Florida Saltwater Hatchery Network Project: 
Developing the FWC Satellite Fish Hatchery Facility 
at Mote Marine Laboratory 

Fourth Progress Report 

Submitted to:
Mr. Chris Young, Project Manager 
Stock Enhancement Research Facility 
Florida Fish and Wildlife Conservation Center 

Submitted by:
Kevan L. Main, Michael Nystrom and Kenneth M. Leber 
Mote Marine Laboratory 

Mote Technical Report #1299 

November 3, 2008
PROJECT OVERVIEW
This is the fourth progress report for the Florida Saltwater Hatchery Network project entitled Developing the FWC Satellite Fish Hatchery Facility at Mote Marine Laboratory and covers the work conducted from January 15 to October 15, 2008.

The overall goals of this project are to:

- expand the partnership between Mote Marine Laboratory (MML) and Florida Fish and Wildlife Conservation Commission (FWC),
- design, construct and evaluate a prototype system to produce Phase I and Phase III red drum intensively,
- initiate development of a saltwater hatchery at MML as part of the Florida Saltwater Hatchery Network Initiative.

The tasks completed during this project period are summarized below.

PROJECT ACCOMPLISHMENTS
(I) Initial activities: Site Suitability Analysis
No progress has been made on this task during this reporting period.

(II) Initial activities: Initial Systems Development
The Mote Marine Laboratory design team (Dr. Tom Losordo, Aquaculture Engineer and Collaborator, North Carolina State University; and Dr. Kevan Main, Michael Nystrom, Jim Michaels, MML) held four on-site meetings at Mote Aquaculture Park (MAP) and several conference call meetings to continue refining the system design and review construction plans for the large-scale prototype fingerling (Phase I and Phase III red drum) production system at MML’s MAP location. The design of the prototype system is based on the existing state-of-the-art recirculating systems at MAP and the available information on intensive culture of red drum.

From August 2007 to February 2008, two trials were conducted in MML’s 100% recirculating D-ended raceway (21.2 m³) (Figure 1). These trials were designed to evaluate red drum growth, survival, husbandry requirements, and system operational capabilities. The first trial was initiated on August 15 and completed on October 16. The second trial was initiated on October 31 and completed on February 26, 2008. Analysis of these trials was completed during this reporting period. Each of these trials provided vital information that was needed to facilitate the design and construction of the large-scale prototype system.

Evaluating the System Operational Capabilities of the D-ended Raceway Intensive Culture System – Results from Trials 1 and 2
The red drum fingerlings used in the two production trials were supplied by the FWC Stock Enhancement Research Facility (SERF) in Port Manatee, Florida. In both trials, phase-I, 30-80-mm standard length (SL) fingerlings were stocked in a single D-ended raceway equipped with primary and wastewater treatment filtration systems. The study periods for Trial 1 and Trial 2 were 62 and 118 days, respectively. Fingerling growth, condition, survival, oxygen and feed requirements, and system operational capabilities were recorded, mean values were calculated where appropriate, and results were examined for efficiency and manageability. The D-ended
raceway system was designed to be fed a maximum load of 20-25 kg feed per day. During Trial 1, the maximum feeding rate achieved was 16-18 kg feed per day and in Trial 2 the maximum feeding rate that could be achieved was 13-14 kg feed per day.

Figure 1. D-ended raceway and primary treatment filtration system design.

In Trials 1 and 2, phase I red drum were freshwater dipped and quarantined for approximately one month prior to transport from SERF to MAP. Transported fish were acclimated to temperature and pH variations between the transport tanks and the raceway system prior to stocking. Trial 1 fingerlings were size graded within the phase-I size range, 30-80 mm SL and acclimated from a salinity of 30 to 15 ppt prior to transport. A total of 28,870 fingerlings (mean SL = 60.02 ± 8.08 mm, mean weight = 3.96 ± 1.63 g) were transported in two insulated hauling trailers on August 15, 2008 to MAP. The fish were stocked at a salinity of 15 ppt and were reared at this salinity for a majority of the study period (Figure 2). Temperatures during Trial 1 ranged from 25.5 to 30.8°C (Figure 3). Only one raceway system was available to conduct Trial 1 and 2, which did not allow us to grade fish when size disparity and associated aggression occurred. We observed more problems with aggression in Trial 1 because there was greater size variation within that group at stocking; Trial 2 fish were more uniform in size at stocking, which allowed for a longer culture period before size disparity issues developed. Trial 2 fingerlings were acclimated from 30 to 15 ppt and 31,706 fingerlings (mean SL = 74.53 mm ± 6.19 mm, mean weight = 6.98 g ± 1.79 g) were transported to MAP on October 31, 2007, as described for Trial 1. Health concerns arose in Trial 2 similar to those observed in Trial 1, which led us to raise the salinity from 18 to 33 ppt after approximately one month (Figure 2). Near the end of
Trial 2, salinity was lowered to about 11 ppt in an attempt to reduce mortality. Culture temperatures during Trial 2 ranged from 22.7 to 28.8°C, but were typically maintained at 26°C (Figure 3). In Trial 2, the system was consistently maintained at lower temperatures due to the installation of a chiller/heat pump.

![Salinity](image)

**Figure 2.** Mean salinity (ppt) throughout Trial 1 and 2.

![Temperature](image)

**Figure 3.** Mean temperature (°C) throughout Trial 1 and 2.

The raceway system was equipped with a propeller wash bead filter for solids filtration, fluidized sand bed (Cyclobio ®) for biological filtration, ultra-violet sterilizer, foam fractionator with ozone, degassing tower, oxygen cone, a heat pump/chiller unit and a water quality meter/alarm system. During Trials 1 and 2, the culture system efficiency and performance were monitored for water chemistry and overall system manageability. Water quality was monitored twice daily for dissolved oxygen, temperature, salinity, ORP, and pH. Dissolved oxygen and temperature
were continuously monitored using a computer-controlled YSI monitoring probe that was connected to a Sensaphone to alert staff when variables fell outside the desired levels (Figure 4). Ammonia and nitrite were also monitored twice daily (8 a.m. and 3 p.m.) to insure that these variables stayed within desired levels (<0.5 ppm ammonia; <0.4 ppm nitrite) (Figures 5 and 6). Water exchange with the on-site wastewater treatment system (C-water system) was performed when either ammonia or nitrite exceeded our normal culture parameters. Alkalinity was monitored daily and sodium bicarbonate was added to keep alkalinity between 250-350 ppm; there were times when alkalinity was as high as 800-1000 ppm.

In Trial 1 the lack of a heat pump/chiller unit on the system presented difficulties in maintaining an ideal temperature of 26°C, with late summer ambient temperatures reaching as high as 35°C (Figure 3). The high ambient temperatures, in combination with the heat radiated from the system's life support units (i.e., pumps, UV), resulted in tank water temperatures up to 30°C during Trial 1. High temperatures reduced saturated oxygen levels in culture tanks, which limited the amount of food that could be added to the system. Before Trial 2, a chiller/heat pump was added to reduce the high temperatures experienced in Trial 1 and to increase water temperatures during winter months, which can drop as low as 19°C. Without the capability of maintaining a constant water temperature (26°C), the system would have easily reached temperatures too low or too high to administer a full feed ration. In Trial 2, the heat pump allowed for the raceway to be fed a consistent daily ration with water chemistry being the only factor impacting feed ration levels. Another advantage of the heat pump was that it allowed the system to operate with both pumps, which then allowed the oxygen cone to be used and resulted in the ability to maintain dissolved oxygen levels in the tank (Figure 4). Finally, the heat pump allowed the Cyclobio® to achieve optimal fluid expansion, resulting in better stability among key water chemistry parameters (i.e., NH₃-N and NO₂-N) (Figure 5 and 6).

![Dissolved Oxygen Graph](image)

Figure 4. Mean dissolved oxygen (mg/liter) throughout Trial 1 and 2.

Although improvements were made to the filtration system in Trial 1 that helped in managing the system, in Trial 2 we identified additional improvements that were needed. For example, solids removal from the culture tank was inefficient and fish waste was routinely seen drifting in the
water column. We suspected this was due to currents in the tank and that all the particulate matter was not being efficiently drawn toward the tank drains. Another explanation for high suspended solids in the water column may have been due to the swimming motion of the fish. When no fish are in the system, tank hydrodynamics causes food and debris to slowly migrate along the bottom of the tank to the drains. However, swimming motion of juvenile red drum at the bottom of the tank may resuspend solids into the water column. During Trial 1 and 2, additional screens were permanently mounted over the existing drains, which were bio-fouled over time, creating resistance to solids removal. These screens were placed over the drain to prevent juvenile fish from swimming into the drain. To eliminate this problem, removable screens with different size holes that can be easily exchanged will be used in future trials. The difficulty with solids removal in the D-ended raceway led us to use a more conventional circular tank design in the prototype system.

![Ammonia graph](image1)

**Figure 5.** Total ammonia nitrogen (TAN in mg/liter) throughout Trial 1 and 2.

![Nitrite graph](image2)

**Figure 6.** Nitrite (mg/liter) throughout Trial 1 and 2.
The biofilter for the D-ended raceway system is a fluidized sand column (Cyclobio®), which can easily collapse if there is a restriction in water flow prior to entering the biofilter. When the fluidized sand bed is not fully expanded, the nitrification capabilities greatly decline. Restrictions in water flow between the bead filter and the biofilter occurred when the bead filter accumulated solid wastes from the tank system. At the end of Trial 2, the biofilter was replumbed and separated from the bead filter allowing maximum water flow to the unit and full expansion of the sand bed. Although this unit has a number of advantages (i.e., small footprint combined with large surface area for nitrifying bacteria), the energy requirements (high head and water flow from large pumps) to maintain fluidity in the media bed along with susceptibility to failure when water flow is restricted, kept us from using this unit in the prototype system.

A continuing problem throughout both trials was poor water clarity. Water returning to the tank from the bead filter after backwashing was a major cause of water clarity problems. Management strategies for the system require multiple backwash cycles daily to maintain maximum water flow and reduce the pressure buildup in the bead filter. Our Second Progress Report described system modifications that were incorporated to correct this clarity issue (i.e., bypassing the return line to allow a rinse cycle for the bead filter to waste, prior to sending the water back to the tank; addition of a sand filter to polish the water prior to returning it to the tank; addition of foam fractionation with ozone). Although improvements in water clarity occurred, there was still a water clarity following the backwash cycle. We concluded that the bead filter is not the best solids filter unit for this system and are not using it in the prototype system.

In Trial 1 pH levels remained fairly consistent throughout the trial, with the exception of isolated events involving high ammonia levels. In Trial 2 however, there was a trend for decreasing pH after the fish were stocked; pH levels as low as 6.0 were recorded (Figure 7). The most likely cause for the drop in pH was the build up of carbon dioxide (CO₂) in the water. Low pH levels were first seen in Trial 2 before the end of December 2007 and continued into 2008. At the same time, we experienced high ammonia and nitrite levels (Figure 5 and 6), which may have been due to the high biomass (20.09 kg/m³ being fed at 3.52% body weight) in the system.

Figure 7. pH trends observed in Trials 1 and 2 at Mote Aquaculture Park.
In order to ensure the safety and health of the fish remaining in culture, we decided to reduce the number of fish in the system in December. The goal was to reduce CO₂ levels, which appeared to be causing low pH and high ammonia and nitrite levels. Prior to the scheduled culling event, a failure in the dissolved oxygen alarm system on 12/13/07 resulted in an accidental loss of 3,385 fish. One week later, we removed 5,066 additional fish from the system. Following these reductions in biomass, ammonia and nitrite levels in the system were more stable and pH increased for the remainder of Trial 2. Because the maximum feeding rate of 20-25 kg/day was never achieved, the biofiltration capabilities of the system still remain unanswered. In January, the degassing tower was disassembled and we discovered that the holes in the tower’s horizontal dispersal plates were clogged with biofilm. This clogging decreased the capability of the degassing tower and provided a possible explanation for low pH readings. Future trials will incorporate routine cleaning of the existing unit or replacement with a unit that can be more easily accessed for routine cleaning and/or less susceptible to clogging.

**Evaluating Red Drum Performance in an Intensive Culture System – Results from Trials 1 and 2**

Growth data was collected for Trials 1 and 2 every two weeks (Figures 8 and 9). At each sample date, 20 fish were weighed, measured, and examined for overall health. During the first and second trials, 10-20 fish were sent to SERF and/or FWRI for external and internal health assessments. Positive growth (weight and length) was observed in both trials. The fish in Trial 1 grew from a mean weight of 3.96 ± 1.63 to 23.51 ± 7.99 g (60.02 ± 8.08 to 110.21 ± 11.24 mm mean SL) with an overall growth rate of 0.32 g/day over the 62-day culture period. The FCR during Trial 1 was 1.38 to 1. The fish in Trial 2 grew from a mean weight of 6.98 ± 1.79 to 43.66 ± 13.91 g (74.53 ± 6.19 to 139.3 ± 13.84 mm mean SL) with an overall growth rate of 0.31 g/day over the 118-day culture period. The FCR in Trial 2 was calculated three different times because of the fish mortality event on 12/13/07 and the culling event on 12/20/07 during this trial (see Table 1).

![Trial 1 & 2 Growth](image)

**Figure 8.** Mean weight (g) and standard deviation for red drum in Trials 1 and 2.
Throughout both trials fish behavior and mortality was recorded. In Trial 1, we observed frequent incidents of aggressive behavior, with large fish nipping and chasing smaller fish. Also in Trial 1, high mortality was recorded during the first week after transport (approximately 7% or 2,028 fish in week 1). Water quality (temperature, salinity, pH, and dissolved oxygen) and chemistry (with the exception of a single high nitrite reading one day after stocking that was quickly corrected that morning with a 60% water change) was optimal during the period of high mortality. Of the 2,028 fish lost following transport, most were smaller fish. It seemed likely that the small fish would be most affected by transport and stocking stress. This theory was further supported by the fact that the morning after stocking 732 dead fish were removed from the tank. During next few weeks, mortality declined in comparison to the first week after stocking; although the majority of mortalities were small fish with injuries that pointed toward cannibalism or aggressive behavior from larger fish. As Trial 1 continued and water quality problems increased in frequency, we observed mortality in both small and large fish. These poor water quality events may have had affected the mortalities observed among the small fish. When water chemistry is poor, one way to improve it is to decrease the food ration amounts until chemistries become more stable. The effect of decreasing the food ration on aggression/cannibalism between the larger and smaller fish is unknown. Difficulties in maintaining suitable water chemistry, poor physical condition of the fish, and plans to restock a new set of fingerlings for a second trial led us to terminate Trial 1 in mid October. At the end of the Trial 1, the estimated mortality was 5,838 fish. Trial 1 was terminated on October 16 and all fish were size graded, counted, and a true mortality was recorded at 9,482 fish. Total survival was 67.3% (Table 1). This survival rate was very good, considering the problems that occurred during the trial with water quality, filter performance, and size disparity at stocking.

The overall health condition of the Trial 1 fish at harvest was poor - although both large and small fingerlings looked healthy in respect to body composition (girth and length), almost all fish had badly frayed fins and scales that could be easily detached even if lightly handled. Fish health was evaluated twice during Trial 1. Twenty fish were removed from the raceway at the end of the first week and transported to SERF and FWRI to be evaluated by fish health specialists. The fish were diagnosed with lamellar telangiectasis or aneurysm, which is a pathological change in the gill due to either physical or chemical trauma. The health specialists
noted that this condition has been found in hatchery fish after activities like grading or moving fish. A few days before harvest, 20 fish were removed and transported to SERF and FWRI to be evaluated by fish health specialists. The majority of the fish were observed to have severe fin fraying and scale loss. A ciliate (Coleps sp.) was found in low concentration in the water sample and the trophont stage of Amyloodinium sp was found on the gills of four out of ten fish examined. At harvest, a large amount of scales was removed from the bottom of the tank. The MML staff attributed the poor condition of the fish to periodic nitrite and ammonia spikes that necessitated reductions in feeding rates and subsequent water exchange, high temperatures (>29°C), frequent low dissolved oxygen conditions, and variation in fish size at stocking that resulted in aggressive behavior. FWC staff also observed scale loss in Phase III red drum held at low salinities (11 ppt) for 4-5 months in a greenhouse during 2006.

In Trial 2 we started off with a salinity of 17-18 ppt and after two weeks fish were sampled for health evaluations. It was determined that the majority of the fish had severe fin fraying and scale loss, along with low concentrations of a ciliate (Coleps sp.) in the water sample. After receiving these results, we slowly increased the salinity to full strength seawater (30-35 ppt). Although notable improvements in fish health were made in Trial 2, with regards to scale loss following the increase in salinity, problems with some scale loss and frayed fins continued to be present in Trial 2. To monitor health conditions in Trial 2, fish health was evaluated by FWRI biweekly. The cause of continued health concerns during Trial 2 was attributed to high stocking density and aggressive feeding behavior among the fish. On December 13 we had an unexpected mortality event and on December 20, more fish were removed to help reduce the incidence of scale loss and frayed fins seen within the fish culture. After the December 20 culling event, mortality levels stabilized and incidence of aggression was reduced. However, the appearance of the fish near the surface led us to lower the salinity about one month before the end of this trial. Typically, daily mortality ranged from 40-60 fish; however, from approximately February 8 until the day of harvest (February 26-27), mortality increased to approximately 150-200 fish per day. During this time of high mortality, many poor condition fish were observed swimming lethargically around the tank. These fish were commonly swimming alone or separately from the rest of the schooling fish and had lesions on their body and head. Some of these sick fish were easily caught with a dip net and discarded, but most were still too active to be efficiently removed. Samples were sent out for necropsy analysis, but no definitive diagnosis was identified as the cause of these losses.

Trial 2 was terminated after 118 days on February 26-27 and all remaining fish were harvested and counted. Unlike Trial 1, the Trial 2 fish were not size graded prior to harvest; however, a subsample was taken from the total population to determine final weight, length and biomass estimates. The decision to end this trial was a result of the high number of continuous losses from mortality and because there were signs that the health of the fish was compromised. A total of 13,929 surviving fingerlings were harvested. The percent survival was calculated to be 43.9% with both the fish loss on 12/13/07 and the culling event on 12/20/07. At harvest, we were surprised to find that the overall health condition of the fish in Trial 2 was better than in Trial 1. This assessment was based on visual observations made by the MML research team during harvest. We observed that a majority of the fish appeared well fed and had no apparent signs of fin fraying or scale loss, with less than 8% of displaying characteristics associated with compromised health. Unfortunately, we were unable to determine the condition prior to harvest
because of water clarity issues and the black tank bottom, which made it difficult to see the fish. Following Trial 2, we painted the raceway bottom and the bottom of the tanks in the new prototype system white, which will enable us to better observe the condition of dark colored fingerlings in future trials.

In summary, the preliminary results of Trial 1 and 2 provided a vast amount of information concerning the performance of both the culture system components and red drum husbandry requirements. Observations from both of these trials were used to design the new prototype system.

Table 1. Summary of Biological Performance Parameters in Trials 1 and 2.

<table>
<thead>
<tr>
<th></th>
<th>Trial 1</th>
<th>Trial 2</th>
</tr>
</thead>
<tbody>
<tr>
<td># of Fish</td>
<td></td>
<td></td>
</tr>
<tr>
<td>@ Stocking</td>
<td>28,870</td>
<td>31,706</td>
</tr>
<tr>
<td>@ Harvest</td>
<td>19,388</td>
<td>13,929</td>
</tr>
<tr>
<td>Stocking Density (fish/m³)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>@ Stocking</td>
<td>1362</td>
<td>1496</td>
</tr>
<tr>
<td>@ Harvest</td>
<td>915</td>
<td>657</td>
</tr>
<tr>
<td>% Survival</td>
<td>67.3</td>
<td>43.9</td>
</tr>
<tr>
<td>Biomass (kg/m³)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>@ Stocking</td>
<td>5.4</td>
<td>10.4</td>
</tr>
<tr>
<td>@ Harvest</td>
<td>21.5</td>
<td>28.7</td>
</tr>
<tr>
<td>Growth</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weight (g)</td>
<td>3.96 ± 1.63</td>
<td>6.98 ± 1.79</td>
</tr>
<tr>
<td>@ Stocking</td>
<td>23.51 ± 7.99</td>
<td>43.66 ± 13.91</td>
</tr>
<tr>
<td>@ Harvest</td>
<td>60.02 ± 8.08</td>
<td>74.53 ± 6.19</td>
</tr>
<tr>
<td>Standard Length (mm)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>@ Stocking</td>
<td>110.21 ± 11.24</td>
<td>139.3 ± 13.84</td>
</tr>
<tr>
<td>@ Harvest</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Culture Period (days)</td>
<td>62</td>
<td>118</td>
</tr>
<tr>
<td>Growth Rate (g/day)</td>
<td>0.32</td>
<td>0.31</td>
</tr>
<tr>
<td>Growth Rate (mm/day)</td>
<td>0.81</td>
<td>0.55</td>
</tr>
<tr>
<td>Total Fish Ration</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fed(kg)</td>
<td>556.13</td>
<td>1112.25</td>
</tr>
<tr>
<td>FCR</td>
<td>1.38:1</td>
<td>2.52:1</td>
</tr>
</tbody>
</table>

* A mortality event in Trial 2 resulted in the loss of 3,385 fish due to low DO
** A culling event in Trial 2 resulted in the removal of 5,066 fish to reduce density
(III) Schematic Design Phase
The design for the new large-scale prototype fingerling (Phase I and Phase III red drum) production system was completed by the MML design team and is currently under construction (Figure 10). This prototype system was designed to be a large-scale fingerling production module capable of producing 30,000 phase III red drum per production run. This prototype module would be replicated to expand production capability, but continue to provide biosecurity from other modules, when the full-scale satellite hatchery is constructed at MAP.

Figure 10. Schematic of the large-scale prototype facility.

(IV) Design Development Phase
The large-scale fingerling production module is under construction in an existing building at MML’s MAP site. Removal of old tank and filtration systems and building preparation for the new prototype system began in May 2008. We expect to complete construction of the module in early November and will be preparing the biofilter media for stocking. Estimated timing for stocking fish in the system is early December 2008.

As of this date, most of the infrastructure is in place (i.e., biofilter tank, drum screen, trough system, and culture tanks) (Figures 11 and 12). The prototype module includes six 8.9 m³ tanks and one 35.65 m³ tank on a common filtration system. The number and size of these culture tanks were chosen to facilitate fish stocking and grading within the fingerling production system.
We project that we will need to size grade the fish at least twice during the culture period based on the filtration capacity of the tanks. However, mortality, size variations and/or aggressive behavior may require modifications in this strategy. Based on filtration capacity, size grading and redistribution is proposed from four into six of the 9-m$^3$ tanks when the fish reach 7.5 g in size (estimated biomass 2.78 kg/m$^3$). The second size grading is proposed from six 9-m$^3$ tanks into the 35.6-m$^3$ and the six 9-m$^3$ tanks when the fish reach 13 g in size (estimated biomass 9.15 kg/m$^3$). At this size grading, distribution within the tanks will be based on the number of fish in each size class. Final harvest densities for each trial are estimated at 30,000 phase-III (60 gram) red drum (estimated biomass 20 kg/m$^3$).

The filtration system will have a rotating drum screen filter for solids removal, a 23.3 m$^3$ moving bed for biological filtration, an open channel ultra-violet sterilizer, foam fractionators with ozone, an up-flowing media bed for additional solids removal, low head oxygenators (LHO), and oxygen cones or concentrators for supplemental oxygenation. The filtration system was designed to provide flexibility in tank turnover rates, filtration capacity and oxygen requirements. The components included in the prototype filtration system were chosen based on the experience gained in Trials 1 and 2 (see Evaluating the System Operational Capabilities of the D-ended Raceway Intensive Culture System included in this report) and on proven fresh and salt water system designs currently in operation at MAP. The system will be monitored with an oxygen monitoring unit that can be attached to a remote dial alarm system. The system was designed to handle a maximum feed load of 50 kg/day (42% protein), which will support an estimated density of 30,000 fingerlings (Mean weight = 60 g per fish). The tanks will be fed with automated feeders. Feeders will be set to release the daily feed ration between 8:30 a.m. and 5:00 p.m., dispensing food every 30 minutes. When chemistry problems occur or fish behavior changes, modifications to this strategy will be made. The system is designed to have a maximum turnover rate of one turnover every 36.48 minutes (2,837 liters per minute or 750 gallons per minute). Based on the number of tanks being used, the flow rate for the system will be changed to meet the oxygen and biofiltration needs calculated by the estimated biomass in the culture tanks. Water currents in the tanks will be managed to accommodate the fishes swimming abilities and varied with the directional flow of the vertical manifold attached to the incoming water line. This 7-tank production module and its associated filtration system is a biosecure unit that can be treated or eradicated if a disease occurs within the system.