DBML Irish Moss Cultivation Project Science Draft 1.1

Matthew-Pierre Rogers

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Last Edit: June 1, 2023

Irish Moss Cultivation Project

Figure 1: Matthew-Pierre Rogers with a line of Eucheuma cotonii

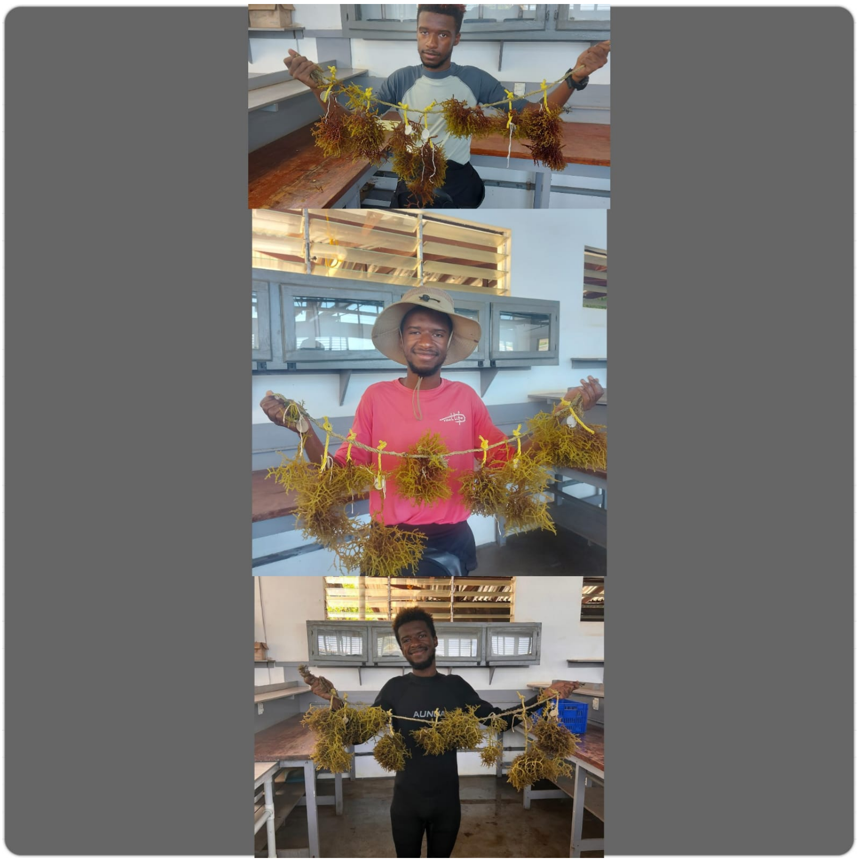

Figure 2: Images of Matthew-Pierre Rogers with a line of Eucheuma as it Grows

Figure 3: Raft on May 31, 2023 after cultivation

This project serves as a preliminary attempt to begin the cultivation of Irish Moss, *Eucheuma cotonii*, at the Discovery Bay Marine Lab. This document outlines some of the rationale, methods and procedures and results undertaken during the course of this project.

Background

Jamaica has been noted to have some of the most overfished waters in the Caribbean. At the same time, the territory has over 20 000 fisherfolk who are experiencing less income as a result of the lower quantities of smaller lower quality fish which are caught.

At the same time, environmental degradation from development, climate change and the ecosystem effects of overfishing and other human activity further reduce the sustainability and productivity of the fisheries sector.

Seaweed mariculture provides the unique opportunity for fisherfolk and fisherfolk communties to use much of their existing skillset, to transition to a sustainable alternative livelihood.

Introduction

Jamaica has a tradition of utilizing seaweeds in some traditional foods and beverages. Many species collectively called "Sea moss" and "Irish Moss" are consumed locally. As with many sales of agricultural/natural products, many sales occur informally.

However, effectively all the seamoss sold locally is harvested from wild populations by divers and fisher folk. Despite the high value of the product, (over the course of the project, prices per pound ranged from $2000 to $5000 jmd), there is no cultivation of the sea moss, which can lead to depletion of natural stocks.

The project seeks to explore the potential viability of cultivating irish moss locally. Specifically this project involves a small scale cultivation of *Euchuema cotonii* using different methods.

Rationale

- The production and cultivation of seaweeds such Irish Moss represent a new income earner for coastal communities
- providing an alternative income for fisherfolk can ease fishing pressure and allow fish stocks to recover
- Potential income to supplement the revenue of marine parks and sanctuaries
- The Seaweeds cultivated can provide the raw materials for producing new or more value added products

Aims and Objectives

There are several aims and objectives undertaken with this project:

1. To attempt to grow commercially important seaweed species locally
    1. To determine suitable conditions for growing Irish moss locally in Jamaica
    2. To determine compare 2 methods of cultivation and determine which work best in a Jamaican context
2. To quantify the mean growth rate of the seaweed
3. To determine the potential profitability of cultivating seaweed in Jamaica

Methods

For this project, *Eucheuma cotonii*, one of many species of seaweed commonly known as “irish moss”, was grown using two methods in the Discovery Bay Area. These methods were a floating raft method and an off-bottom method. Both set ups were implemented in same area to cultivate the *Eucheuma* over a six week period as suggested by the literature.

The off-bottom method was adapted from previous efforts by the Discovery Bay Marine Lab to cultivate *Eucheuma*. Two pieces of iron rebar were driven into the sandy substrate using a combination of a hammer and body weight. A rope was run between the two rebar posts by untwisting the rope and running the rebar through the gap. This was followed by tying the remaining length to further secure the rope.

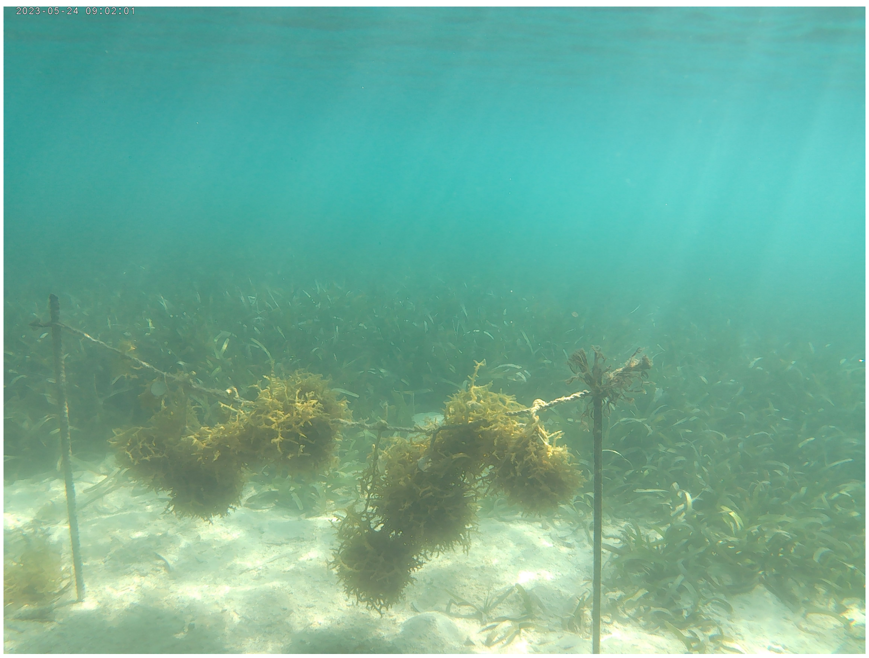

Figure 4: Image of off bottom line

For the raft method, a small raft was constructed. This raft consisted of 1 metre long 3/4” PVC pipes capped with 3/4” PVC caps at the ends. four 1.5 metre long 5mm polypropene ropes were run through holes drilled in the PVC and knotted to prevent them from falling out. Buoys adhered to the corners of the PVC frame were used to keep the raft afloat, but bottle floats should also be a viable alternative. Cement blocks were used to anchor the whole structure, one at each end of the raft. (although adjacent rafts could share anchors)

For both methods, samples were labelled with numbered aluminum tags. These tags were threaded with construction cord. Where possible, the construction cord and tag were attached to a 10cm section of rope. The rope was untwisted and then the and end of the cord was run

Figure 5: Image of Raft while being deployed on April 4, 2023

through the opening and tied. the rope was then retwisted. The ends of the rope were burned to reduce fraying. The weight of these attachment ropes was found to be 5g(most of which is the aluminium tag itself.)

Where materials ran low, construction cord was directly tied into the rope of the cultivation line.

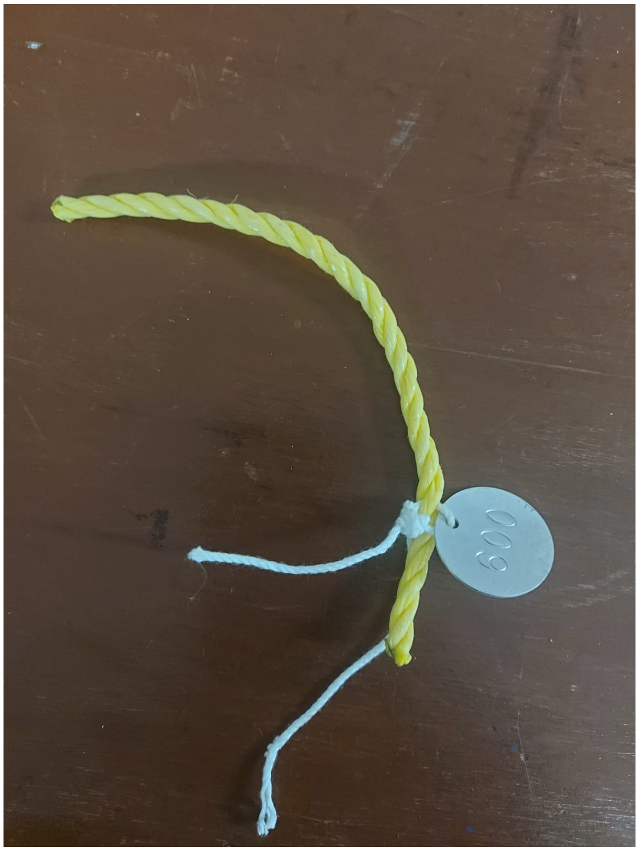

Figure 6: Image of attachment rope which is twisted into the main cultivation line, with a measurement tag attached

Once a week the samples were removed from the water and carried back in a slotted crate. The crate was allowed to drain for a minute and then carried to the lab out of direct sun and wind. The samples were weighed on a balance/scale and their masses recorded. For some samples, images were taken.

The seamoss was then returned to the crate and reattached to the cultivation line the same way.

The attachment ropes are intended for measuring the weight, but make removing seamoss far easier.

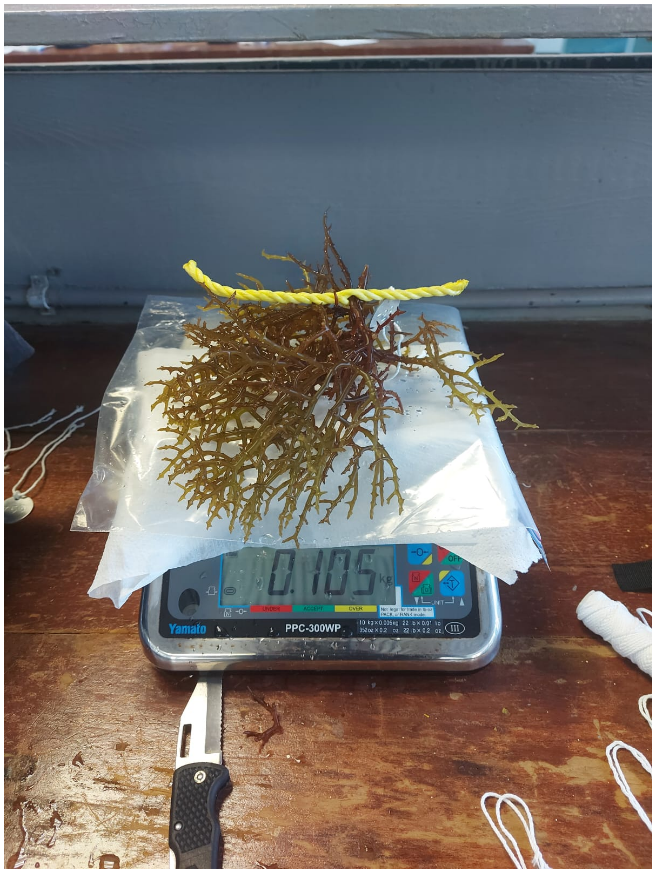

Figure 7: Image of Seamoss Sample being measured

The Site

The cultivation took place in a sand patch roughly 10 metres from shore in water of approximate depth 1.5 metres. This sand patch was surrounded by seagrass beds(*Thalassia testudinum*) and is located in the Discovery Bay Special Fisheries Conservation Area, well behind the reef crest. This site is known to have a number of freshwater upwellings where freshwater seems up through the underlying limestone into the Bay. The *Eucheuma* was grown in one such sand patch. Data on the site was taken on April 14, 2023 using a YSI mulitparameter probe yielding the following data:

Table 1: Table 1 showing Conditions in the sand patch where cultivation took place

Site	Temperature (c)	DO(%)	DO(g/L)	Salinity	pH
Surface	26.9	69	4.9	34.08	8.01
Near Bottom	28.3	98	6.4	35.69	8.21
Near Surface	26.8	67	4.8	31.70	7.99

Observations and Results

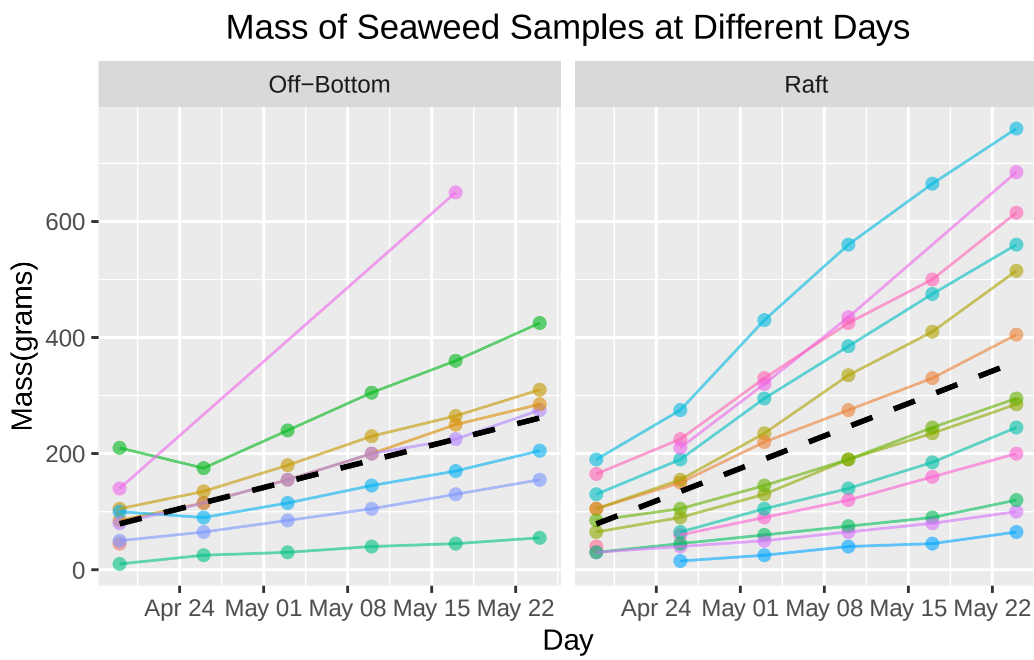

Figure 8: Figure 1 showing change in mass of seaweed over time

There is no statistically significant difference between the mean percentage growth rate(p=0.65). While the raft had a higher mean percentage growth rate than the off bottom method (5.22% vs 4.68%), the results were not proved significant by the Welch's two sample T test used.

Below are the results of the mean growth of the *Euchuema* grown over the period:

```
[1] "The mean growth rate is to be 6.9735  grams per day + or - 5.346"
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```
[1] "The mean percentage growth rate is to be 4.5096  % per day + or - 2.6381"
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[1] "The estimated mean time to double in size is  16  days(to the nearest day)"
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When quantified, the absolute growth per day is scattered. Trends are far easier to see when the percentage growth rate is analyzed as in figure *4* below.

Assuming a number of values the researcher heard informally as selling prices per unit weight. Prices ranged from \$2000 to \$5000 so an intermediate value of \$3500 was used in calculating the potential revenue.

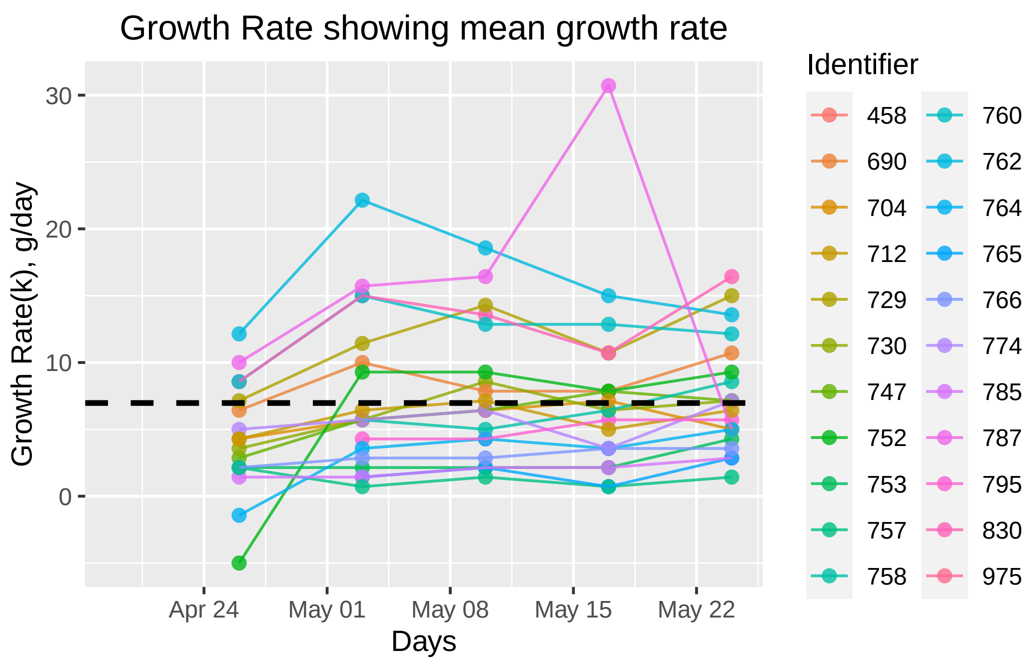

Figure 9: Figure 3 Showing mass change of individual samples over time

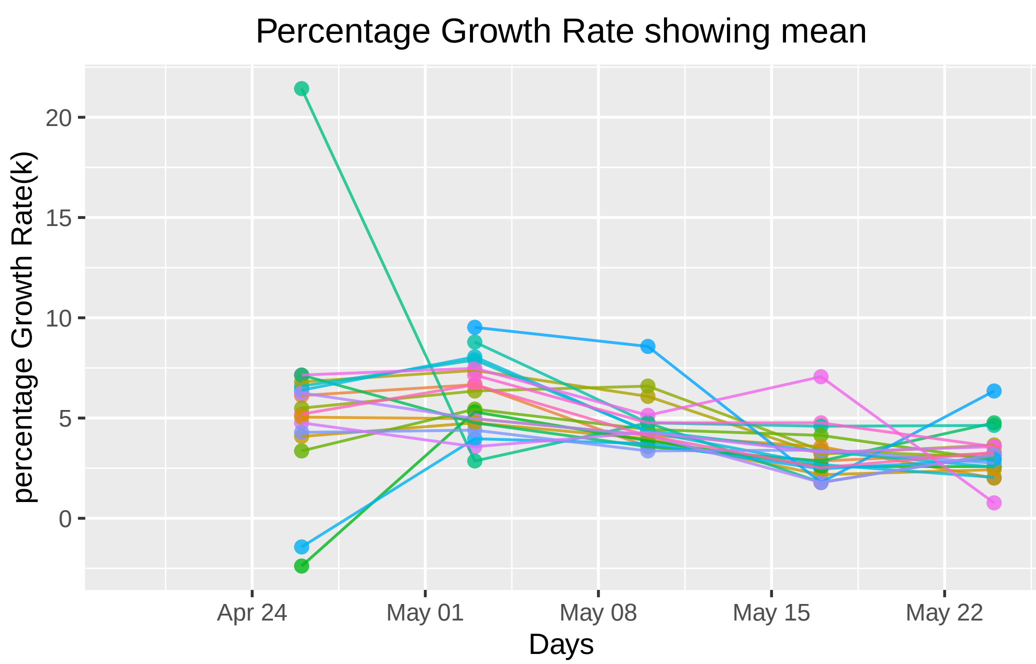

Figure 10: Figure 4 Showing percentage mass change over time

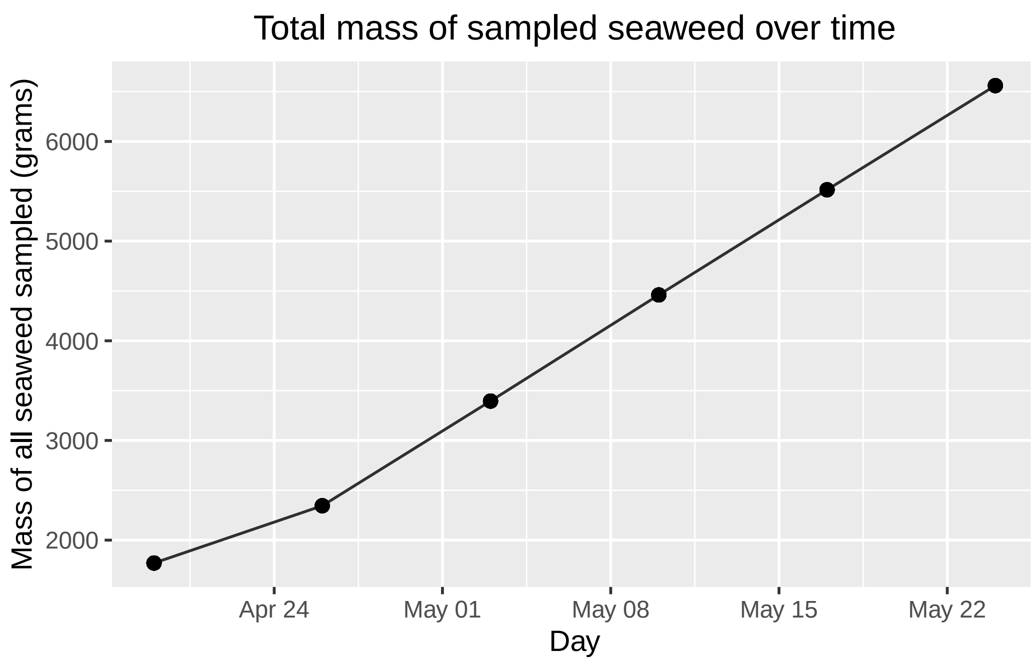

Figure 11: Figure 5 Showing total mass of all samples over time

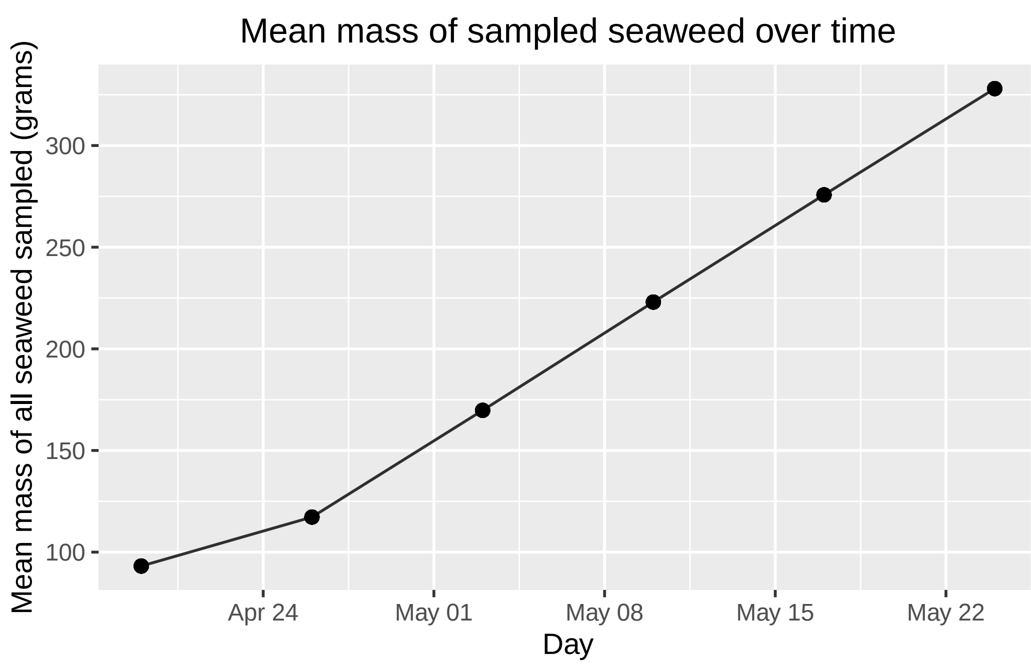

Figure 12: Figure 6 Showing mean mass of all samples over time

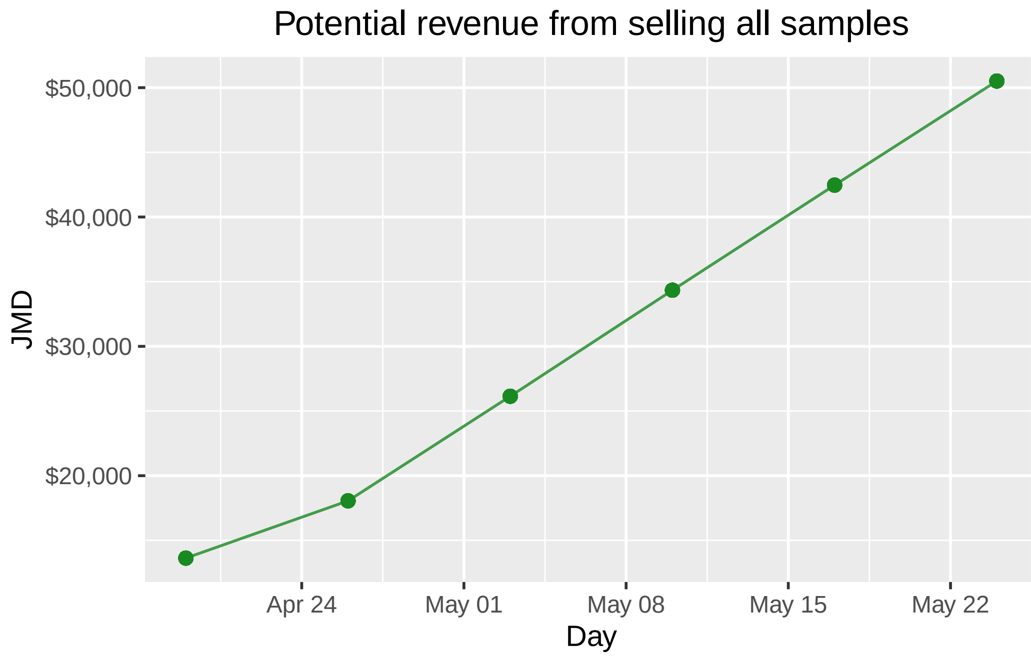

Figure 13: Figure 6 Showing potential revenue as seaweed is sold over time

Throughout the process of cultivating the Seamoss, several observations were made by the researcher, which are relevant to potential future cultivation in Jamaica.

Upon undergoing shock, the *Eucheuma cotonii* undergoes a response which is similar to the disease known as "ice-ice". This takes the form paling and whitening of the thallus. The tissue softens and eventually sloughs off. This results in breakage, and consequently lost mass of the seaweed.

This shock response can be recovered from, and new growth can occur at tips where breakage from ice ice has occurred. However this obviously takes time and reduces the size(and detracts from the growth which would have occurred in the absence of breakage.)

This shock can be brought on by extended period out of the water. During the experiment, the sea moss was only out of water for measurement for approximately half an hour at a time. This time was not sufficient to induce the shock response. Sudden changes in salinity, temperature and light intensity are partially responsible for this shock response. Samples not removed from water for long periods showed these responses when moved to areas with different water conditions. For example when the seaweed was moved from the sand patch to shallower saltier water for a few days, ice-ice was noted.

Originally when the seaweed was brought up to be cut, separated and placed onto the raft and off-bottom lines, some of the shock response was seen as seen in the images above. The response eventually faded and growth proceeded. It must be noted however, that if the breakage occurs

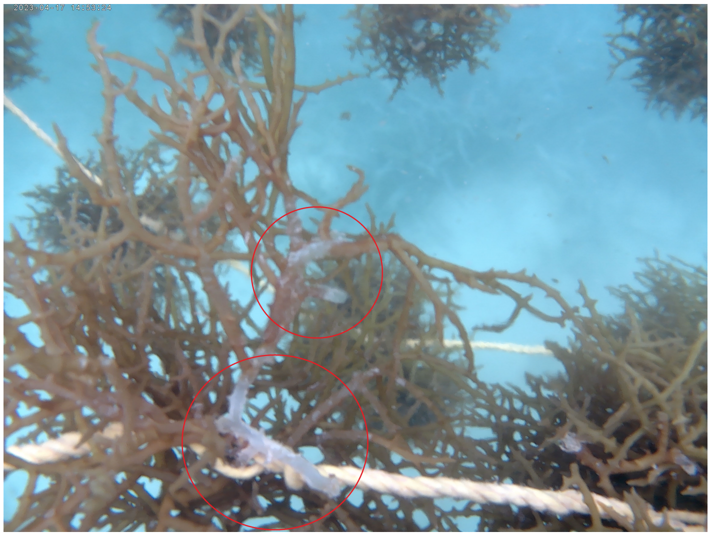

Figure 14: Image showing ice-ice in the Euchuema cotonii

Figure 15: Image showing the characteristic breakage and paling

near where the seaweed is attached to the cultivation line it can easily come loose, detatch and be lost to waves.

Measurement did not begin immediately after the rafts were deployed, but some time was allowed for the seaweed to acclimatize. The off-bottom seaweed was deployed later and so took longer to acclimatize, with some ice-ice associated breakage seen in early weeks.

The raft method in particular experiences a great deal of fouling. This fouling material can tak the form of silt or other algae. For the most part, this fouling builds up on the ropes and PVC, with less on the crop itself. However, it must still be cleaned. The crop itself can be brushed off, shaken in the water, or shaken above and below the waterline. The ropes and PVC can be rubbed with gloves or a coarse brush. If the site is particularly silty, or fouls particularly fast cleaning more often that twice a week may be needed. However under research conditions, the seaweed was cleaned once a week and the Raft itself cleaned more thoroughly every 2 to 3 weeks.

Figure 16: Fouling build up 3 weeks into Raft deployment

The off-bottom method however experienced almost no fouling. In light of growth rates not being significantly different, the off bottom method seems a viable methodology, especially when starting *Euchuema* cultivation or when the attention which can be devoted to maintaining it is lower.

Over the process of tending the seaweed, some small degree of breakage was noted. For the most part this is fine. Measured growth rates were sufficient to warrant interest in spite of any breakage seen. Furthermore, the broken fragments continue to grow and regenerate, and may establish smaller stocks if they settle somewhere favourable. These reserves can be used later if significant amounts of the cultivating stock is lost.

The seaweed stock is also found to change colour. In general, this is an indicator of depth. Under lower light intensities, a more reddish colour is seen. whereas in more direct light, the colour is a yellow-green. This often takes the form of the underside of the crop which does not face the sun behind red, while the other, top facing surface is yellow-green.

Figure 17: Image of crate clearly showing the colour difference in irish moss

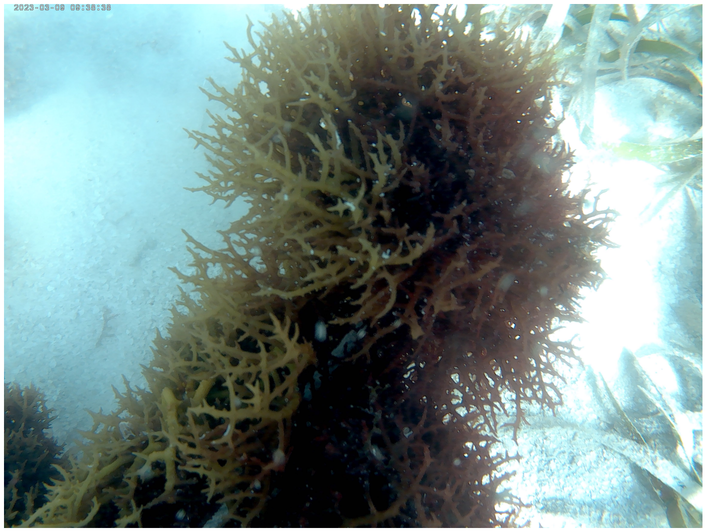

Figure 18: Eucheuma underwater showing difference in colour. The red surface was bottom facing, while the yellow surface was top facing

Discussion

Growth rates

The growth rates of the *Eucheuma cotonii* were found to be very encouraging. All samples saw noticeable growth over the 6 week cultivation period as seen in graph 1. This growth resulted in the mean sampling growing to 367% of its original mass. This surpasses the commonly seen literature, which suggests growing to 300% of the seaweeds original mass in 6 weeks. The total mass of all samples increased to 6.46kg from 1.68kg, representing an increase to 385% of their original weight.

While a few samples initially showed some decrease in mass due to ice-ice breakage, these samples recovered their original mass within 2 weeks and grew well beyond their original mass.

While the mean mass growth rate is 6.97g/day, this data is too scattered to be of much use as seen in figure 3. This is largely due to the large difference in the starting size of the *Eucheuma* fragments. Instead, the percentage mass growth per day is far more useful. As seen in figure 4, despite the huge variation in the absolute masses of the fragments, the percentage mass changes fall into a close band. The mean percentage growth is 4.5% per day. With the exceptions of a few outliers, all the growth falls between 3% and 7% growth per day. Also of note, is this growth rate appeared to slow as the weeks went on.

This may indicate a phase of growth in response to cutting/fragmentation which then plateaus. If this is the case, regular fragmentation for sale and replanting at the end of a harvest cycle

Figure 19: Raft showing size of seaweed samples April 12, 2023

Figure 20: Raft May 24, 2023 showing increase in size of seaweed

Figure 21: Matthew-Pierre Rogers and Andrew Dorsey Lifting Raft on May 31, 2023

will likely improve stock growth. This however requires further study.

At the levels of growth seen, it took approximately 13-16 days for the mass of sea moss to double. If this level of growth is consistent, only between 3 and 4 harvest cycles would be needed to convert a small 10kg starting stock into a farm capable of produce 100s of kilograms of wet *Euchuema* every 6 weeks. This however assumes that all sea moss is being used for cultivation, which may not be feasible.

Potential Revenue

Over the course of the project, through conversation, a number of selling prices through-out Jamaica for irish moss were gathered. These selling prices ranged from $2000 jmd per pound to $5000 per pound. Using a mid range price of $3500 was used to project the earnings. This information is seen in figure 6, showing that significant revenue can be generated selling the sea moss locally.

Reserve Establishment

It is advised that a reserve stock be established nearby. Occasionally, during cleaning, wave action or other events, some *Eucheuma* will become broken off. The plant is capable of regenerating. The fragments will also settle and begin regrowing if the site and conditions support it. If fragments do break, it makes sense to use them to establish a reserve in some favourable location. In the event of a complication, this reserve can be used to reestablish the cultivation stock. It can also be used for potential expansion later if it is left time and sufficient sea-moss to regrow. This process can also help establish nearby favourable sites, by seeing if the sea moss grows healthily where the fragments settle or are scattered.

Site Selection

The selection of a good site is perhaps one of the most important elements of establishing a potential seaweed farm. Further research will be conducted with different sites to see what is feasible but until this is available, sites with conditions as close to the pilot site are advised.

This includes locating a site with coarse white sand which will settle quickly. Other substrates will cover the irish moss, slowing growth. The depth of cultivation, while more important for the off bottom method, should be over a metre, but also shallow enough that the farm can be tended to and cleaned. Wave action should be strong enough to help clean the seaweed, but not enough to significantly damage the cultivation set-up. It helps if this area is located in the reef flat, where the reef can buffer some of the wave action. The water conditions of the cultivation site can be referred to in table 1.

Further Recommendations for Future study

- More Sites: Test growing at other sites throughout the bay, take YSI data and potentially NPK?
- More Species: *Eucheuma cotonii* is not the only “Irish moss” or potentially valuable species, try growing more. Namely There are known locations where Gracilaria verrucosa and domingensis can be found.
- More Samples/Replicates: particularly for the off bottom, get more replicates for more accurate data
- New Methods: If materials allow, attempt floating longline or net culture
- Samples more uniform in size: the wide range in size makes collecting data iffy. if possible, while cultivating all, try to have all measured samples fall around a certain mass range
- More anchors for raft - anchor raft at each corner to minimize twisting
- Don’t drill raft - try a rolling hitch to secure it, adds more buoyancy, decreasing need for floats.
- Material substitution: To what extent can bamboo be substituted for PVC and rebar? is it cheaper, does it hold up longer(or at least for a harvest cycle), can bottle floats be substituted for buoys
- Cost to set up a raft using current materials?

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Acknowledgements

I must express my immense gratitude to the Discovery Bay Marine Lab. Without the generous allowance for the use of lab space, and starting stock this project could not have taken place. Special thanks to Shanna Lee Thomas, Chief Scientific Officer at the Discovery Bay Marine Lab for her assistance, guidance and giving the freedom for this project. Thanks to Calese Hare for assisting in collecting YSI data during the project. Thanks to Ginelle brown for assisting in collecting YSI data and in taking some of the photographs. Thanks to Cor and Andrew Dorsey as well.