USING MUSSEL SEED (*MYTILUS EDULIS*) BORDER AS A BARRIER AGAINST THE JAPANESE OYSTER DRILL (*OCINEBRELLUS INORNATUS) IN THE YERSEKE OYSTER PITS*

Incomplete experiment as of April 17, 2019

Delta Academy
4/13/2019

Savita Owens-Frank

USING MUSSEL SEED (*MYTILUS EDULIS*) BORDER AS A BARRIER AGAINST THE JAPANESE OYSTER DRILL (*OCINEBRELLUS INORNATUS)* IN THE YERSEKE OYSTER PITS

Title: Using Mussel Seed (Mytilus edulis) border as a barrier against the Japanese oyster drill (OCINEBRELLUS INORNATUS) in the Yerseke oyster pits

Report type: Final report Savita Owens, Ongoing research experiment. Edited Report

Date: April '19

Author: Savita Owens

Supervised by: Eva Hartog

Contact: HZ University of Applied Sciences

Internship supervisor: Eva Hartog

Institute: HZ University of Applied Sciences

Version: 2

Status: Ongoing Experiment

CONTENT TABLE

0. ACKNOWLEDGMENTS

I would like to express my very great appreciation to my wonderful supervisor Eva Hartog who designed the experiment and guided me through the implementation. I would also like to thank Jose de Koeijer for being so kind as to allow the use of two of his oyster pits for the entire duration of this experiment as well as draining the pits for observations and aiding in the cleaning of the plots. I would also like to offer my special thanks to Greg Wacklawek for aiding in the monitoring and driving to Yerseke many times. Assistance provided by Tony van der Hiele also contributed in the success of this research.

1. PREFACE AND BACKGROUND

"Learn to live with the Oyster Drill" the project focuses on lessening the effect of the oyster drill for oyster farmers. The Japanese Oyster drill is an invasive marine snail that has expanded fast in the last couple of years. It drills a hole in the shell of an oyster and eats it. Some oyster cultivation plots are home of ten thousand of drills, leading up to 90% of oyster mortality.

Practical research with the grant from SIA, the research group Aquaculture aims to research knowledge questions about oyster drill mobility, feed preference, and eradication on oyster plots, together with the Dutch Oyster Association and 14 farmers. Experiments will be carried out by researchers and students, both in the SEA Lab and at oyster cultivations sites in the Oosterschelde. There is a collaboration with a University in the USA, that already has some experience with similar research.

The ambition of the project is to find recommendations for oyster farmers on how to minimize the negative effects of the oyster drill." From: https://hz.nl/en/news/projectvoorstel-leren-leven-met-de-oesterboorder-als-beste-beoordeeld-door-sia-1

"The Japanese Oyster Drill (*Ocinebrellus inornatus*) was first spotted off the coast of France in 1995, and has since then by means of transportation and importing of oysters has brought them into the Netherlands, being first spotted in Gorishoek in 2007. Two species of Oyster drills are present in the Netherlands, the American Oyster drill (*Urosalpinx cinerea*), and the Japanese Oyster drill (*Ocinebrellus inornatus*), which will be the main focus of this dissertation. Since the first spotting of the Japanese Oyster drill in off the coast of the Eastern Scheldt, it has two primary locations that it calls "home", the oyster cultivations plots in on the Yerseke bank, nearby Yerseke and Lake Grevelingen. The Japanese Oyster drill is an invasive species and because of that it has no natural predators found in the Netherlands, it is suspected that it arrived by import from a ship. Ever since its initial introduction in 2007 in the Netherlands, *Ocinebrellus inornatus*, or commonly there known as the Japanese Oyster drill has become a problem for the economy and oyster farms.

It is incredibly difficult to control an invasion once it has begun thus why researchers, and research group Aquaculture under HZ University of Applied Sciences is working diligently to finding a feasible solution in order to contain the problem. Prevent the oyster drills from spreading to further parts of the Netherlands, and also figuring out a way to limit the damage the level of damage they are so capable of inflicting." *From Belma Colakovic Report December 2018*

A previous research experiment attempted to explore the effect of a mussel seed barrier on the predation of oysters by the Japanese oyster drill. This experiment was conducted on a smaller scale (100x100cm plots) and took place in the intertidal zone close to Yerseke in the Oosterschelde. The results were inconclusive due to a large storm disturbing the experimental set up, so this experiment is being conducted in the oyster pits in order to minimize disturbance.

2. THE EXPERIMENT

By forming a mussel seed barrier around the oyster drills there can be tested if it would be possible to inhibit or delay the movement of the oyster drills towards pacific oysters. There are three variables which are being tested in this experiment: the width of the barrier, the time the oyster drills were added to the experiment (to give time for the mussels to "attach" and produce sediment) and the presence or absence of a substrate. The reason behind the different size barriers is due to the different effect it may have on the mobility. The oyster drill senses it's prey via chemical cues with its sense of "smell" and previous research indicates different prey smells influencing the behavior of the oyster drill depending on the abundance and ratio of different prey. The presence of the substrate will also show if the movement may be influenced by the presence of a favorable egg laying medium. Lastly, the reason behind two different dates in which the oyster drills are added is to see if the mussels need time to produce sediment and fully attach with their byssal threads in order to be most effective as a barrier.

3. Aim and main question

The aim of this experiment is to see if a mussel seed barrier might act as an effective way to limit the movement of the Japanese oyster drills towards pacific oysters.

Main Question:

How effective can a barrier of mussel seed (*Mytilus edulis*) be against the Japanese Oyster Drill (*Ocinebrellus inornatus*) in order to reduce predation on oysters?

Sub questions:

- Do the mussel seed need time to attach to a surface, using their byssal threads, and the production of sediment in order to be most effective?
- Does the presence of substrate affect the effectiveness of the barrier?
- How wide must the barrier be in order to be most effective?

4. HYPOTHESIS (EXPECTED RESULTS)

For this experiment it will be tested if mussel seeds are an effective barrier against the Japanese oyster drill. Multiple hypothesis includes the mussel seeds acting as:

- **An Alternate Food Source**

The oyster drill is an opportunistic predator and will often prey on whatever is readily and easily available. If the mussel seeds are more numerous and easily available, the oyster drill may choose to prey on the mussels rather than the oysters.

- **A Chemical Barrier**

Oyster drills sense their prey via chemical smells, previous research has shown that when multiple food sources are present the chemical reactions can influence oyster drill behavior.

- **A Physical Barrier**

Mussels create byssal threads to attach themselves to a solid surface. This may possibly act as a net to catch the oyster drills. Additionally, by creating uneven terrain due to the mussels, the oyster drills may have more difficulty reaching the oysters.

5. MATERIALS AND METHODS

5.1EXPERIMENTAL SET UP

5.1.1 Preparing And Painting The Drills

A size class of drills between 38mm-43mm was used in this experiment. Prior to placing the oyster drills in the plots, the drills were kept in the HZ sea lab with proper aeration, temperature control at 6 degrees Celsius (current Oosterschelde water temperature), and their tanks were cleaned every 2 days to ensure a stable living environment. The drills were not fed for a week prior to being placed in the pits.

The oyster drills were painted so that they could be better noticed and easier to observe. This would also ensure no oyster drills would escape into the oyster pits.

30 drills for each of the first six plots were primed with a silver iron primer by lightly dabbing the shell with a sponge. The same process was then repeated with a colorful spray paint and sponge. The drills were let too dry before being reintroduced into the sea lab tanks until placed into the plots.

5.1.2 Forming The Plots:

The experiment was conducted for a total of four months in the Yerseke oyster pits. A total of 13 plots spread between two oyster pits were used in this experiment. Each plot was sectioned off by oyster crates consisting of Pacific Oysters (*Magallana gigas*). Image 1 shows one of the pits which, at the time, formed eight plots. This image was taken during the set up process before the mussel barrier was put in place. Each plot measured three meters by three meters (including the oyster crates, therefor creating an overlap by 48cm) each with a variation of 0,5, 1,0 or 1,5 meter mussel barrier.

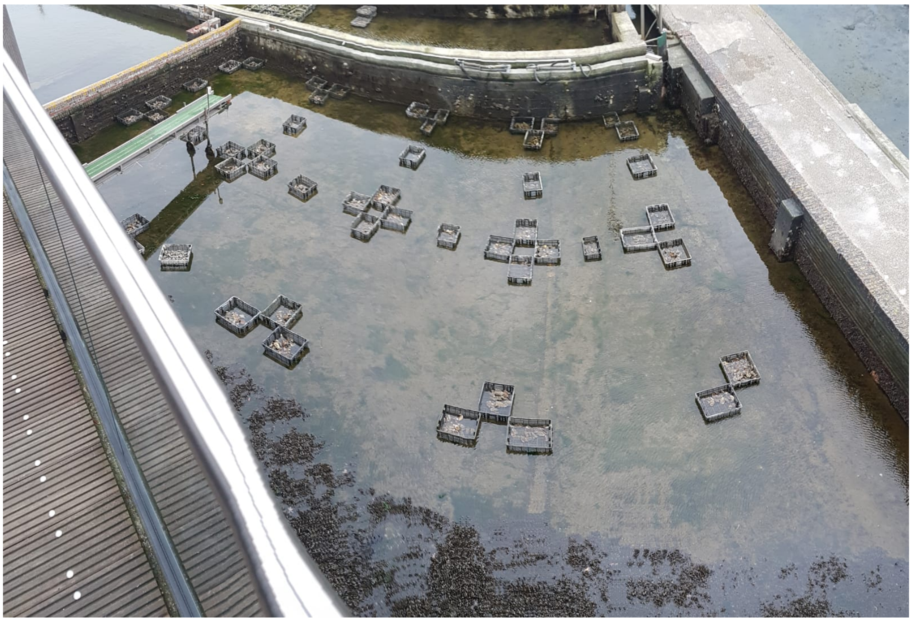


Image 1: 8 Oyster Plots In The Process Of Being Formed, Prior To The Addition Of The Mussel Seed Barrier.

Each plot consists of 3 zones which is depicted in diagram 1. Zone 1 is in the middle and is 50x50cm. It has 30 colored oyster drills. Zone 2 is the mussel seed barrier of either 50cm, 100cm, or 150 cm in width (the plot of a 0.5 M barrier consisted of 24kg of mussels divided on 2m^2, the 1M barriers contained 72kg of mussels divided on 6m^2 and the 1,5M barrier consisted of 144kg of mussels divided on 12m^2. Zone 3 is beyond the mussel seeds and has the pacific oysters.

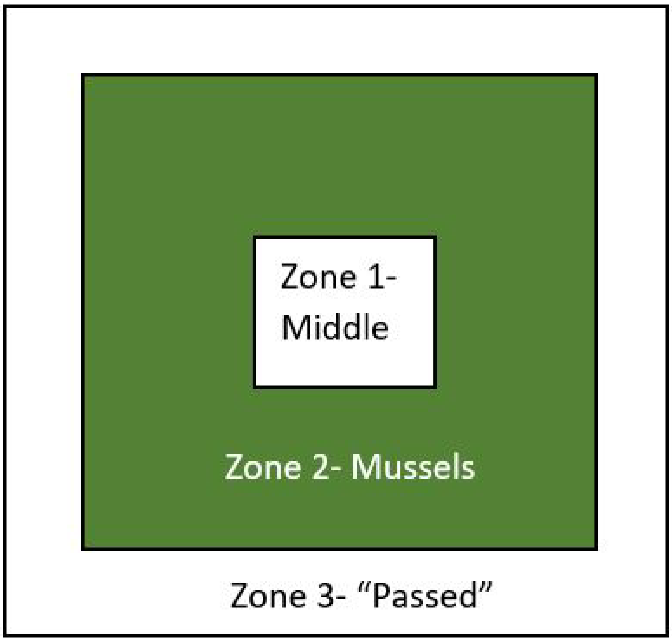


Diagram 1: The Three Zones Associated With Each Of The 13 Plots In The Experiment

6.1.3 Placing The Mussel Seed Barrier:

1100kg of mussel seed was fished on the Yerseke bank 48/49 with a vessel from MinLNV called The Regules. The mussels were then brought to the Yerseke oyster pits and spread out in order to ensure no suffocating of the mussels would occur. A 50cmx50cmx100cm cage was placed in the center of a plot before spreading the allotted amount of mussels in its respective width around the cage. Each plot was randomly assigned the size of the mussel barrier by means of a computer form all of the 13 plots. 30 oyster drills were added into the center of the first 6 plots by means of a hollow circular tube to ensure accuracy in the placement. Image 2 shows the overall set up and the plot number associated with each plot. Table 1 shows the set in of the experimental set up, including which plots have substrate, the width of each barrier, the color of the added drills, and the week in which the drills were added. The 6 other plot where provided with 30oyster drills after a period of 4 weeks, to give the mussels time to make some sediment.

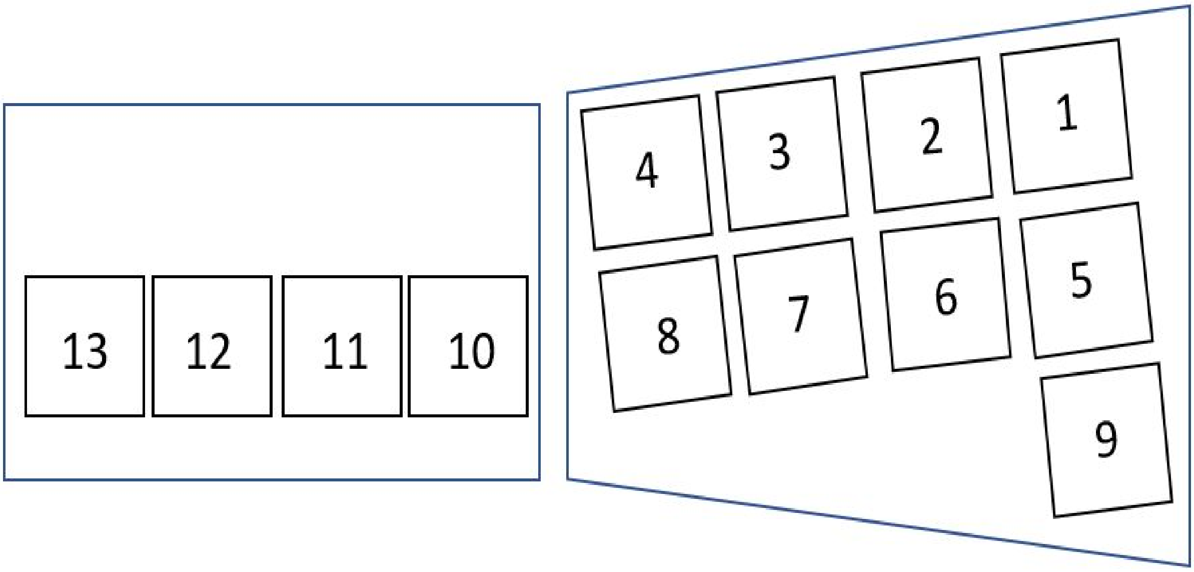


Image 2: The Plot Layout In Each Of The Two Pits With Their Associated Plot Number.

Table 1: Set In Of The Experimental Set Up In Full Detail

Plot number	Drill color	Barrier size (CM)	Drills Introduced On Week	Substrate Present
1	yellow	100	1	yes
2	pink	150	1	no
3	orange	50	4	yes
4	pink	150	4	no
5	white	50	1	no
6	yellow	100	4	yes
7	green	100	4	no
8	green	150	1	yes
9	orange	150	4	no
10	blue	50	1	no
11	orange	100	1	no
12	green	50	4	yes
13	no color	50	2	no

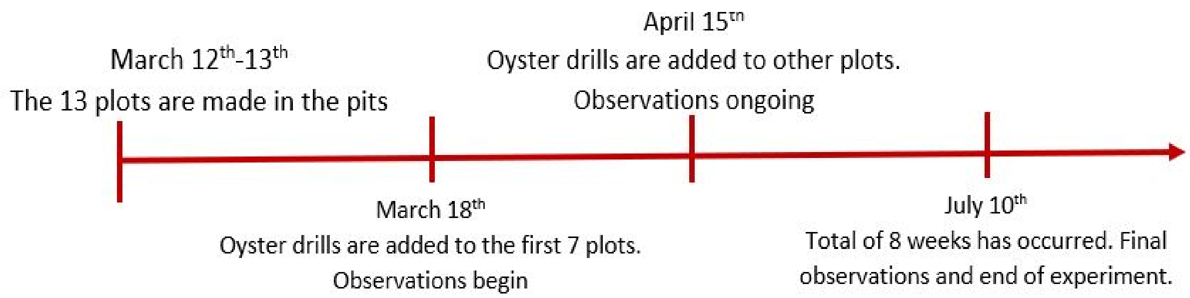
5.2 MONITORING

Monitoring is being conducted 2-3 times a week, for a total of 4 months. This includes:

- Noting the position of all visible oyster drills, broken down into the three zones and two border zones (when a drill is found between zone 1 and 2 or zone 2 and 3).
- Taking pictures of the drills or anything notable with the waterproof camera and the underwater window.
- Removing all drills who have passed into zone 3.

- Raking all algae and additional growth which impacts visibility in the pits (once a week).
- Draining the pits, either half way or fully

TIMELINE:



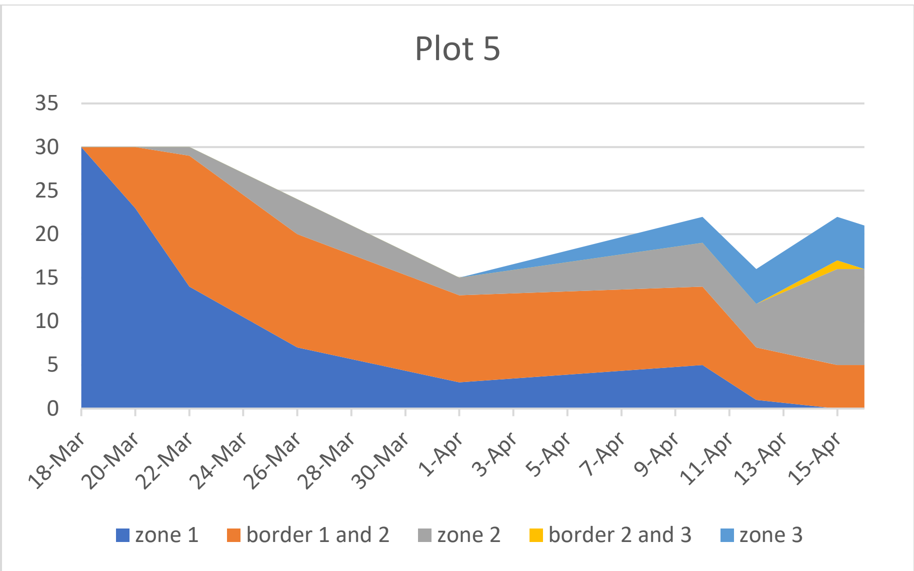
6. RESULTS

While the experiment is still ongoing and will continue for the total duration of four months, an intermediate conclusion can be drawn from the results and data collected within the first month. Since implementing the experiment on March 18th 2019, the following has been observed:

- The oyster drills in the plots with the smaller barriers have had a higher and quicker "pass" rate so far.
- The direction of the drill movement is correlated with the current formed by draining the pits, especially with plot number 1 which is directly beside the drainage door.

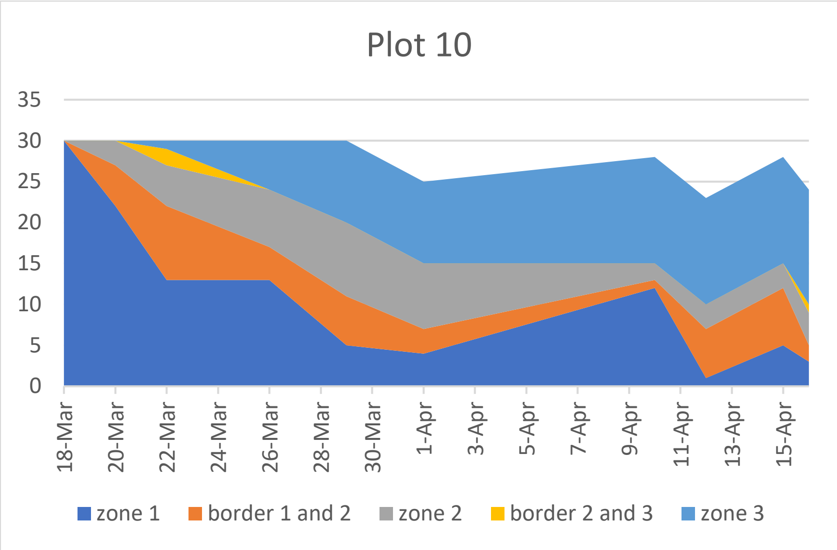
6.1 RESULTS SO FAR BY PLOT:

Plots of 50 cm barriers



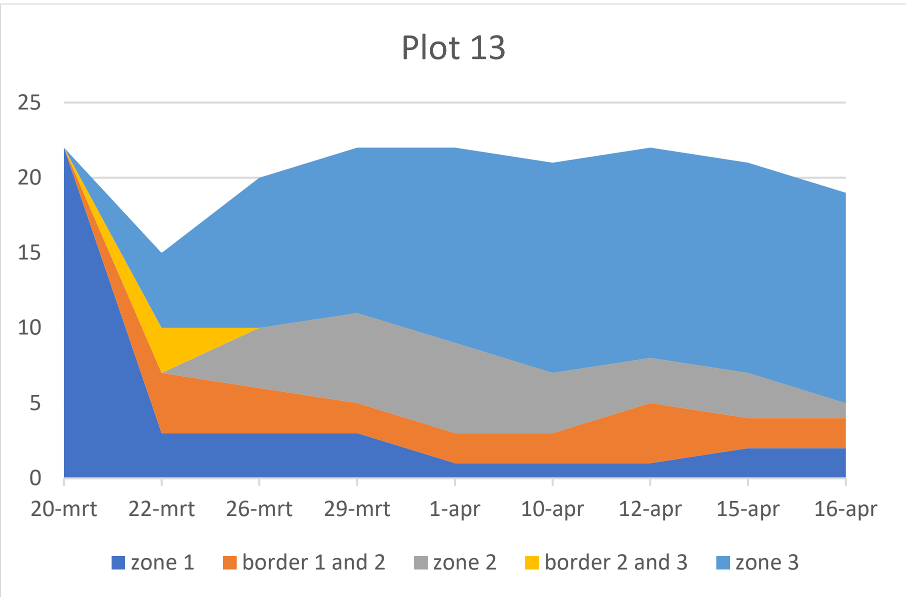
Graph 1: Plot 5, 50cm mussel barrier

This one-month observation of plot 5, a 50 cm mussel barrier, shows that the first drills to pass into zone 3 passed 23 days into the experiment and a total of 3 have passed so far. This is a success rate of 10%.



Graph 2: Plot 10, 50cm mussel barrier

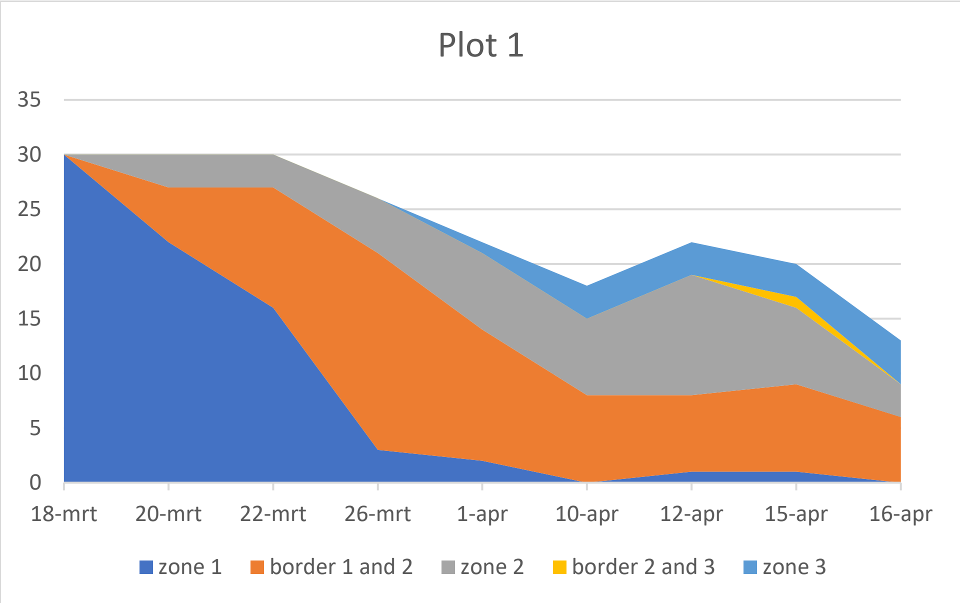
This one-month observation of plot 10, a 50 cm mussel barrier, shows that the first drills to pass into zone 3 passed 5 days into the experiment and a total of 13 have passed so far. This is a success rate of 43.33%.



Graph 3: Plot 13, 50cm mussel barrier

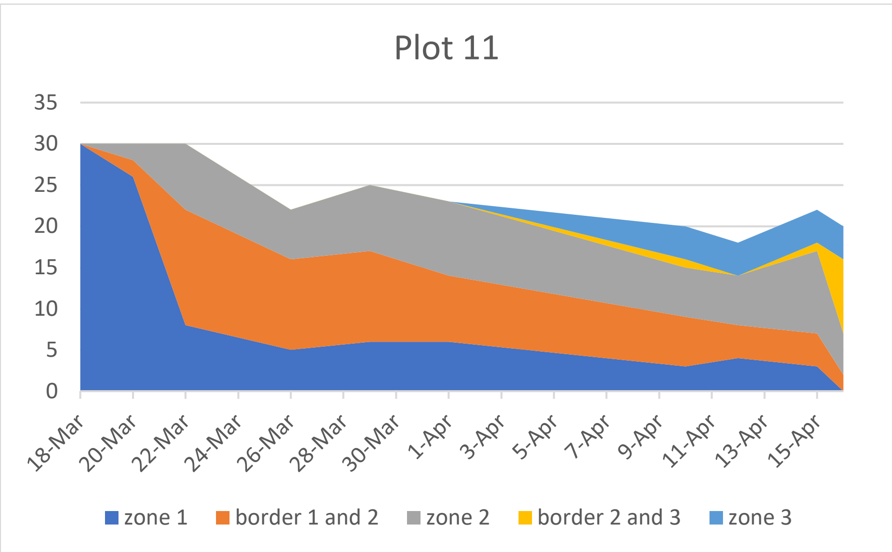
This one-month observation of plot 13, a 50 cm mussel barrier, shows that the first drills to pass into zone 3 passed 2 days into the experiment and a total of 14 have passed so far. This is a success rate of 46.67%.

Plots of 100 cm barriers



Graph 4: Plot 1, 100cm mussel barrier

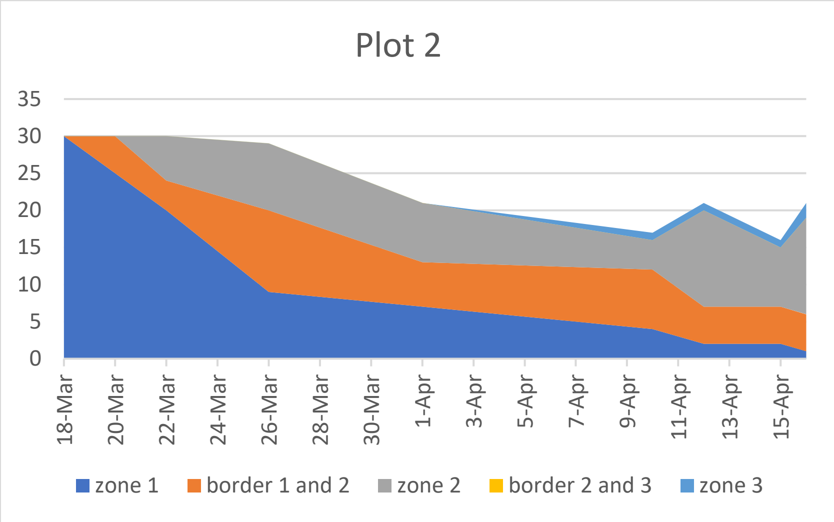
This one-month observation of plot 1, a 100 cm mussel barrier, shows that the first drills to pass into zone 3 passed 14 days into the experiment and a total of 3 have passed so far. This is a success rate of 10%.



Graph 5: Plot 11, 100cm mussel barrier

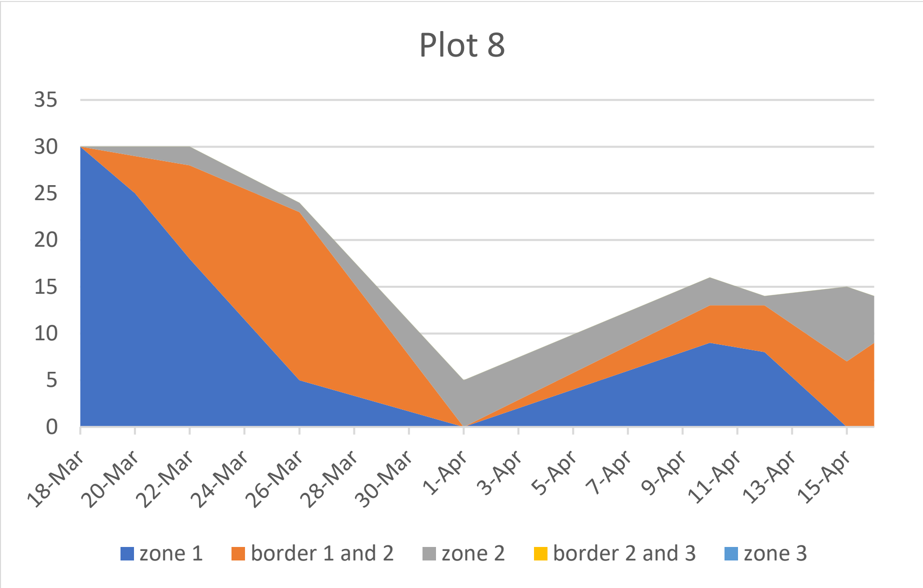
This one-month observation of plot 11, a 100 cm mussel barrier, shows that the first drills to pass into zone 3 passed 23 days into the experiment and a total of 4 have passed so far. This is a success rate of 13.33%.

Plots Of 150 Cm Barriers



Graph 6: Plot 2, 150cm mussel barrier

This one-month observation of plot 2, a 150 cm mussel barrier, shows that the first drills to pass into zone 3 passed 14 days into the experiment and a total of 3 have passed so far. This is a success rate of 10%.

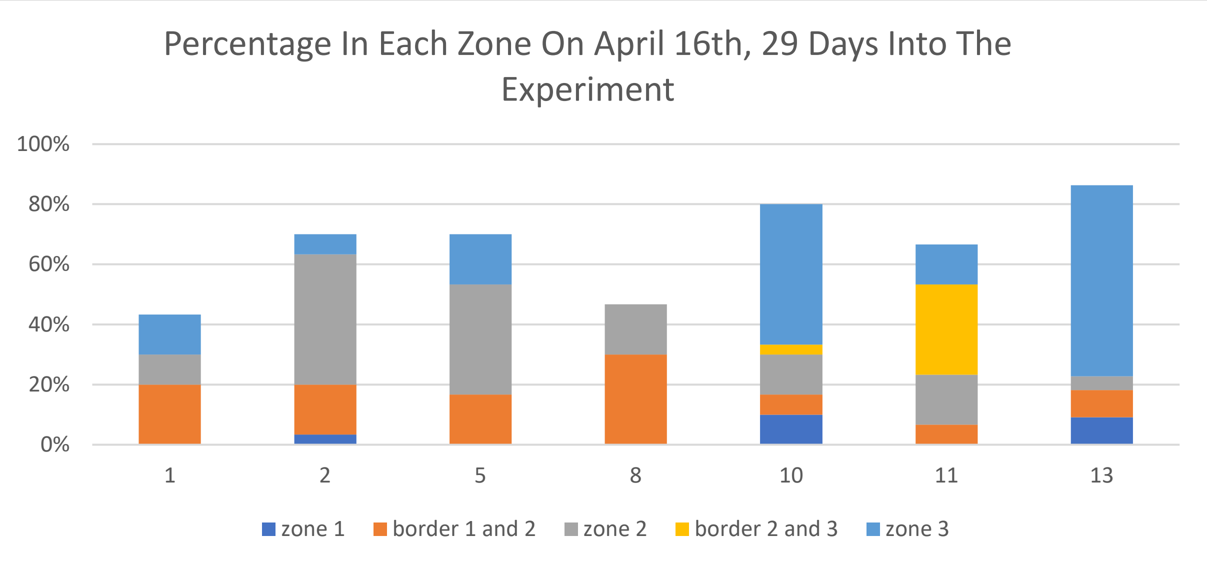


Graph 7: Plot 8, 150cm mussel barrier

This one-month observation of plot 8, a 150 cm mussel barrier, shows that no drills have passed into zone 3. This is a success rate of 0%.

6.2 RESULTS SO FAR IN PERCENTAGE OF EACH ZONE BY APRIL 16TH, 2019

Graph 8 demonstrates the percentage of drills in each zone in every plot.



Graph 8: Percentage In Each Zone As Of April 16th 2019 (29 Days Into The Experiment)

Table 2 shows the percentage of drills in each zone after a month had passed. The 50 cm barriers saw a higher pass rate with an overall average of 42.67% The 100 cm barrier had an overall average pass rate of 13% and the 150 cm barrier had an average pass rate of 3.5%

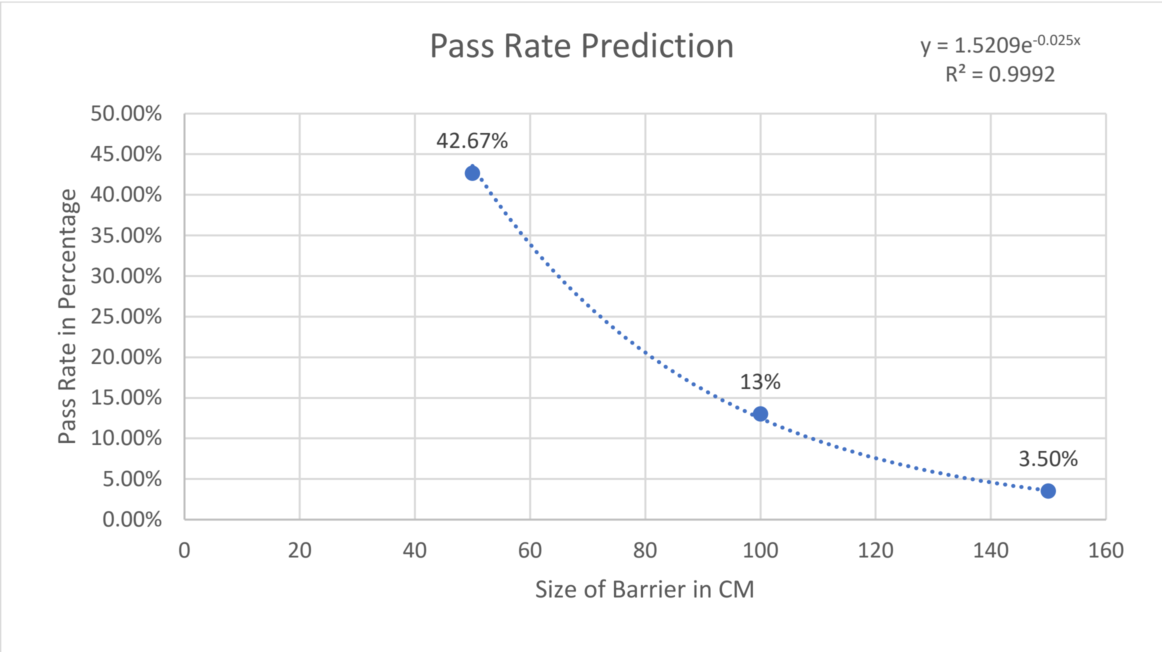
Table 2: Percentage Of Drills In Each Zone By April 16th 2019

PLOT:	1	2	5	8	10	11	13
ZONE 1	0%	3%	0%	0%	10%	0%	9%
BORDER 1 AND 2	20%	17%	17%	30%	7%	7%	9%
ZONE 2	10%	43%	37%	17%	13%	17%	5%
BORDER 2 AND 3	0%	0%	0%	0%	3%	30%	0%
ZONE 3	13%	7%	17%	0%	47%	13%	64%

50 CM BARRIER **100 CM BARRIER** **150 CM BARRIER**

Graph 9 shows the predicted trend between barrier size and pass rate using the assumption that the trend is of logarithmic nature. For a more certain and reliable conclusion it is recommended that this experiment be conducted with more then three barrier size variables implemented as using only three barrier size classes leaves room for uncertainty.

Graph 9: Pass Rate Prediction



7. INTERMEDIATE CONCLUSION

Based on the above observations and data collected one is able to draw an intermediate conclusion on the effect of the mussel seed barrier size on drill pass rate towards pacific oysters. At this time no conclusions can be drawn on if the presence of substrate impacts the pass rate of oyster drills or of giving the mussel barrier time to attach and form sediment influences the pass rate either.

Given the results so far, one can conclude that a wider mussel seed barrier decreases the likelihood that an oyster drill will successfully travel through the barrier and reach the pacific oysters found on the other side of the barrier.

8. RECOMENDATIONS

- Don’t paint the drills so heavily. now we dip the drills into a sponge which has been sprayed and they seem to be less affected by the toxins.
- Begin a regular cleaning schedule of the pits in order to ensure best visibility when observing and monitoring.
- Better communication with Jose in order to ensure the pits are drained for proper monitoring
- It is recommended that more than three sizes of barriers be tested so that this information may be used to create a reliable equation in order to predict pass rate of the oyster drills.