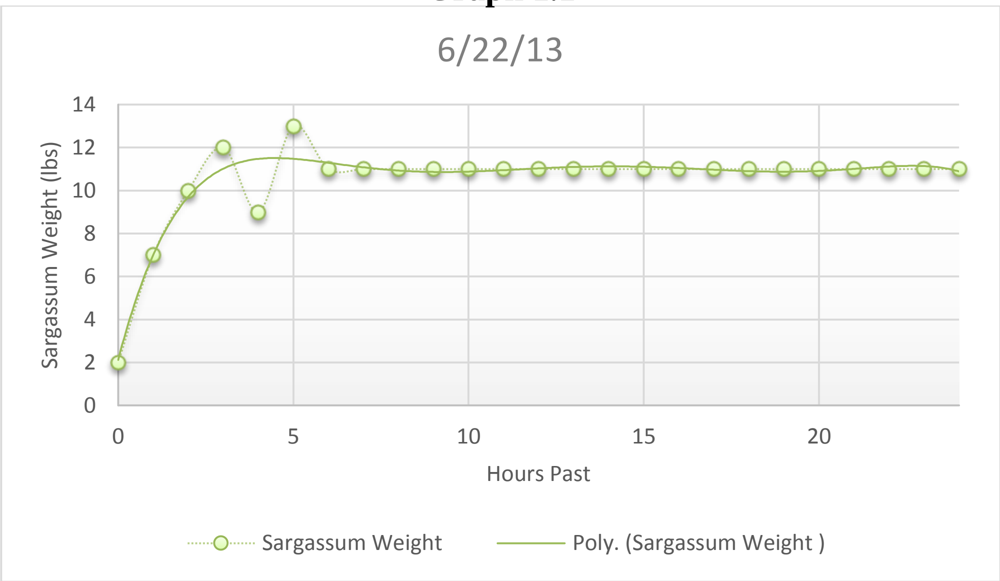

Table 1.1

Time (CDT)	Temp.	Heat Index	Dew Point	Humidity	Pressure	Visibility	Wind Direction	Wind Speed	Conditions
8:52 AM	86.0 °F	96.9 °F	77.0 °F	74%	30.06 in	10.0 mi	SSE	10.4 mph	Scattered Clouds
9:52 AM	87.1 °F	98.8 °F	77.0 °F	72%	30.07 in	10.0 mi	South	9.2 mph	Partly Cloudy
10:52 AM	88.0 °F	98.5 °F	75.9 °F	67%	30.08 in	10.0 mi	South	9.2 mph	Scattered Clouds
11:52 AM	88.0 °F	98.5 °F	75.9 °F	67%	30.09 in	10.0 mi	South	9.2 mph	Scattered Clouds
12:52 PM	89.1 °F	99.1 °F	75.0 °F	63%	30.09 in	10.0 mi	South	8.1 mph	Scattered Clouds
1:52 PM	89.1 °F	100.2 °F	75.9 °F	65%	30.07 in	10.0 mi	South	9.2 mph	Clear
2:52 PM	89.1 °F	99.1 °F	75.0 °F	63%	30.05 in	10.0 mi	SSE	9.2 mph	Clear

On 6/28/13 the “rocket” suspension unit made its maiden voyage. Over seven hours the rocket was tethered via deep sea fishing pole to the pier. During this time from 8:05 on an average growth of 4.04% biomass increase by weight an hour. The temperature averaged 87.6°F while the wind maintained a Westward originating wind occasionally coming from the South, averaging 9.4 mph. The dips in the growth chart can be attributed to the lack of familiarity with the new equipment and methods of obtaining data.

Graph 1.2

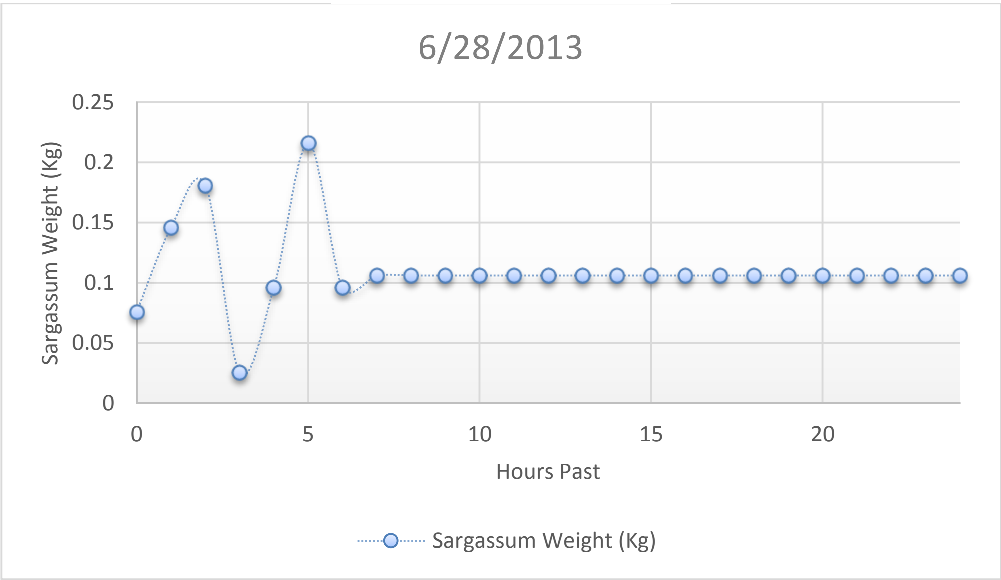

Table 1.2

Time (CDT)	Temp.	Heat Index	Dew Point	Humidity	Pressure	Visibility	Wind Direction	Wind Speed	Conditions
7:52 AM	84.0 °F	94.8 °F	78.1 °F	82%	29.97 in	10.0 mi	SW	10.4 mph	Scattered Clouds
8:26 AM	84.2 °F	96.1 °F	78.8 °F	84%	29.97 in	10.0 mi	West	10.4 mph	Mostly Cloudy
8:52 AM	84.9 °F	96.6 °F	78.1 °F	80%	29.97 in	10.0 mi	West	8.1 mph	Scattered Clouds
9:52 AM	87.1 °F	98.8 °F	77.0 °F	72%	29.97 in	10.0 mi	West	12.7 mph	Scattered Clouds
10:52 AM	90.0 °F	101.3 °F	75.9 °F	63%	29.97 in	10.0 mi	West	10.4 mph	Scattered Clouds
11:52 AM	90.0 °F	100.2 °F	75.0 °F	61%	29.96 in	10.0 mi	West	8.1 mph	Scattered Clouds
12:52 PM	93.0 °F	104.6 °F	75.0 °F	56%	29.94 in	10.0 mi	Variable	5.8 mph	Partly Cloudy
1:52 PM	91.0 °F	106.2 °F	78.1 °F	66%	29.92 in	10.0 mi	South	13.8 mph	Clear
2:52 PM	91.0 °F	104.2 °F	77.0 °F	63%	29.90 in	10.0 mi	SSW	15.0 mph	Clear
3:52 PM	90.0 °F	102.5 °F	77.0 °F	65%	29.88 in	10.0 mi	SSW	16.1 mph	Clear

The trial held on 7/11/13 showed for the first time what came to be a predictable growth rate pattern. Over the five hour period the average biomass increase observed was 13.33% per hour. The temperature averaged around 89.2°F, the winds averaged 10.4 mph and came from the south for the majority of the experiment period, and there were also scattered clouds all day long.

Graph 1.3

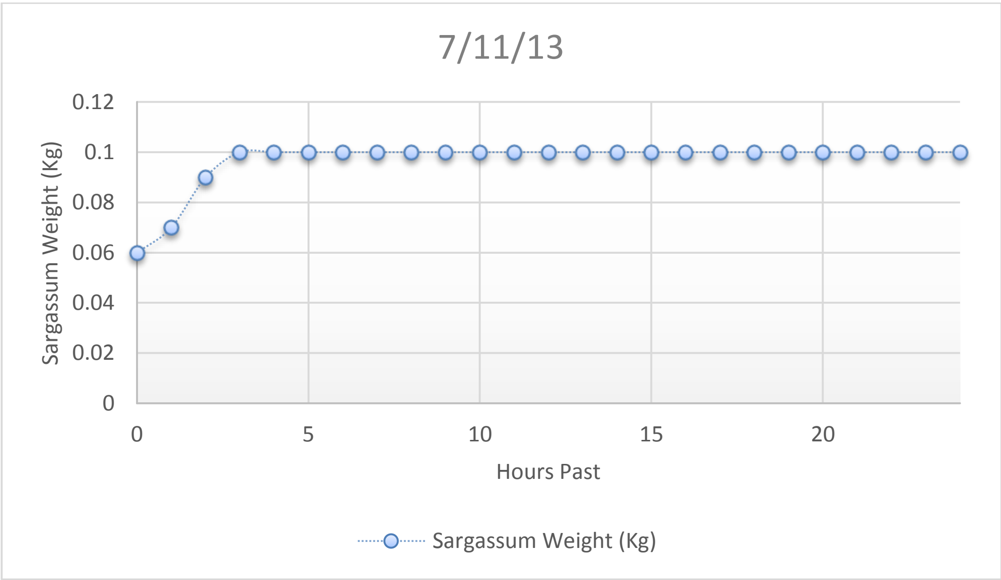

Table 1.3

Time (CDT)	Temp.	Heat Index	Dew Point	Humidity	Pressure	Visibility	Wind Direction	Wind Speed	Conditions
9:52 AM	88.0 °F	97.5 °F	75.0 °F	65%	30.01 in	10.0 mi	WSW	6.9 mph	Scattered Clouds
10:52 AM	89.1 °F	99.1 °F	75.0 °F	63%	30.01 in	10.0 mi	Variable	5.8 mph	Scattered Clouds
11:52 AM	90.0 °F	102.5 °F	77.0 °F	65%	30.01 in	10.0 mi	South	10.4 mph	Scattered Clouds
12:52 PM	90.0 °F	102.5 °F	77.0 °F	65%	30.00 in	10.0 mi	South	13.8 mph	Scattered Clouds
1:52 PM	89.1 °F	100.2 °F	75.9 °F	65%	29.99 in	10.0 mi	South	13.8 mph	Scattered Clouds

On 7/12/13 a very significant spike in growth occurred between 10:00 am and 11:00 am. The average hourly growth rate based on biomass was an average of 10.00% an hour. The temperature averaged 85.7°F, winds were variable, however came from the west the majority of the time, averaging a 6.75 mph speed. The day remained mostly cloudy throughout the testing.

Graph 1.4

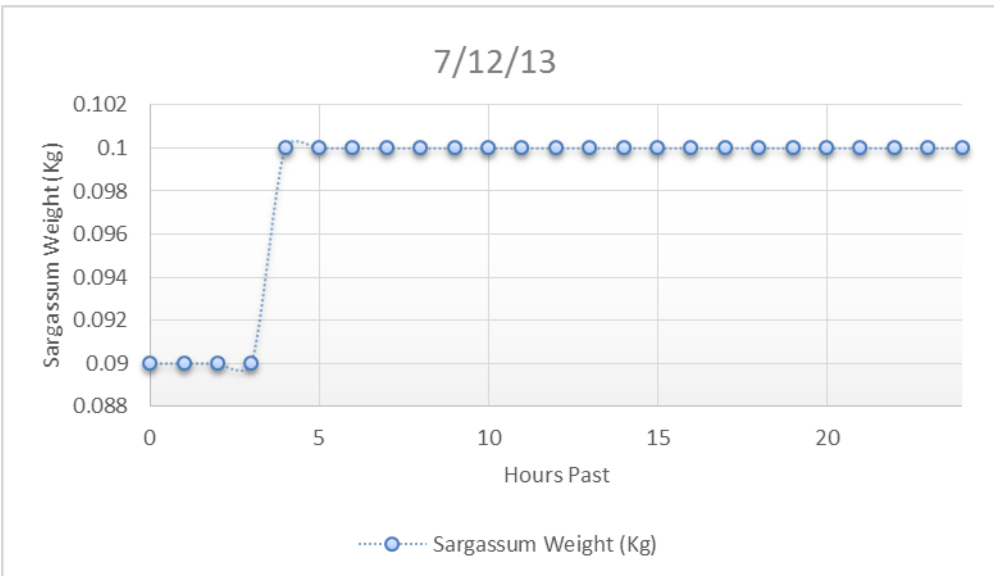

Table 1.4

Time (CDT)	Temp.	Heat Index	Dew Point	Humidity	Pressure	Visibility	Wind Direction	Wind Speed	Conditions
7:52 AM	82.9 °F	90.8 °F	75.9 °F	79%	29.96 in	10.0 mi	West	8.1 mph	Mostly Cloudy
8:52 AM	84.0 °F	92.6 °F	75.9 °F	76%	29.98 in	10.0 mi	West	9.2 mph	Mostly Cloudy
9:52 AM	84.9 °F	94.1 °F	75.9 °F	74%	29.98 in	10.0 mi	West	5.8 mph	Scattered Clouds
10:52 AM	86.0 °F	96.0 °F	75.9 °F	72%	29.98 in	10.0 mi	Variable	3.5 mph	Mostly Cloudy
11:52 AM	89.1 °F	98.0 °F	73.9 °F	61%	29.97 in	10.0 mi	Variable	3.5 mph	Scattered Clouds
12:52 PM	87.1 °F	97.3 °F	75.9 °F	69%	29.97 in	10.0 mi	SSE	10.4 mph	Mostly Cloudy

On 7/25/13 two “rocket” suspension units where utilized in the surf zone. This gave a unique side by side comparison which turned out to be beneficial and will be repeated in further testing. The sample in the first unit grew steadily until the fourth hour, at a rate of 52.63% an hour. The winds came from variable directions and had an average speed of 5.32 mph. The skies were clear nearly all day, and temperatures averaged 84.04°F.

Graph 1.5

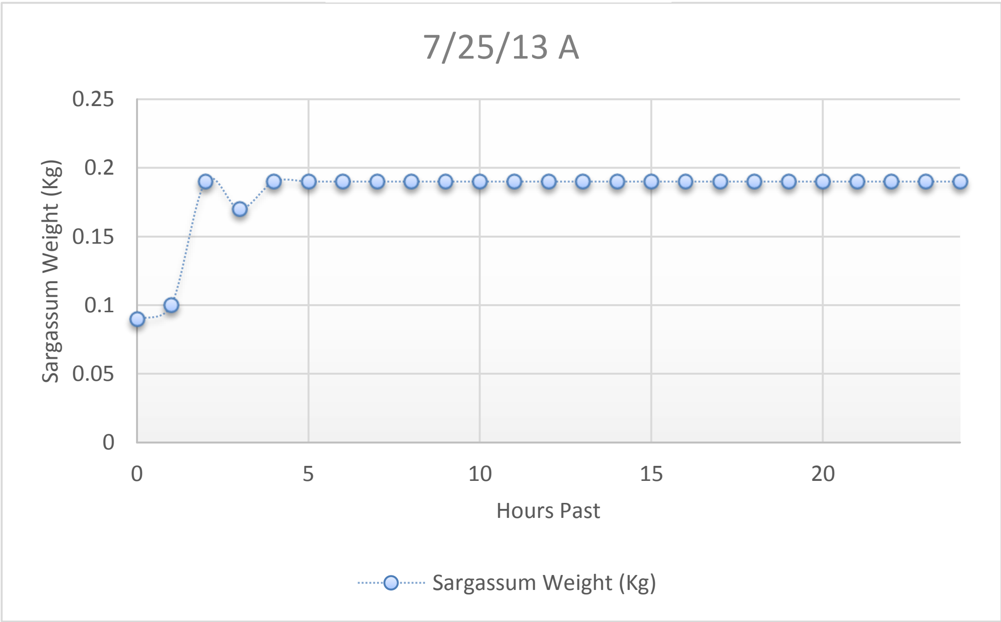

Table 1.5

Time (CDT)	**Temp.**	**Heat Index**	**Dew Point**	**Humidity**	**Pressure**	**Visibility**	**Wind Direction**	**Wind Speed**	**Conditions**
8:52 AM	**66.0** °F	-	-	N/A%	**30.03** in	**10.0** mi	Variable	**4.6** mph	Clear
9:52 AM	**87.1** °F	-	**77.0** °F	72%	**30.04** in	**10.0** mi	Variable	**5.8** mph	Clear
10:52 AM	**87.1** °F	-	**77.0** °F	72%	**30.04** in	**10.0** mi	WNW	**5.8** mph	Scattered Clouds
11:52 AM	**90.0** °F	-	**75.0** °F	61%	**30.04** in	**10.0** mi	Variable	**5.8** mph	Clear
12:52 PM	**90.0** °F	-	**73.9** °F	59%	**30.04** in	**10.0** mi	Variable	**4.6** mph	Clear

The second rocket was deployed right beside the first, creating as nearly identical conditions as possible. The sample in the second "rocket" suspension unit achieved a growth rate of 66.67% an hour. This was achieved in nearly half of the time of the first sample. These measurements are uniform adding credence to the outcome. These are the highest growth rates observed over the tests and also the highest period of clear conditions.

Graph 1.6

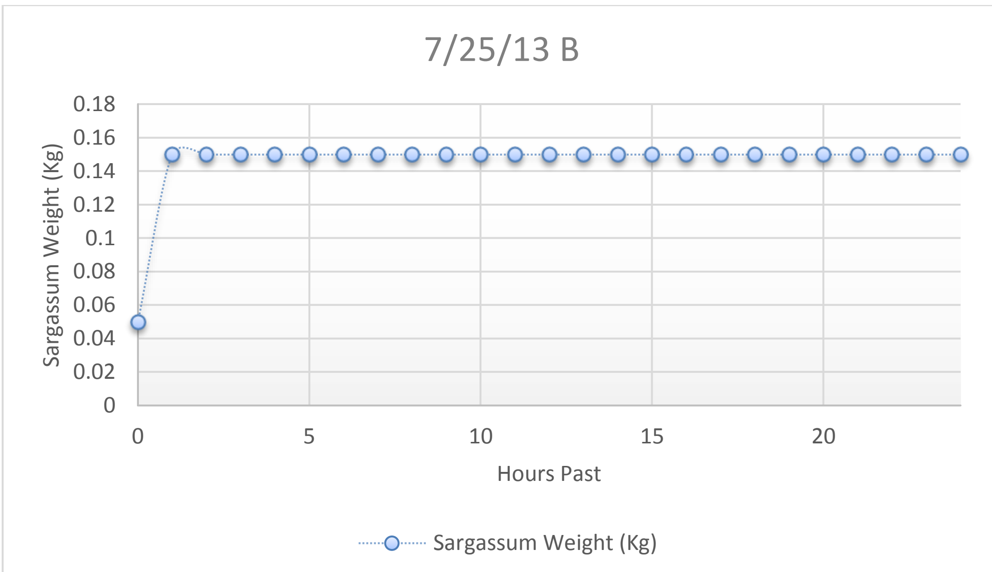

Table 1.6

Time (CDT)	Temp.	Heat Index	Dew Point	Humidity	Pressure	Visibility	Wind Direction	Wind Speed	Conditions
8:52 AM	66.0 °F	-	-	N/A%	30.03 in	10.0 mi	Variable	4.6 mph	Clear
9:52 AM	87.1 °F	-	77.0 °F	72%	30.04 in	10.0 mi	Variable	5.8 mph	Clear
10:52 AM	87.1 °F	-	77.0 °F	72%	30.04 in	10.0 mi	WNW	5.8 mph	Scattered Clouds
11:52 AM	90.0 °F	-	75.0 °F	61%	30.04 in	10.0 mi	Variable	5.8 mph	Clear
12:52 PM	90.0 °F	-	73.9 °F	59%	30.04 in	10.0 mi	Variable	4.6 mph	Clear

CHAPTER V

CONCLUSION

In his similar work, Lapointe stated that high levels of Nitrogen and Phosphorous is key to a higher rate of growth in Sargassum *natans* and *fluitans*(Lapointe 1995).His work took place off of the East coast of Florida, in the Western North Atlantic. The study began in this paper is unique in its location and means of data collection. The findings in this study indicate a biomass increase rate of up to 60% an hour or higher and no less than 4%. This stunning rate confirms the high rates observed by Lapointe as well as his inference of the importance of the nutrients within the neritic water.

In order to fully understand the exact significance of the neritic Texas coast nutrient load to the Sargassum's growth, further tests will be conducted. A series of surf-zone tests will take place to cement an expected growth rate. Tests further from shore will be continued to see if there is a significant difference in growth rate due to the approach to land caused by a spike of available nutrients and the turbulence of the depth of closure. AYSI meter will take readings in all testing locations to determine the extent of nutrient availability. This information could point toward whether or not a large growth spurt does take place in Sargassum as it is pushed through the Gulf of Mexico and onto the Gulf Coast. Emphasis will be placed on the monitoring of iron, phosphorous, nitrates, dissolved oxygen and other variables that may influence Sargassum's growth. This data will also shed light on the Gulf of Mexico's nature as a nursery for the Sargassum as it proceeds through the loop system.

Another theory that this study has produced evidence to support is that Sargassum has unique mechanisms allowing it to be well adjusted to the high amount of solar radiation in the air-sea interface.(WilDlife 2010)Sargassum is thought to be capable of making cellular adjustments to decrease or increase its functional light absorption depending on the amount of radiation in the environment. As was measured in every trial run in the experiment, the Sargassum would cease to grow after a certain period of time. On one occasion, the Sargassum was monitored hourly overnight and no growth was seen during the hours when the sun was down. When the trials were run beginning in the morning the rate of growth was always observed to settle off after several hours. It is hypothesized and supported in this work that the Sargassum does in fact have an optimum level of solar radiation. Once it has absorbed that level, or if the radiation becomes overly extreme it alters its molecular functions in order to slow, or all together stop growth. This observation, if found to be consistent, could imply that Sargassum will only grow significantly if making landfall at a certain time period. Or if it is found to be related to other factors this should be fleshed out for a better understanding of the life cycle of Sargassum *natans* and *fluitans*.

The means of data collection described in this work will be used in order to further understand the life cycle of Sargassum. The interplay of nutrients and turbidity due to wave action in the surf zone are to be investigated. There is thought to be a positive correlation between growth rate and the turbulence in the surf zone, due to the churning of the alga in the high amounts of nutrients. An expected growth rate will be investigated and determined in order to allow for a calculation of growth as Sargassum moves through neritic waters.

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APPENDIX A

Standard Operating Procedure

1. *Purpose*

Sargassum Early Advisory System (SEAS): An Investigation of the Hourly Growth Rate of Sargassum While Suspended in the Neritic Coastal waters off of Galveston, Texas. This SOP serves to outline safety precautions and proper procedures when performing further studies of this nature.

Sargassum, while vital to beach health, can become a significant burden to coastal communities if too much washes onto a beach at one time. Brown macro algae, such as Sargassum, grow in a vegetative manner, absorbing nutrients located within the surface waters through the external membrane. The nutrient rich coastal Gulf waters provide access to such growth-spurring nutrients and serve to accelerate the Sargassum's growth. This research will address the growth rate within the depth of closure of Texas coastal beaches. Knowing the exact rate of Sargassum's growth after it enters neritic waters is vital for forecast accuracy in the SEAS project. This information will give researchers the ability to compute the amount of Sargassum projected to make landing with far greater accuracy.

2. *Scope*

For use in research endeavors, detailing methods of data collection for the purpose of replication of findings. This SOP is vital to performing a successful measurement of Sargassum growth rate within the tidal surf zone. The Data and information uncovered may also be helpful in tests ran further out from shore.

3. Prerequisites

A working knowledge of water safety and situational awareness (NOAA Beach Hazards and Safety)

Boating and Sea safety preparation, (http://www.tpwd.state.tx.us/fishboat/boat/safety/safety_tips/)

4. Responsibilities

Two personnel, minimum are required for this experiment. This allows for maintained reliability of data as well as safety and ease of operation. One individual should keep track of time between measurements as well as notate the results of the measurements while the other performs the measurements and aids in hauling the apparatus from the water. A third or fourth participant can be added based upon the platform on which the experiment is to be carried out. If a boat is used rather than a long pier then a captain will be a necessity as well as an extra deckhand for both safety and help in performing scientifically accurate tasks.

5. Procedure

Necessary Equipment:

- Sargassum Growth Apparatus
- Minimum 50ft of nylon line
- Hand scale
- Small bucket
- Gorilla Tape
- Lynch pin or equivalent

- Hitch pin
- Carabineer
- Anchor and line (optional, used at deeper test sites)

Step one: Construct Sargassum Growth Apparatus

- The most effective apparatus to date is a clear plastic container.
- The apparatus must have ample perforations to allow for natural water flow, however must prevent Sargassum from entering or leaving the apparatus.
- The apparatus should have neutral buoyancy, allowing an average 50% of the internal area to be flooded with water. The apparatus should simulate a Sargassum mat, allowing as natural of an environment for the sample as possible.
- The apparatus must be clear, to allow for the infiltration of sunlight promoting the natural growth of the Sargassum.
- Once testing, use the line and pins to secure the apparatus where it can float freely yet not break away.

Step Two: Deploy Growth Apparatus

- First notate weather conditions, be sure to track this throughout testing period as may it significantly affects the results.
- Collect a sample of fresh Sargassum between 7:00-7:30 AM, this can be accomplished a myriad of ways including a treble hook or by hand depending on platform.

- Keep this healthy sample in a small bucket of water collected from the test site. This will keep the sample from beginning to wither due to lack of nutrients.
- Dunk the apparatus in the water and then retrieve to simulate any extra weight that retained water may contribute.
- Weigh the Sargassum sample alone before inserting into the apparatus and then weigh the apparatus before and after adding the Sargassum, the difference of these weights should be equal to the weight of the Sargassum sample.
- The Sargassum weight should be 10 ounces.
- The strong adhesive tape can be used to cover the means of inserting the Sargassum into the apparatus.
- Deploy the apparatus utilizing nylon or similar line.
- Depending on the platform chosen either fasten the line to the pier on which you are measuring (taking note of the exact position) or anchor it and utilize your coordinates to relocate if you leave the location via boat.

Step Three: Observe Growth Apparatus

- The Apparatus should be released and observation begin by 8:00 AM when temperatures are between 70-90°F and the cloud cover should be no greater than +50%
- In 55 minute intervals the suspension unit should be retrieved and inspected. Within 5 minutes the apparatus should be returned to the waters.

- If any debris has clung to the apparatus remove it while dewatering the apparatus for 60 seconds.
- Using a hook scale with an error bar of 0.1 ounce, weigh the apparatus, notating the mass in ounces.
- Time stamped images must be taken at the beginning and end, to show change in appearance over time.
- The apparatus should be deployed in a timely manner as to maximize the natural simulation of conditions.
- The Sargassum sample will only be retrieved from the apparatus at the conclusion of testing and at that point will be weighed separately and photographed.

Step Four: YSI

- At each station measurements will be taken of Ammonia, Dissolved Oxygen, Nitrates, Salinity, and Temperature.
- Error bars will be noted
- Measurements will be taken with a YSI 9500 Photometer

Step Four: Record Findings

- Data shall be recorded in a research log with the appropriate initials
- The infield data will be notated on cite and then inserted into an excel spreadsheet

- The data can then be manipulated into growth charts comparing time to percent change
- A GIS Map Archive will be kept recording the exact locations of specific studies as well as the conditions that occurred as the apparatus was deployed.

7. Definitions

Sargassum Mats: This is a terminology used to describe large pods of Sargassum. These mats form as Sargassum reaches near shore and grows exponentially. Often these thick, healthy collections of Sargassum can be picked up as a fluorescent, green glow on the Landsat images.

Sargassum Pods: Small individual amounts of Sargassum, these clumps are the beginnings of large healthy Sargassum mats.