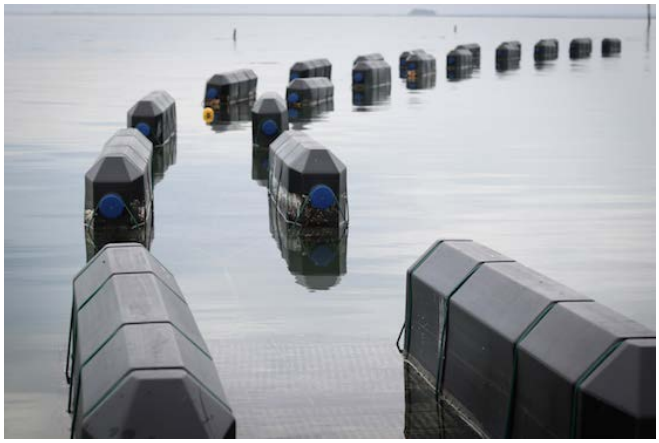
Techniques to Improve Production of Off-bottom Cultured Oysters

Reporting Period: September 1, 2018 - October 31, 2019
Length of Project: 2 years
Current Project Year: 2
Total Funds Committed: $249,691
Principal Investigator: Susan Lovelace, *South Carolina Sea Grant Consortium*; Thomas Bliss, Robert Bringolf, *University of Georgia*; Leslie Sturmer, *University of Florida*; John Supan, *Louisiana State University Agricultural Center*; William Walton, *Auburn University*; Charles Weirich, *North Carolina State University*

Relevance: The benefits associated with fine tuning methods to control biofouling when using the OysterGro™ system to grow high value single oysters include: reduced labor costs, improved product quality, improved yield, and shorter grow-out time. The methods used commercially today by the emerging oyster aquaculture industry in the Southern U.S. are effective, however, reducing or increasing the frequency of aerial drying and/or applying a fouling release coating could improve the profit margin of the business without impacting or improving product quality. These benefits will allow growers within the Southern U.S. to grow their businesses quicker and take advantage of strong and expanding markets for high value single oysters.



Response: The objectives of this project are to:

1) Determine the impacts of cage manipulation to decrease biofouling, and evaluate the effects on time to harvest, survival, and morphometric factors, such as meat weight and shell shape (height, length, depth).
2) Determine the impacts of antifouling agents to decrease biofouling, and evaluate the effects on time to harvest, survival, and morphometric factors, such as meat weight and shell shape (height, length, depth).
3) Determine the economic impact of each methodology on production costs.

Results: The field component of the project on Gulf Coast was terminated in June 2018 with harvesting of the product and final sampling. On the Atlantic Coast, by June 2018, 70% or more of the oysters in the bi-weekly flipping treatment had reached harvest size in North Carolina and South Carolina within the reporting period. In Georgia, however, the oysters were smaller. As of June 2018, the gear in each Atlantic state had not been exposed to what would be considered a heavy fouling season (i.e. summer). The decision was made to treat the June sampling trip as a 'harvest' sampling for NC and SC. At that time the densities were reduced in each bag as outlined in our proposal and the experimental treatments continued to be applied until the one-year post-deployment time. Sample processing for the Gulf States commenced during the reporting period and carried on into 2019, as did sample processing for the Atlantic States.

October 2018

In October 2018, in the South Atlantic, all remaining bags were emptied and weighed immediately using a fish scale to determine the overall wet weight of bag fouling and bag sides were photographed. Fouling on oysters appeared to be unaffected by both drying regimes and bag coatings.
This was unexpected, as tidal aerial exposure has been shown to decrease fouling coverage on oysters (Bishop and Peterson, 2006). Increased fouling on cultured shellfish within bags coated with fouling-release agents has also been observed, as organisms settle on the next hard uncoated substrate they encounter (Sievers et al., 2017; Tettelbach et al., 2014). While there were small but significant differences among drying treatments in hard fouling ratios for SC and
NC oysters in June, there were no differences among any treatments for total or soft fouling ratios among any states in June or October.

Biofouling accumulation trends varied among sampling seasons. Overall, there seemed to be a negative relationship between drying frequency and fouling accumulation in December.
Triweekly drying treatments had the highest fouling percent coverage in SC and weekly drying bags had significantly lower percent fouling coverage for GA, NC, and combined data. In contrast, biweekly drying in GA had higher fouling coverage compared to weekly and triweekly bags. However, fouling coverage in all drying treatments in December was low (<20%) and oysters were not yet at harvest size. The negative trend between drying frequency was not as evident in March. While SC and combined data showed that triweekly bags had higher percent coverage, GA and NC showed no difference.

While our findings suggest that aerial drying frequency and bag coating treatments provide little difference among fouling coverage, ratios, and occurrences, there are many factors that could have altered our findings. Differences in October bag coverage trends and the lack of difference among bag weights in GA and SC may be explained by the overall success of the flipping regimes. With SC having reduced stocks, drying regimes continued without any issue while GA oysters grew heavier than the cages could handle, causing them to flip back over before the full 24-hour drying time was complete, thus decreasing the efficacy of the drying regimes. While fouling ratios may have showed little to no treatment effects, the length of time between sampling season may have resulted in us overlooking differences. By the October sampling period, GA oysters were so significantly fouled that stocked bags were full, and oysters needed to be broken apart in the bags prior to harvest. Freezing oysters prior to fouling analysis may have also affected our results. Ascidians either fell off the oysters as they were removed or lost water while traveling back to the freezers, decreasing both their mass and occurrence. If fouling was assessed biweekly or monthly and with live organisms, differing trends may have been easier to identify.

Overall results

Data were organized using Excel®2016. Bags within cages represented our experimental units as these bags were the lowest level of randomly assigned treatment and each oyster sampled was considered a subsample. Therefore, mean oyster measurements, growth rates, weights, and CI were calculated per bag. Comparisons were made within states with data analyzed quarterly to determine seasonal effects of treatments. No comparisons were made among states because of site variation.

In the South Atlantic States (GA, SC, NC) the experiment started in early October with oysters in SC and NC reaching harvest size by June. Oysters in Georgia reached harvest size by August. Our endpoint for the experiment was set at when the majority of oysters in the 'every other week' flipping treatment reached 76 mm (3 inches). Across all states, the oysters flipped less than that (every three weeks) were larger and those flipped more frequently (weekly) were smaller. Reasonably, the oysters not flipped as

often have more time to feed and are not jostled around by the flipping action thereby maintaining their fragile growing edge longer. The oysters contained in cages that were flipped on a weekly basis needed a bit longer to reach market size (4 weeks) but they were slightly 'cuppier' than the other treatments, which is a desirable market characteristic.

The most profitable scenario in SC and NC was to flip every three weeks, however, the oysters reached market size in June prior to the peak of heavy fouling season. In SC, a sample of oysters was maintained in each cage and flipping treatments applied until September. By September, the oysters in cages flipped every other week and every three weeks were more fouled than those flipped every week. In Georgia, the degree of fouling was higher likely due to site selection in a high energy area prone to barnacle settlement. The degree of fouling in GA was such that the oysters would have required some cleaning prior to being sent to market. In SC, had the oysters been held through the summer, those flipped on a non-weekly basis would have required cleaning prior to harvest as well. Based on the results of the study, we recommend employing a more frequent flipping routine when larval settlement (and therefore fouling) is at its peak in your area, which is usually during the warmer months of the year.

We recommend an approach that increases the frequency of flipping in the warmer months because even though fouling can be cleaned off of the oyster it is: 1) more difficult and time consuming to clean the cage and bags and can impact life span of the gear; 2) the appearance of the oyster is marred by cleaning fouling and you may not achieve the price point you desire, and; 3) when fouling becomes heavy it will impact meat quality.

Oysters in Louisiana and Florida reached market size quicker than those in Mississippi and Alabama. In FL and LA, oysters were ready for harvest after 24-30 weeks while in MS and AL they required 32-38 weeks of grow out time. Florida experienced the highest degree of fouling which impacted profit. Although flipping every three weeks is most profitable it is important to consider product quality, impact of fouling on the longevity of the cage and associated rigging, and the fact that meat quality was poorer in those oysters which were in cages flipped only every three weeks. In Alabama, mortality was higher than in other states and did not correlate with air drying frequency but was the biggest factor impacting profit. The shortened grow-out time in FL and LA could lead to higher profits overall and help off-set the cost of a more frequent flipping routine because the crop can be turned over more frequently.

It is important to keep in mind that these models represent an experiment conducted at one site in each state. Each state and indeed each waterbody can have its own characteristics and differences in fouling. The information presented here is a reflection of our experience with this experiment and it should not be assumed the experience will be the same at every site. It does, however, aid the thought process on factors to consider when employing an air drying routine to control biofouling in the Southern United States

Outreach Overview:
As this project reached its conclusion the team focused on sharing products and information with growers throughout the project area. This included presentations at scientific and trade meetings, posting on information websites, video production, presentations and thesis generation by the two student involved in the project.

Targeted Audiences: Oyster producers in the Gulf and Atlantic States.

Outputs: Economic Model, A Microsoft Excel spreadsheet model which will assist a grower in determining the effect of employing either a weekly, every other week, or every three weeks, air drying routine. A separate model has been developed for each state based on the biological results of the study.

Outcomes/Impacts: During the reporting period, there are no impacts as the project had yet to be deployed. In the South Atlantic, however, the project realized one significant accomplishment in that as a result of this project, the state of Georgia allowed import of oyster seed with no detectable level of disease into the state. This project also represents the first time floating oyster cages have been permitted for deployment in Georgia and Mississippi.

Partnerships Developed: None to date.

Products developed and Students Supported:

Journal Articles and Abstracts:
Chapman, E., Davis, J., Rider, J., Sturmer, L., Walton, W., & Supan, J. 2019. Comparing Off-Bottom Techniques of Oyster Aquaculture *Crassostrea virginica* on Biofouling in the Northern Gulf of Mexico. Program and Abstracts of the 2019 Triennial Aquaculture Meeting of the World Aquaculture Society, National Shellfisheries Association, Fish Culture Section of the American Fisheries Society, and the National Aquaculture Association: 217. ABSTRACT

Simon, N., Sturmer, L., & Markham, R. 2019. Gear Type Comparison for Off-Bottom Oyster Aquaculture in Florida, USA. Program and Abstracts of the 2019 Triennial Aquaculture Meeting of the World Aquaculture Society, National Shellfisheries Association, Fish Culture Section of the American Fisheries Society, and the National Aquaculture Association: 1013. ABSTRACT

Book Chapters: None reported.

Extension/Outreach Publications:

- Management Strategies for Culturing Oysters in Floating Cages. UF/IFAS Extension, *Online Resource Guide for Shellfish Aquaculture*. http://shellfish.ifas.ufl.edu/oyster-culture-other-projects/floating-gear-comparison-for-off-bottom-oyster-culture/. WEBSITE PAGE, 3,488,915 valid hits in 2019
- Floating Gear Comparison for Off-bottom Oyster Culture. UF/IFAS Extension, *Online Resource Guide for Shellfish Aquaculture*. http://shellfish.ifas.ufl.edu/oyster-culture-other-projects/comparison-of-stocking-densities-for-floating-bag-oyster-culture/. WEBSITE PAGE 3,488,915 valid hits in 2019
- Florida results were summarized in the following article: https://shellfish.ifas.ufl.edu/oyster-culture-other-projects/biofouling-control/
- Alabama and Mississippi results were distributed via the 'On the Lid' newsletter to 169 readers in May 2020.

Oral Presentations:

- Chapman, E., Davis, J., Rider, J., Sturmer, L., Walton, W., & Supan, J. 2019. Comparing Off-Bottom Techniques of Oyster Aquaculture Crassostrea virginica on Biofouling in the Northern Gulf of Mexico. Presented at Aquaculture 2019, New Orleans, Louisiana, 7-11 March.

- Simon, NA., Sturmer, L., & Markham, R. 2019. Gear Type Comparison for Off-Bottom Oyster Aquaculture in Florida, USA. 24 slides. Presented at Aquaculture 2019, New Orleans, Louisiana, 7-11 March.
- Aquaculture 2019 Conference, est. attendance 2000 people

Results of the experiment were presented by each graduate student at the following venues:

- Aquaculture America, March 7-11, 2019, New Orleans, LA
- Louisiana American Fisheries Society Meeting, 2018
- Oyster South Symposium (OSS), February 22-23, 2019, Orange Beach AL (170 attendees).
- Economic model results also presented at OSS19. All presentations were recoded and are available on the OysterSouth You Tube channel. To date, Kirk and Chapman's have been viewed 29 and 23 times, respectively.
- Georgia Chapter of the American Fisheries Society 2018 Annual Meeting, January 23-25, 2018 (120 attendees)
- Georgia Chapter of the American Fisheries Society 2019 Annual Meeting, February 5-7, 2019 (120 attendees)

Poster Presentations: None reported

Digital Products:
Popoff Enterprises worked with growers and extension agents in South Carolina, Florida and Alabama to produce two videos. Growers and prospective growers are the target audience for the video entitled "Oyster Farming in the Southern United States Using the OysterGro System" (10 minute duration) which is hosted on the OysterSouth YouTube channel, https://www.youtube.com/channel/UCJxNbOcCLXdNxKqz3GC5SAg/videos, and to date has 1000 views since posting in February 2020. Hosted on the same channel is 'Oyster farming in the South' which is a five-minute long video aimed at a consumer audience. This video has been viewed 956 times in the past five months since posting in February 2020. Additionally, the South Carolina Sea Grant Consortium had both videos captioned and can provide that option.

Student Participants**:**

- Shannon Kirk, University of Georgia. "Efficacy of Biofouling Mitigation Methods for Floating Cage Production of Southeastern Triploid Eastern Oysters (*Crassostrea virginica*)". Degree awarded December 2019
- Ellis Chapman, Louisiana State University. "Assessment of Off-Bottom Oyster (Crassostrea virginica) aquaculture techniques on biofouling in the Northern Gulf of Mexico". Degree awarded December 2019.