HSWRI Aquaculture Program Research Report
**** August & September 2014 ****

Self-Cleaning Larval Tank Project Launched

After years on the drawing board, a new aquaculture engineering project that links directly with biology and education is being launched by researchers from Hubbs-SeaWorld Research Institute (HSWRI), the University of Southern California (USC) and Ocean's Design of San Diego. The primary goal of the project is to advance sustainable marine aquaculture in the United States by improving larval rearing success and efficiency through enhanced microbial control. The team first plans to pilot-test a single production-scale, self-cleaning culture tank at HSWRI's laboratory in San Diego. Then they will rigorously test the functionality and efficiency of self-cleaning culture tanks against traditional tank designs using two different species of marine fish – white seabass and California yellowtail. Qualitative performance measures will be 1) operation and robustness of the mechanical components, 2) observations of the behavior of the fish larvae and circulation patterns of the water compared with what is known to be desirable, and 3) observations of the cleaning efficiency as indicated by cleanliness of the tank bottom. Quantitative performance measures will include fish performance (growth, health, and survival), feeding levels, water quality (dissolved oxygen, ammonia, pH, temperature, suspended solids, and turbidity), and bacterial loading. Finally, the labor requirements for each system will be recorded on a daily basis. As part of the outreach program, USC partners will be working with HSWRI education leaders to establish a "Seabass in the Classroom" (SITC) program at a high school in Los Angeles, which will be the first such program in that county and the ninth participating school in southern California.

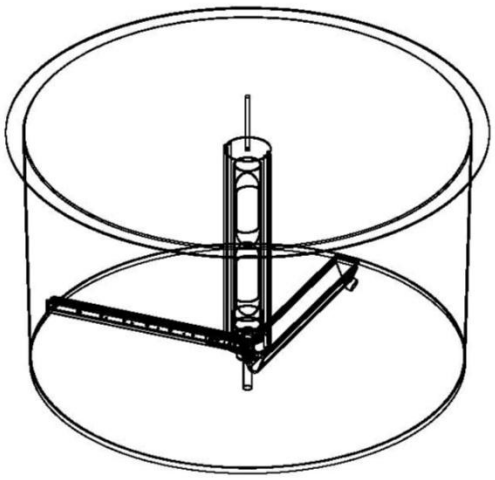

Figure 1. Illustration of a self-cleaning tank design.

The new tank system has been fully designed and engineered, and is expected to be operational in early 2015.

Fish Eggs and Larvae Find Uses in Impact Studies

As researchers first and aquaculturists second, we have a great appreciation for the value of reliable access to significant quantities of high quality fish (eggs, larvae and juveniles) for science. Currently there is great interest in the effects of pollution, climate change and ocean acidification on ocean animals, so this is one area that our young fish are being used to help advance science. Years ago there was a great deal of interest in understanding how thermal effluent from (water-cooled) coastal power plants would affect coastal organisms – cultured fishes were often used to investigate these concerns. Today, there are similar interests surrounding the potential effects of desalination facilities that are being constructed around the world to help secure fresh water supplies for burgeoning human populations.

HSWRI researchers were asked recently by Poseidon Water, the leading seawater desalination developer in the U.S., to investigate the effects of two potential operational aspects of desalination on fish eggs and larvae. First is the effect of short duration (2min) exposure of eggs and larvae to hypersaline conditions of 40-45ppt resulting from discharge of concentrated brine after the freshwater is extracted. Second is the potential effect of a novel water pumping technique that uses an Archimedes screw to move water rather than an impeller. Intuitively the screw pump will much less impactful to larval fishes but it needs to be tested. If successful, this pump design can be used to move seawater with less concern about impacts. From there, the larvae will need to be safely diverted from the desalination process via one or more screens, which represents another refinement need.

Figure 2. Special Projects Manager, Federico Rotman, with pilot scale Archimedes screw pump (top). Research Assistant, Enrique Mauser, counts larvae after a salinity exposure trial (bottom).

Pilot testing is currently underway for salinity exposure trials and a small-scale Archimedes pump is being customized for experimental purposes. Interestingly, we have used salinity exposure tests in the past as a form of stress testing of different cohorts to determine their quality. In those tests, salinities of 50-60ppt were used. HSWRI is uniquely suited for this work because of our experience working with early life stages of fish and active spawning populations of halibut, yellowtail and seabass.

Larval Nutrition Project Winds Down With More Interesting Results

HSWRI's collaborative larval nutrition project with researchers from Oregon State (OSU), NOAA, USDA and UC Davis is winding down after three years of productive research. Our Year 3 progress report was recently presented to the Western Regional Aquaculture Technical Advisory Committee in Spokane, WA. Among some of the significant findings reported was the effectiveness of stimulants incorporated into the feeds to increase feeding incidence on microdiets. Among individual attractants tested (betaine, glycine and alanine), glycine had a significant positive effect. Similarly, using the commercially available attractant ProMega 55 significantly improved feeding response. In fact, using ProMega 55 in microdiets for white seabass showed that the larvae could be weaned off *Artemia* ten days earlier than those fed a traditional diet without sacrificing growth or survival. The study with glycine provided strong evidence that the stimulation was gustatory rather than olfactory. In other trials, OSU researchers demonstrated the effectiveness of using liposomes to deliver taurine into live feeds – achieving very efficient uptake in both rotifers and *Artemia*, with minimal loss during several hours of cold storage. This offers benefits over traditional means of adding it to the water, which is more wasteful and less precise. Finally, USDA research partner, Dr. Rick Barrows, developed a new processing method for microdiets that allows larger scale quantities to be made much more efficiently to support the scale of trials that marine fish often require. When compared to the Particle-Assisted Rotational Agglomeration (PARA) process used in our open formula diet, the new Larval Extruded (LEX) performed similarly, so it will be used in future trials.

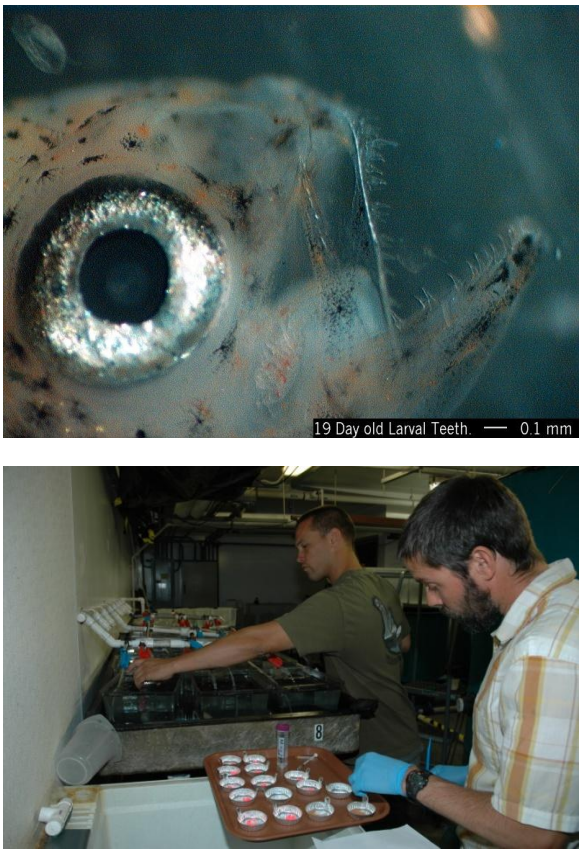

Figure 3. Close-up of white seabass head and jaws at 19 days old (top). Kevin Stuart from HSWRI and Matt Hawkyard from OSU collaborate on feeding study at HSWRI.

The nutrition team is finalizing the few remaining trials for the project and strategizing about follow-on research opportunities to explore through other grant opportunities. In addition to the research activities, the team is planning a larval feeds and feeding workshop as a key outreach deliverable to be held in the fall of 2015.

Acknowledgements

This document reports on aquaculture research projects supported by numerous grants, contracts and private contributions. It also represents the hard work of many dedicated staff and volunteers throughout southern California, as well as collaborators around the country. This information was contributed by HSWRI staff and compiled by Senior Research Scientist and HSWRI Aquaculture Program Director Mark Drawbridge.

The aquaculture research program has been active for more than 35 years at HSWRI. The primary objective of this program is to evaluate the feasibility of culturing marine organisms to replenish ocean resources through stocking, and to supply consumers with a direct source of high quality seafood through aquatic farming. Please direct any questions to Mark Drawbridge at mdrawbridge@hswri.org.

Aquaculture research at HSWRI is currently supported by these major contributors:

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- Cabrillo Power/NRG
- California Sea Grant
- Chevron Corporation
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- San Diego County Fish and Wildlife Advisory Commission
- Santa Monica Seafood
- SDG&E Environmental Champions
- SeaWorld Parks and Entertainment
- SeaWorld San Diego
- Soy Aquaculture Alliance
- The California Department of Fish and Wildlife's Ocean Resources Enhancement and Hatchery Program
- The Catalina Seabass Fund
- The Fletcher Foundation
- The Shedd Family
- The U.S. Fish and Wildlife Service's Sport Fish Restoration Account
- United Soybean Board
- USDA National Institute of Food and Agriculture
- Western Regional Aquaculture Center (WRAC)

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