Optimal Stocking Density of the Eastern Oyster (*Crassostrea virginica)* in Upwellers at the Sound School

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INTRODUCTION

The aquaculturing of oysters has been practiced since the late 1800's, when eastern North American species were transplanted to western coasts in order to rebuild the population (Dumbauld 2009). *Crassostrea virginica*, commonly known as the eastern oyster, inhabits the eastern coast of the U.S. in the mid-Atlantic. This species has been found recently, within the past few decades, on the northern coasts of the Atlantic around New Hampshire and Maine (Capone 2008). The sale of these shellfish are important ecologically, and are continuously growing. Data taken from the Virginia Institute of Marine Science show that in only one year, the value of oysters (28 million single oysters) has gone up from $6.7 million in 2011 to $9.5 million in 2012 (NOAA). The demand for oysters is steadily increasing, along with many other aquacultured organisms, and is predicted to continuously increase over time (State 2014). Since oysters are becoming heavily sought out for food, the aquaculturing of these organisms is becoming more popular.

C. virginica is an oyster species that has been grown at the Sound School Aquaculture Center for many years. This research on the bivalve suspension feeders was focused on the upwelling stage of oyster culturing, where seeds were cultured in silo upwellers. This technique has been used for many years, but the site specific optimum stock density for a silo in these upwellers has not been analyzed at their facility. Hundreds of oyster seeds can be cultured in these upwellers, but it has not been determined how many of these seeds should be cultured in the silo in order to create an optimum harvest (minimum amount of mortality and maximum amount of growth). By finding the optimum density of oysters in a silo, oyster culturing can become more efficient, and allow oyster aquaculturing facilities to increase their profit. It was predicted, that if the density is lighter, there will be greater growth for the oysters, since there would be less competition for nutrients.

METHOD & MATERIALS

Approximately 90,000 oysters were taken from the downwelling system at the Sound School Aquaculturing Center (Sound School), and organized into 9 silos within the upweller system (Figure 2). Three replicates were made for the three possible stocking densities: light, medium, or heavy. Light (l) stocking densities averaged .3L of oysters, medium (m) densities averaged .8L, and heavy (h) densities averaged a 1.6L density. Each silo was approximately 37.9L with a surface area of 637.6 in^2. The silos were placed in an upweller tank located on the end of the Sound School's dock. Each silo's density was labeled (Dl, Dm, Dh) and what number of the density it was (1, 2, or 3) by cutting an inch PVC pipe 1 inch long, and cutting a slit to wedge it on the edge of the silo. Each week the position was changed for each silo within the upweller, to ensure no bias towards flow rates, by generating random numbers using the computer program "R".

Different measurements were taken each week. The total volume of each silo was taken using graduated cups, and filling them with the oysters without the water. Sizes were also taken from each silo, by selecting 20 random oysters, and taking the diameter using calipers. Average volumetric counts of each silo were taken each week. The tank and silos were thoroughly scrubbed each week to assure biofouling on the bottom and sides of the silos did not affect the flow of water to the oysters. The data was analyzed by looking at the change in volume for each density over the six (6) week period.

RESULTS

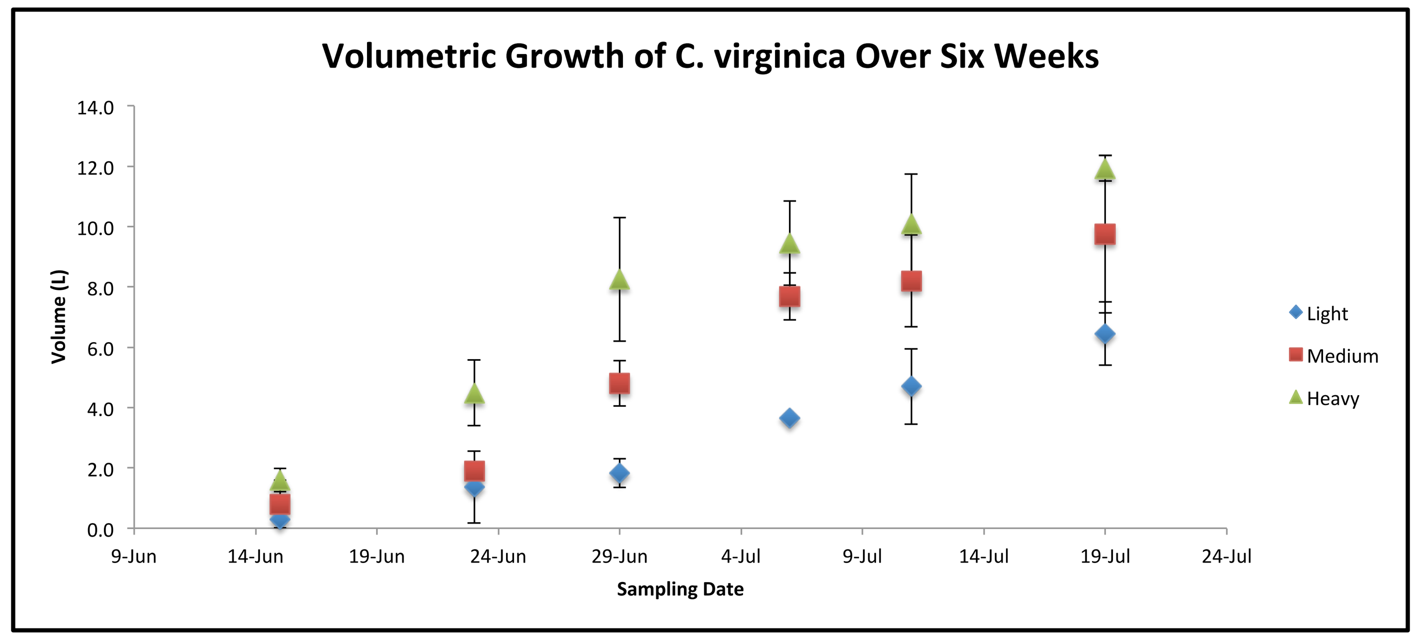

Figure 1: Average volume of the silo densities for each sampling date.

Figure 2: Upweller system holding the nine (9) silos of oysters.

	Light	Medium	Heavy
Initial Average Volume	0.3	0.8	1.6
Final Average Volume	6.45	9.75	11.93
Change	21.5	12.1875	7.45625

Table 1: The initial and final volume of oysters in the 14.5 inch diameter silos. Then the change in volume is indicated as a proportion of the final volume compared to the initial volume (Final/initial).

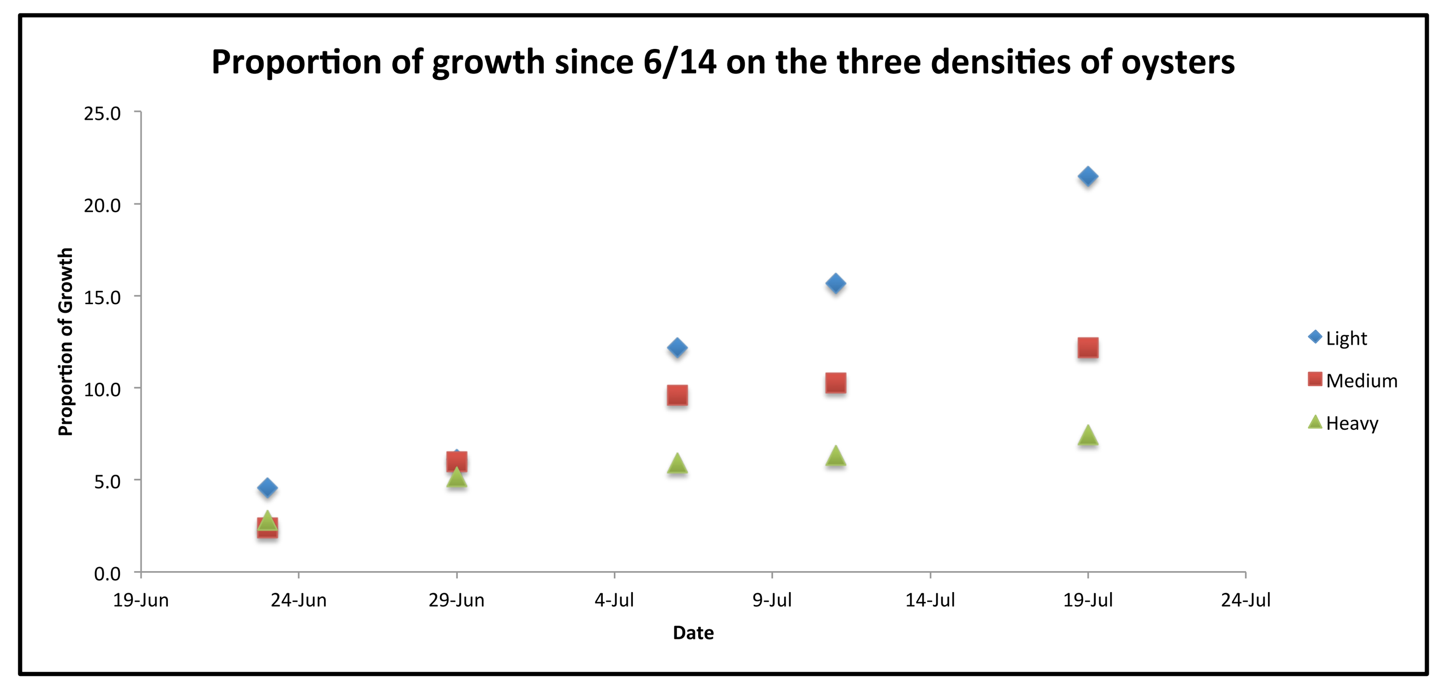

Figure 3: This graph depicts the proportion of total silo growth since the first week of sampling in the heavy, medium, and light densities.

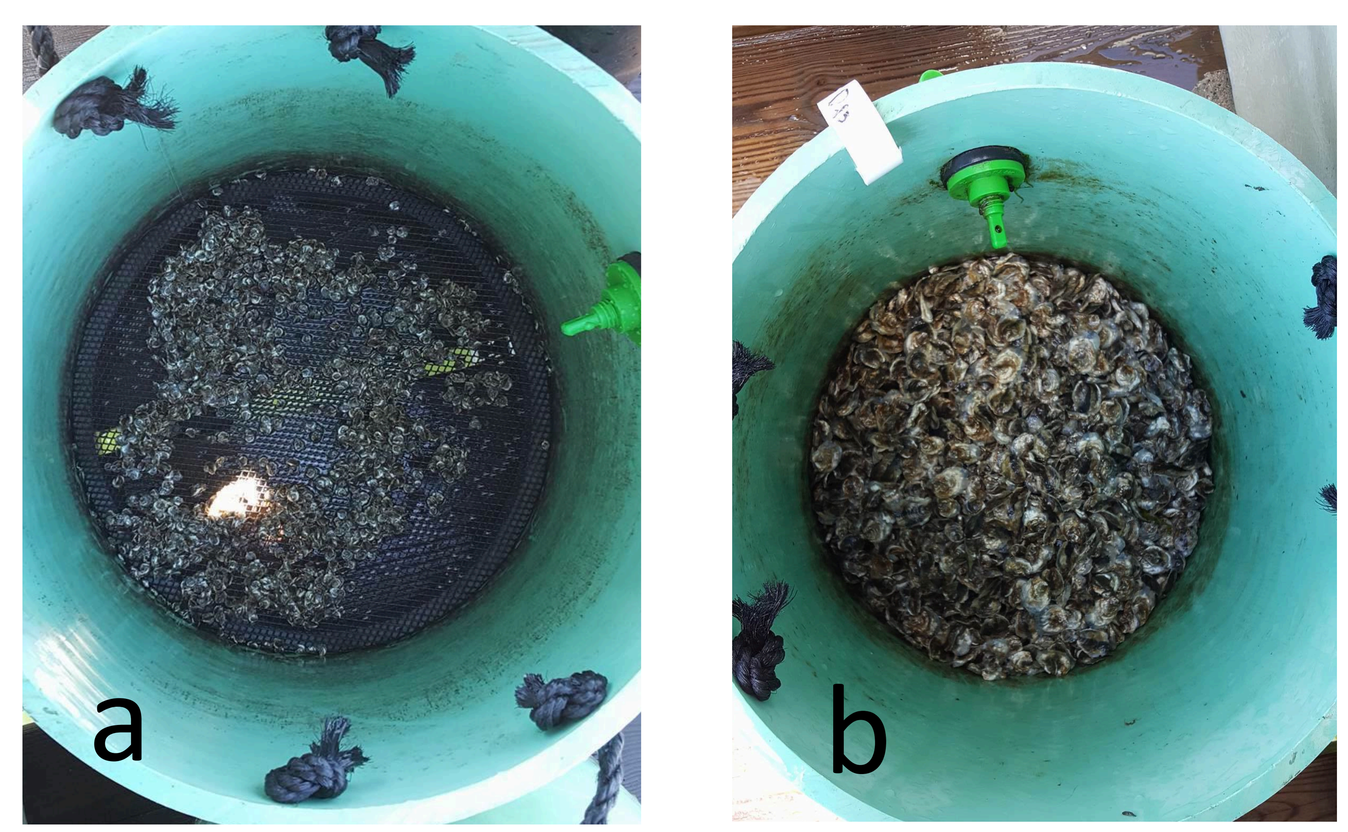

Figure 4 (a&b): The left photo (a) is the starting density for Dl_3 (Light density #3) on 6/14/16, while the right photo (b) is the Dl_3 silo on 7/19/16.

- Growth was seen volumetrically in all three densities of the silos.
- There was a higher change in volume in light densities compared to heavy densities.
- Sizes of oysters varied more in the higher densities than in the lower densities.
- Larger oyster sizes were found in light densities.

DISCUSSION

Through simple visual observations, it could be seen at the end of the 6 week data collecting period, that the oysters in heavy densities varied in their sizes (Figure 1, and no significance could be determined. Each week, it was also observed that the larger oysters were closer to the surface of the silo. Since the oysters at the surface of the silo are accessing the nurtients first, they are outcompeting the other oysters in the silo, making them larger (Dumbauld 2009).The heavy densities resulted in the largest volume of oysters, and the light density resulted in the smallest volume by the end of the data collection. This was only because the heavy densities started with larger volumes/densities (Figure 1). By looking at the increase of volumetric growth each week compared to the first week, proportional increases in volume can be derived, allowing comparisons between the three densities (Figure 3). The light stocking density increased 21.5x in size, the medium density increased 12.2x in size, and the heavy density increased only 7.5x in size (Table 1). This infers that decreasing crowding in the silos could result in increased growth rates in oysters. It can also be seen that the medium and heavy densities were starting to level out their growth, while the light density continuously had a steady increase in volume (Figure 3); the light density has not reached it's cap yet for efficient nutrient uptake.

Even though the light stocking density (approximately .3L for a silo with a 14.5 inch diameter) had the best growth, it is not the optimal stocking density for the Sound School. There was a total of 7.925 L of oysters to be split into silos. In order to start the silos at .3L each of oysters, a total of 27 silos would be needed, and only 12 silos are available. Further research will need to be done in order to find the optimal stocking density between the light and medium, so that space can be optimized.

REFERENCES

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