# FINAL PROGRESS REPORT

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| **Project Title** | **Hatchery & Nursery Technologies for Improved Production of Blue Mussels** |
| **Reporting Period** | 8/01/15- 6/30/16 |
| **Author (Chair)** | Scott Lindell |
| **Key Word** | Blue mussel, hatchery, seed production, *Mytilus edulis* |
| **Funding Level** | Total funds allocated for this project to date.<br>*NOTE: This could be reported by Year. i.e.,*<br>*Year One: FY 2014, $ amount* 90,875<br>*Year Two: FY 2015, $ amount* $107,202 funded<br>*-$46,418.68 deobligated (awaiting fully executed amendment)*<br>**$60,783.32 net funded *FY 2015*** |
| **Participants** | List participating personnel and respective institutions/agency/business; include outreach representative. Indicate funded participants with an asterisk.<br>**Name(s)/Role(s): Paul Rawson/**co-PI, Dana Morse, PI<br>Institution/Agency/Business: University of Maine, & Sea Grant<br>**Name(s)/Role(s): Diane Murphy**, PI<br>Institution/Agency/Business: Woods Hole Sea Grant |
| **Project Objectives** | List each objective<br>**Objective 1:** Demonstrate that mussels can be conditioned and spawned *contra-seasonally* in the fall.<br><br>**Objective 2:** Determine the cost-effectiveness of standard live microalgal diets vs. new alternative diets (freeze-dried algae and algal paste) for conditioning blue mussel broodstock.<br><br>**Objective 3:** Evaluate the suitability and cost effectiveness of alternative diets for setting mussel spat using new alternative diets (freeze-dried and algal paste) and comparing them to live microalgae.<br><br>**Objective 4:** Evaluate the effect of nursery sites for spat deployment (at 1.5 mm average length) on the growth, survival and yield of seed for growout.<br><br>**Objective 5.** Determine the relative performance of hatchery-produced mussel seed and wild caught seed in field trials.<br><br>**Objective 6:** Determine the cost-benefit of hatchery-based seed production (accounting for alternative diets, seed yield and performance) compared to wild seed, including savings afforded by more efficient production cycles and potential market opportunity associated with favorable traits. |

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| **Anticipated Benefits** | The direct beneficiaries of this research has been the fishermen/farmers in New England who have taken steps to established mussel farms and need a reliable source of mussel seed. The seafood-eating public, seafood processors, restaurants and retail outlets benefit from locally produced seafood. The measurable benefits are sustainable new enterprises conducting best management practices for locally-produced mussels. |
| **Project Progress** | **Objectives 1 and 2: Broodstock Conditioning Experiments;**<br>**<u>Marine Biological Laboratory (MBL)</u>**<br>Between August 2014 and June 2016, the MBL conditioned 20 groups of broodstock mussels (approximately 100 each) collected from Martha's Vineyard and Woods Hole. After failure for 6 months to successfully condition broodstocks with the alternative diets we also tried to condition broodstock with live algae (mostly *Chaetoceros*).We also changed to a continuous feeding system using a peristaltic pump. In our first year, we attempted conditioning 9 different groups of 100 broodstocks for 4 to 6 weeks at a time. None of them spawned. Neither did we get much spawn from wild broodstock collected in November and April (just two animals out of > 100 each time). Finally in June 2015 we got significant spawn from 5 females x 3 males. In the second year we implemented a gradual shift in the temperature regime to simulate a quiescent or winter period in the hopes of facilitating more natural gamete development. This involved slowly dropping the temperature to 4°C over approximately 2 weeks (1 degree a day), holding at that temperature for 2 weeks and then raising slowly to 12°C over another 2 weeks. However, a group started in July 2015 did not spawn 82 days later in October. Another two groups subjected to a drop in temperature to 6°C in October (half conditioned 12°C and half at 18°C) failed to spawn 56 days later in December. We suffered a similar spawning failure in February 2016 with groups initiated in December also under 12°C and 18°C conditioning temperatures. Subsequently, we have continued to condition broodstock at 7 to 9°C. Fortunately, we have been able to consistently spawn wild broodstocks at MBL or MVSG hatcheries in May, June, September and December 2015 to have sufficient larvae for our hatchery nutrition and setting experiments.<br><br>Between January and June 2016, MBL staff_attempted 7 spawns with only 4 of them producing meaningful numbers of fertilized eggs in February May and June. Proportionally, very few broodstock spawned on those occasions. Most of the larvae did not develop properly and died within the first 4 days. In March we produced enough fertilized eggs to stock replicate 1 L jars prepared with different pH seawater to look at the effects of enriching hatchery cultures with carbonate at control (2), 6 and 9 aragonite saturation levels in the face of ocean acidification. There were significant differences between the length of the settled larvae in the highest treatment vs control. There was no difference in survival between treatments which was relatively low (~6%). |

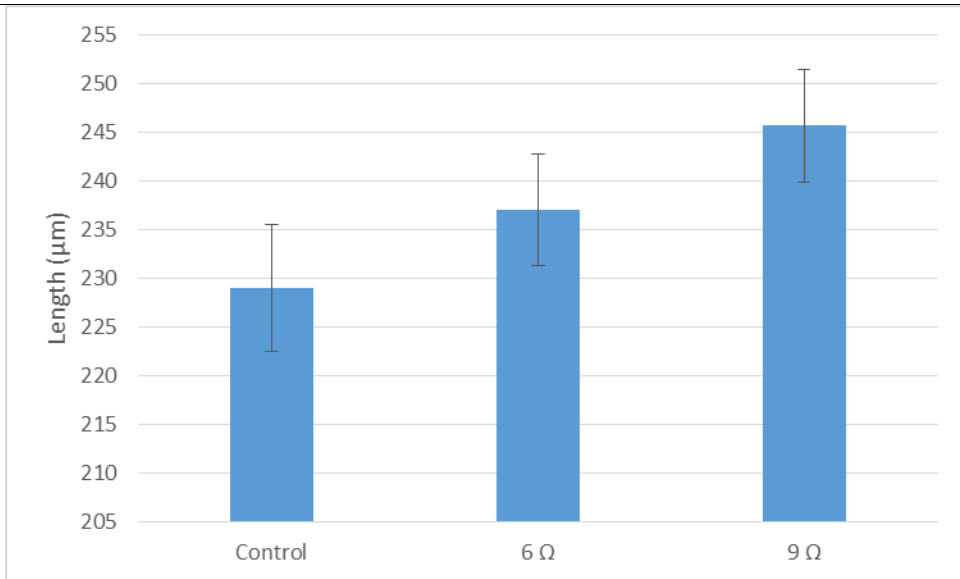


**Figure 1.** Comparison of length of mussel larvae at settlement (20 days post fertilization) at two treatments of enriched carbonate compared to ambient seawater from Vineyard Sound (control).

**<u>Darling Marine Center (DMC)</u>**

After getting started in the second year of the project, DMC (University of Maine) staff started conditioning their broodstock at a 4-5% ration per day based on estimated mussel dry mass in each tank. The mussels in three tanks received live algae, including a mix of *T-isochrysis*, *Tetraselmis sp*., *Chaetoceros calcitrans*, and *Pavlova lutheri*. The appropriate amount of live algae was introduced to each tank over an 6-8 hour period via a drip system suspended above the tank. For the other three tanks, the mussels were fed a ~5% ration of Ori-one, a freeze-dried algal diet.

Broodstock mussels were collected from Casco Bay in March 2015 when water temperature was approximately 6-7°C. Our intention was to slowly raise the temperature in our tanks to condition them but the failure of temperature control systems and the extended time to repair them foiled our plans. We were forced to try feed and condition the brood suddenly at temperatures of 16 to 24C.

Out of the original 150 broods, 27 died due to early mortality from the temperature shock and another 24 were used as sentinels for gonad index. We attempted to spawn the remaining 99 mussels using a standard temperature shock protocol. From the Ori-one conditioned animals we obtained spawn from one female. The eggs were poorly developed. Inspection of the gonads from other mussels in each treatment provided evidence of thin gonad sections with very poor gamete development, confirming our worst expectations. Given a lack of personnel in May we did not start any additional conditioning trials till much later in the year.

We collected a new set of 150 brood mussels on October 9-10, 2015. These mussels were collected from water approaching 11-12°C and transported to the hatchery where they were kept at 14°C during the first four weeks of conditioning. Half of the mussels were placed in two 350 L tanks and fed a 4-5% ration per day of live algae using mixtures of common hatchery microalgal diets but emphasizing the diatoms, *C. calcitrans* and *C. meulleri* (up to 50% of diet). The other half of the broodstock were placed in a separate set of two 350 L tanks and fed a 5-6% diet of Ori-one at 14°C. Approximately once a week, four sentinel mussels were removed from the two feed treatments from which we estimated gonad index.

The gonad index in the initial sample was approximately 20% on a wet weight and dry weight basis (see Fig. 2). After two weeks, the average gonad index in the Ori-one broods had not increased above the initial gonad index. The gonad development in the live algae broods was more consistent across individuals and the gonad index had increased to 25% within 2 weeks. The gonad tissue in broods on live algae all had differentiated gametes and upon exposure to seawater the sperm from males became active.

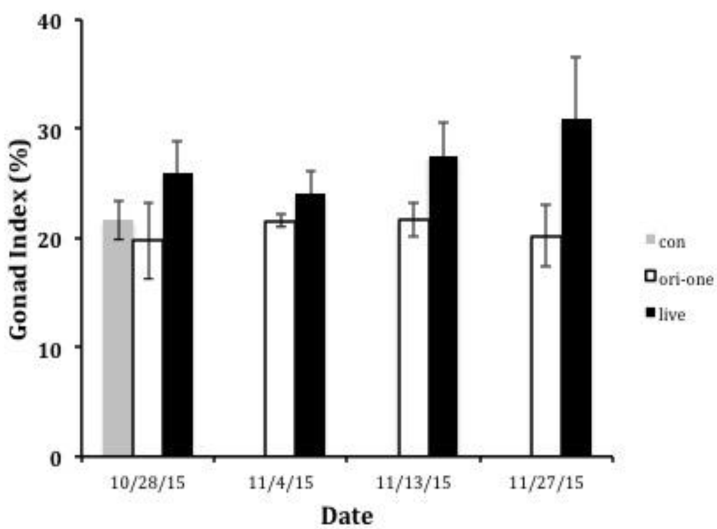


**Figure 2.** Gonad index representing the proportion of total body weight associated with the developing gonad for an initial sample of broods prior to conditioning (con) and for broods conditioned on live algal feed and Ori-one. Bars represent the mean of four mussels and error bars represent the mean ± standard error.

We continued conditioning through November 13th, 2015 with an increase in the ration to 6-7% for the Ori-one tanks. We were concerned that too high a ration might promote somatic growth versus gonad development. By November 13th, the average gonad index in sentinel mussels from the live algal diet was approaching 30% (Fig. 2), which is a value we often see for naturally ripe mussels just prior to spawning. The gonad tissue for the live algae broods was spongy and thick (> 2mm in some cases). In contrast, the average gonad index for the Ori-one individuals remained much lower at around 22% although the variance in the index was substantial. Given the apparent ripeness of the live algae broods we decided to attempt a spawning on November 14th using a standard thermal shock protocol. From this attempt, we obtained sperm from 3 males in the Ori-one treatment and two males from the live algae treatment and eggs from one female in the live algae treatment.

Given that a major focus of this conditioning attempt was to compare gonad index AND egg quality across the feed types, we placed the broods back into the conditioning tanks and fed them at the 5-6% rations for another 3-4 weeks. At this point, we were concerned that keeping the broods at too low of a temperature may have been affecting maturation of the gonad and we raised the conditioning temperature to 18 °C for the rest of the conditioning period. Another check of the average gonad index on November 27th indicated that the index had increased further in the live algae treatment and was still lagging in the Ori-one treatment. By December 13th, we had a major systems failure at the Darling Marine Center when the main heat exchanger failed. This made it difficult to warm ambient seawater for algal cultures but also to maintain broodstock tank temperatures (ambient at the time had dropped < 10°C. We discontinued conditioning and began a second attempt to spawn the broodstock.

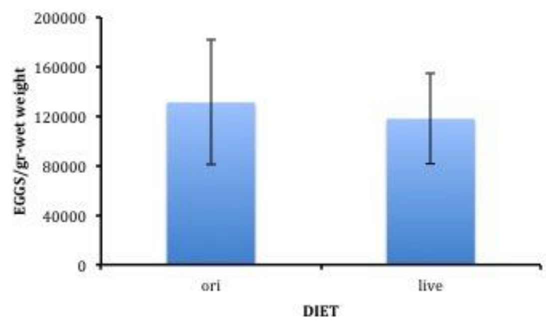


**Figure 3.** Average mass-specific egg production for brood mussels conditioned on live algal feed versus a diet consisting solely of Ori-one. Error bars represent the mean ± standard error.

From this second attempt, we obtained gametes from 14 (5 females) of 36 mussels conditioned with live feed (39%) and from 4 (3 females) of 36 mussels conditioned with Ori-one (11%). The size of the mussels that spawned ranged from 12.1 to 46.1 g wet weight and 42 to 58 mm shell length. We estimated egg production for each female through replicate egg counts and estimated egg production as a function of brood wet weight (shell + tissue). Mass-specific egg production in the Ori-one fed broods was approximately 8% higher than egg production for the live feed broods (Fig. 3). However, there was substantial variation among individuals within each feed treatment in egg production and thus no statistical difference.

Thus, for the broods that are conditioned solely on Ori-one there does not appear from this spawning that there is a difference in egg production. There was, however, a dramatic reduction (28%) in the number of individuals that were successfully conditioned on Ori-one. These differences were apparent within the first two weeks of conditioning; typically 2 of 4 mussels on Ori-one had a low gonad index which weighted the average gonad index

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| | downwards. Our suspicion at this point is that not all mussels readily feed on a diet consisting only of Ori-one. We are presently measuring protein, lipid and glycogen content in eggs sampled from the broods in this experiment and will analyze them in them over the winter of 2016/17. We had planned to also measure and compare fertilization success and survival through early development for each female but due to the heat exchanger failure we had to forego those experiments.<br><br>**<u>MBL</u>**<br>On May 14 2015, our commercial cooperators, Martha's Vineyard Shellfish Group, had a spawn of mussels in their hatchery. By June 18, our commercial hatchery cooperator, Martha's Vineyard Shellfish Group, had a batch of disease-free certified mussel seed (approximately 1 million) that were set on bio-loop rope. They shipped them to the MBL so that these setting ropes could be paired with grow-out ropes; some were socked with a bio-degradable cotton covering. Then the socks were held overnight in running aerated water at the MBL. The next day, June 19th, MBL researchers and the mussel seed ropes were picked up in Woods Hole by Stanley Larson on the FV Four Kids. Approximately 120 feet of seeded grow-out rope was suspended from the longlines in Vineyard Sound.<br><br>A visit to the Vineyard Sound site in September 2015 revealed very few mussel spat on the lines we set out on June 19th. There was considerable fouling instead with lots of hydroids.<br><br>**Objective 3: Seed Feeding and Setting Experiments;**<br>**<u>MBL</u>**<br>Because mussel spat (1 to 3 mm) are too small to effectively place in mussel socks, it is important to understand how they might be grown cost-effectively to the requisite size for socking (10 to 15mm). Massachusetts mussel seed have been subjected to three different feed trials comparing diets consisting of live algae, Ori-one (Skretting Ltd.), and algae paste (Reed Mariculture's Shellfish Diet).<br>The greatest growth occurred on the live algae diet (Figure 4). The Ori-one and paste had similar growth rates, with the paste slightly outperforming the Ori-one. The ambient water control had the lowest growth rates. |

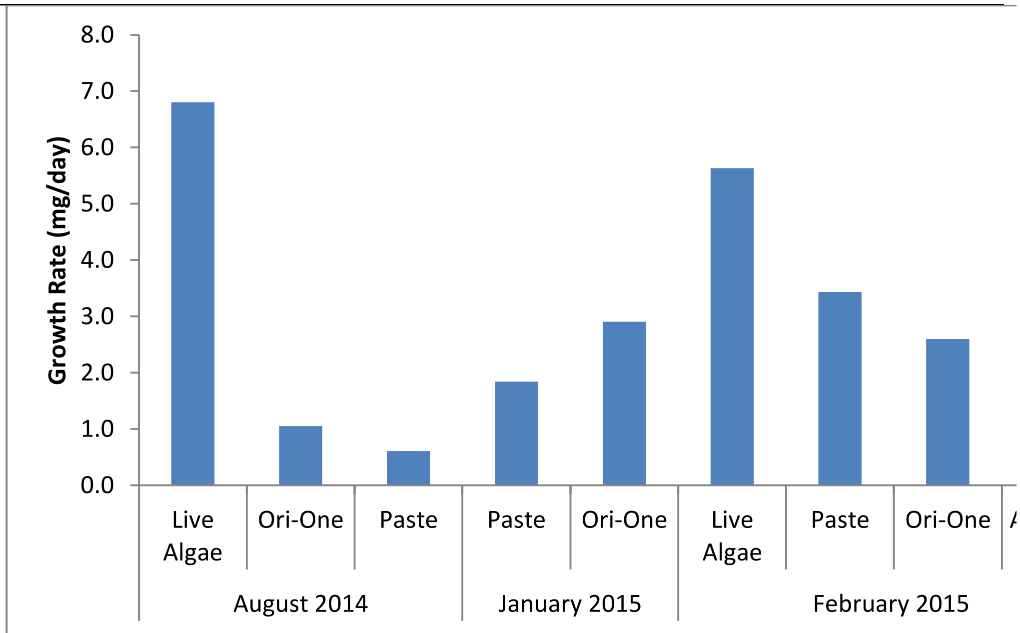



**Figure 4. Growth rates of juvenile mussels fed different diets during three feed trails**

On June 24, 2015 mussels were spawned at the MBL. Larvae were fed a diet of live algae until they reached setting size (caught on a 200µm sieve) on July 13, 2015. Then even proportions of larvae were divided into 12 tanks to compare growth and survival on different diets and setting materials. 66,250 larvae were added to each tank, and the amount of setting material added to each tank was based on the expected spat densities each material could support. Tanks with Christmas tree rope had 4.4 m of material for a stocking density of 15,000 larvae per meter. Tanks with coir rope had 22.1 m of material for a stocking density of 3,000 larvae per meter. All tanks were fed daily and cleaned every other day. On August 20, 2015 all tanks were sampled. Four samples were taken per tank, 3 from the setting material and 1 of the entire tank (all mussels that were alive but not on the setting material). Three samples were based on location in the tank; top, middle and bottom, and seed were individually and digitally measured. One-inch samples were taken from the Christmas tree rope and 5-inch samples were taken from the coir rope to account for the difference in surface area. During the 37-day period in the settling tanks no significant difference in survival or growth was found between the two settling materials. Survival and growth was significantly greater in the tanks on the live food diet compared to the paste and Ori-one diet (Figure 4).

Ropes were hung off the MBL dock where they were monitored through the winter. The ropes were sampled in June 2016 with disappointing survival results; the greatest number of survivors was on Christmas tree ropes fed live or paste diets (up to 200 individuals per rope or about 1% survival) versus none fed the Ori-One diet.

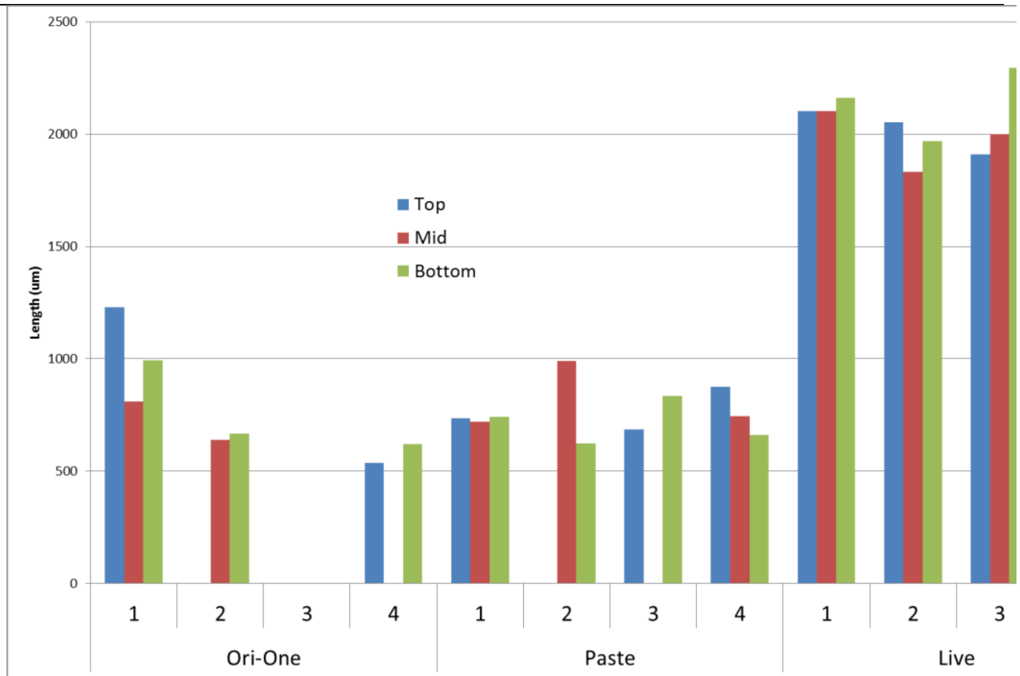
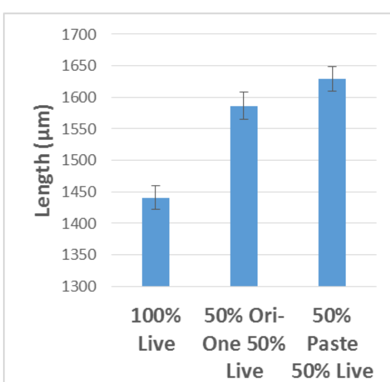



**Figure 4.** Mussel spat average length in replicate tanks fed three types of algal feeds for 37 days. Mussels fed live diets grew significantly better.

In another spat setting experiment, MBL set approximately 500,000 competent larvae on NZ type hatchery ropes on January 12, 2016. Approximately 57,000 eyed larvae (15,000/m) were stocked into each of nine 90-liter tanks. The tanks were assigned one of three diets; (1)100% Live algae, (2) 50% Live algae, 50% Ori-one, and (3) 50% Live, 50% Algae paste. The average length and percentage survival or retained seed on the roped after 5 weeks is described in Figure 5. While not statistically significant, it appeared the Live/Paste combination performed best. All nine setting lines are currently deployed on the WHOI dock and are being monitored bi-weekly (Figure 6)



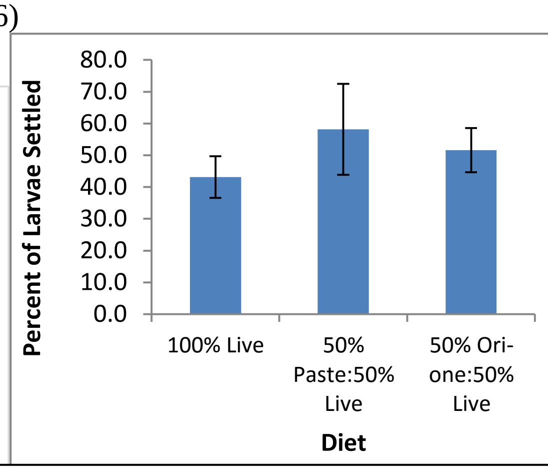




**Figure 5. Average length and percent retained on ropes for each diet type**

**Figure 6. Hatchery settling lines under MBL dock 4/14/16**

**DMC Setting Experiment**

In June 2015, we constructed four PVC frames (4'x 4') to hold settlement ropes vertically within each of four 350 L settling tanks. The frames included connections to allow air to be pumped through the frame and create vigorous aeration and mixing around the frames. Two of the frames were each wrapped with ~40 feet of coconut "coir" rope and placed in individual 350 L tanks. The other two frames were wrapped with ~25 feet of a synthetic "bio-loop" rope. We used less of the latter rope due to the high surface area it provides. Each of the settling tanks was stocked with 185,000 eyed larvae.

We provided vigorous aeration in the settlement tanks and monitored settlement over a two week period. At the end of this period, we sampled 1-inch segments from multiple windings on the rope in each tank, sampling from the top, middle and bottom thirds of each frame. The number of mussels per inch was nearly two fold higher on the synthetic bio-loop rope (Figures 7 and 8), consistent with the larger surface area per inch afforded by this type of rope. Although we deployed fewer windings of this rope per frame (and thereby tank), we still obtained a total settler abundance that was nearly 50% higher in the bio-loop tanks (Figure 8). In general, settlement was highest on the top third of the coir rope while the top third and bottom third of the bio-loop rope had approximately 80% higher number of settlers than the middle third of the rope.

After approximately one month in the hatchery, ropes were transferred to Wild Oceans Aquaculture for nursery field deployment. DMC will follow up with Wild Oceans in the fall of 2016 to check on growth and survival.

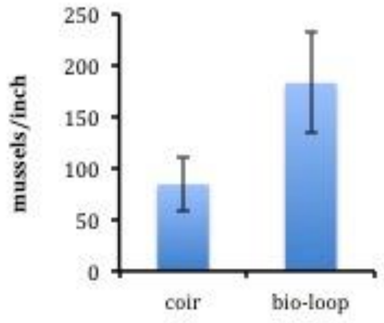



**Figure 7.** Average number of mussels per inch of rope on both coir and bio-loop rope. Error bars are the mean ± standard error.

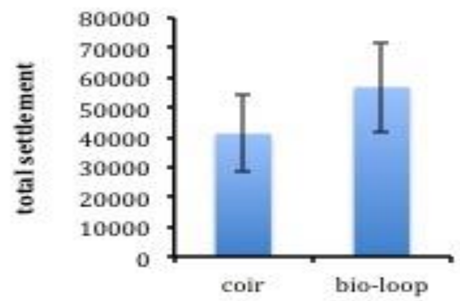



**Figure 8.** Estimated number of total settlers on each frame with coir rope (left) and bio-loop rope (right). Presented are mean settlement ± standard error (n=2).

**MBL "Remote-set" experiments.**

Remote-setting technology for hatchery-produced eyed oyster larvae has enabled the efficient setting of larvae close to the grow-out sites. This methodology frees the hatchery from the space, time and most of the feeding requirements of nursery culture. The hatchery production of blue mussels would likewise benefit from the development of methods that would provide for the setting of eyed larvae on grow-out ropes near grow-out sites remote from the hatchery. To determine whether mussels would also be amenable to remote setting, about 4 million eyed mussel larvae (spawned September 18, 2015) produced in the Martha's Vineyard Shellfish Group Hatchery were transported to four sites away from the hatchery (Figure 9).

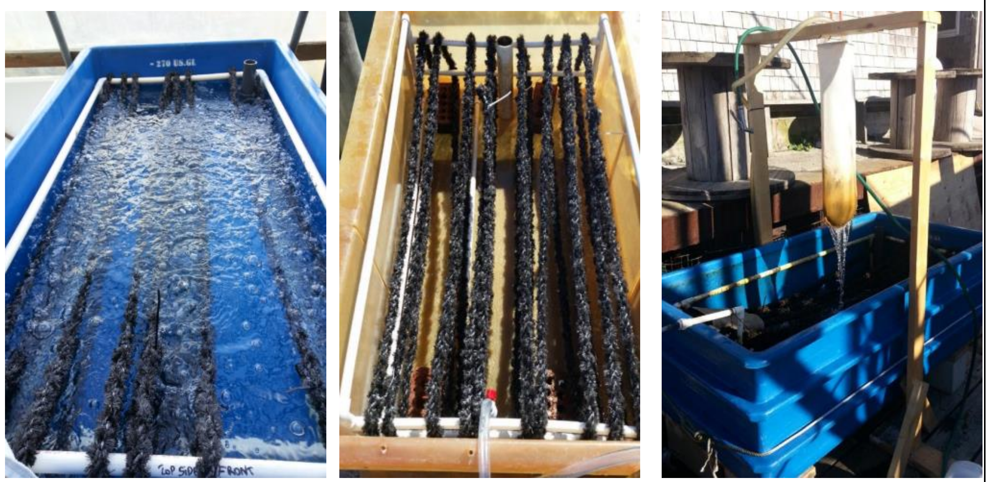


**Figure 9. Remote setting tanks at MVSG (L), MBL (middle) and Menemsha (R)**

The remote setting tanks were supplied with raw seawater filtered through

100u bags (to allow smaller plankton to pass thru as a food source) and supplemented with algae paste once each day. Approximately 40 meters of weighted "NZ hatchery rope" was stretched across frames of pvc pipe above an aeration system on the bottom of the tank. Larvae were released into tanks October 4 – 8, 2015 and ropes were removed for planting December 2- 6, 2015. Mussel spat successfully attached to rope collectors at all sites and were cultured on a diet of both live and algae paste.

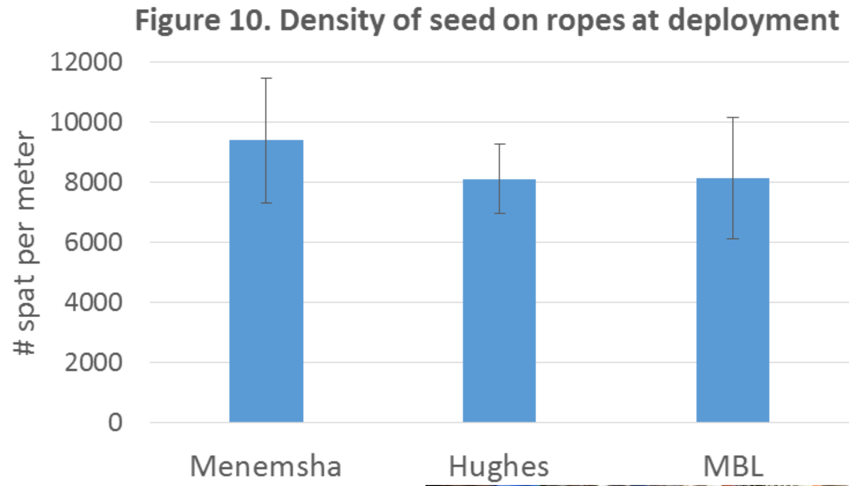
Approximately one million eyed larvae were released into each of the 3 tanks pictured above with the goal of providing 32,000 larvae per meter of setting rope. Just prior to being field planted in December 2015, several 3-6" sections of rope were sampled from each tank, and the mussel spat were measured (2.6 mm average) and counted (Figure 10). One group of eyed larvae set at Roger Williams University tolerated being refrigerated out of water for about 18 hours prior to placement in a setting tank.

**Objective 4: Evaluate the effect of nursery sites for spat deployment on the growth, survival and yield of seed for grow-out.**

We had limited choices for nursery sites, and chose to keep most spat ropes hanging from our protected dock after at least 60 days in remote-setting tanks based on the poor survival we experienced only holding on to the ropes for 35 or 37 days prior to deployment on the farm (September off the dock. The following describes our progress with evaluating the success of hatchery seed on farms.

**Deployment of hatchery seed and remote-set ropes**

Mussel seed lines were removed from the remote setting tanks and hung near each remote set tank site – MVSG dock in Lagoon Pond, MBL dock in Eel Pond, and on longlines at the commercial mussel farm in Vineyard Sound (Figure 11). Some of the ropes were covered with cotton to see if that would possibly improve previous problems with retention (Figure 12). The deployed remote set mussel lines were monitored minimally due to bad winter weather. Due to weather constraints we did not have time to assess the seed when we surveyed the lines in June 2016. We did have time to plant more hatchery-raised mussel seed from over-wintered remote-set ropes.





\ **Figure 11. Remote set ropes at the setting tank (a), being covered with cotton to see if that helps retain seed (b), and deployed on mussel longlines in Vineyard Sound, Dec. 2015 (c)**

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| | **Objective 5. Determine the relative performance of hatchery-produced mussel seed and wild caught seed in field trials.**<br>We have not had an opportunity to sock seed from the wild at the same time as we socked similar-sized hatchery seed. We can report that hatchery seed appears to grow at the same rate as wild seed based on measurements of similar average increases in size of 3 to 4 mm per month.<br><br>**Objective 6: Determine cost-benefit of hatchery-based seed production**<br>Based on our experience the cost of producing mussel eyed larvae (ready to settle) is similar to oyster larviculture. The same principals and time requirements apply. We've documented similar settling success in our remote-set experiments above (~50%). After settling, mussel seed are much easier to handle since they just stick to ropes, and don't require special downwellers and upwellers, or early sorting and grading the way oysters do. Mussel seed isn't graded until its ready to be prepared for socking and grow-out at about 15 to 25 mm in size.<br><br>We think that eyed mussel larvae can be grown profitably at the same price that eyed oyster larvae are sold for ($400/million). The question becomes then, can they be on-grown for another 60 days in remote set tanks until they are at least 2 mm, and can they be sold for $10 per thousand like oysters? Essentially this means that mussel seed would be priced at about 1 cent a piece. Compare this to a similar priced oyster seed, and the comparable wholesale market sales price for mussels (5 cents each) versus oysters (50 cents each). For mussel hatcheries to have the same relationship to the mussel business and markets as do oyster hatcheries, survival and yield would have to be 10 times greater for mussels or the cost to produce market product would have to be 10-times less or a combination of the two. It is hard to compare and quantify survival and yield, and cost of production of the two shellfish species. We expect to elaborate on this and make our best case when we conduct our workshop in January 2016 at the Northeast Aquaculture Conference and Expo. |
| **Accomplishments:** | |
| **Outreach Overview** | Describe in general how your results have been extended to the intended users. OR, if they haven't yet, explain when & how this will occur.<br>We have planted hatchery raised-seed on the mussel farm in Vineyard Sound in June 2015, December 2015, and June 2016 as the first demonstration of the utility of hatchery seed for commercial use in Southern New England. Mussel growers have successfully used their dockside facilities to accept hatchery-raised eyed larvae and settled them on ropes for planting on their farm. |

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| **Targeted Audiences** | Provide information on the **target audience** for efforts designed to **cause a change in knowledge, actions, or conditions**.<br>The target audience is our participating mussel farmers, and prospective entrepreneurs and fishermen who may be interested in starting a mussel farm. A secondary audience will be commercial shellfish hatcheries who might be engaged by mussel farmers to produce seed. |
| **Outputs:** | Outputs are tangible, measurable products (website, events, workshops, products [AV, curricula, models, software, technology, methods, websites, patents, etc.], trainees, etc.). Do NOT include publications as they're listed separately.<br>We have drafted parts of a mussel hatchery and remote-set seed manual which will be one of our major products delivered at the NACE workshop. In August, Lindell met with Dana Morse, Evan Young and DMC hatchery manager, Mick Devin to discuss and plan outputs and the workshop. |
| **Outcomes/Impacts:** | Describe how findings, results, techniques, or other products that were developed or extended from the project generated or contributed to an outcome/impact. **Outcomes/impacts are defined as changes in Knowledge, Action, or Condition.**<br>We have a better understanding of how hard it is to ripen mussels for spawning, and that one needs to start with hundreds of broodstock in order to assuredly have enough fertilized eggs. Once we have fertile eggs, the hatchery process is similar for other bivalves. Mussel seed are relatively easy to culture but retention on the settling ropes is uncertain prior to reaching a size of at least 2mm – thus remote set tanks should be operated for 2 or more months prior to stocking ropes in the open ocean. |
| **Impacts Summary** | Provide short statements (2-3 sentences) about each of the following:<br>(pre-established fields for Researchers to complete short statement answers)<br>1. **Relevance:** Issue – what was the problem?<br>Lack of reliable wild mussel seed available and at times mussel farmers want it<br>2. **Response:** What was done?<br>Develop hatchery techniques for reliable supply<br>3. **Results:** How did your work make a difference **(change in knowledge, actions, or conditions)** to the target audiences?<br>Growers in our region now have an alternative that can help them hedge their bets that they will have sufficient seed if they contract with a hatchery for mussel seed. This is the message we will broadcast at our NACE workshop<br>4. **Recap:** One- sentence summary<br>We have closed the life-cycle on one of the last aquacultured species that depends on wild progeny, and can provide a cost-effective means to secure the industries year round seed supply needs. |
| **Publications** | Lindell and collaborators made a presentation at the Milford Aquaculture Seminar in January 2016:<br>***REMOTE-SETTING EYED LARVAE OF THE BLUE MUSSEL, MYTILUS EDULIS***<br>***Christopher Edwards[1], Emma Green-Beach[1], Amandine Hall[1], Richard Karney[1], Stanley Larsen[2], Dale Leavitt[3], Matthew Griffin[3], David Bailey[4] and Scott Lindell[4]***<br>***[1]Martha's Vineyard Shellfish Group, Inc. MA; [2]Menemsha Fish Market, MA; [3]Roger Williams University, RI; [4]Marine Biological Laboratory, MA*** |
| **Students/Participants:** | Provide the following information for **every** student that worked with you during the reporting period:<br>• Name: Sarah Kate Read |

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| | • Whether Degree was completed during the reporting period (name, yes/no): No<br>• New or Continuing Student: summer intern<br><br>• Name: Matthew Messinger<br>• Whether Degree was completed during the reporting period (name, yes/no): No<br>• New or Continuing Student: summer intern<br><br>• Name: Patricia Vasquez<br>• Whether Degree was completed during the reporting period (name, yes/no): No<br>• New or Continuing Student: summer intern<br><br>• Name: Morgan Bennett-Smith<br>• Whether Degree was completed during the reporting period (name, yes/no): No<br>• New or Continuing Student: summer intern<br><br>• Name: Jamison Nye<br>• Whether Degree was completed during the reporting period (name, yes/no): No<br>• New or Continuing Student: summer intern |
| **Partnerships** | List any partners that you worked with on your project. Provide the following information for each Partner: |

| Partner | Specific Type | Level | Nature of Partnership |
|---|---|---|---|
| Menemsha Fish Market – Stanley Larsen | Mussel Farmer | Provided broodstock, grew-out hatchery seed | |
| American Mussel Harvesters – Bill Silkes | Mussel Farmer | Provided broodstock | |
| Wild Oceans Aquaculture – Matt Morretti | Mussel Farmer | Provided broodstock, grew-out hatchery seed | |
| Blue Hill Bay Mussels – Evan Young | Mussel Farmer | Provided broodstock, grew-out hatchery seed | |
| Reed Mariculture Tim Reed | Feed manufacturer | Provided algae paste | |
| Skretting Nick King | Feed manufacturer | Provided freeze-dried algae (Ori-One) | |