HSWRI Aquaculture Program Research Report
**** December 2010 & January 2011 ****

Reducing Bacterial Levels in *Artemia* Culture

About four days after they hatch out of their eggs, white seabass (*Atractoscion nobilis*; WSB) larvae have exhausted all of their yolk reserves and need to start preying upon live food in order to survive. In nature, these small larval fish (less than 5mm in length) exist in the plankton where they are adapted to feed on microorganisms such as copepods and other small crustaceans. In order to successfully raise WSB in captivity, our team continually works toward providing them with a food source as nutritious and clean as what they would find in the wild. Institute scientists found that newly-hatched *Artemia franciscana*, also known as brine shrimp or sea-monkeys, are a convenient first feed for these larval fish. This type of crustacean hatches out of its eggs at a size of just 400µm and can be raised in the very high numbers needed to support the intensive aquaculture industry.

Figure 1. A) New large fiberglass *Artemia* hatching tanks. B) Illustration of a brine shrimp (*Artemia franciscana*) nauplii. C) A pool of four-week old WSB juveniles that were raised using improved brine shrimp production systems.

Recently, Institute staff under the direction of Research Assistant Federico Rotman took steps toward further improving brine shrimp production systems at the WSB replenishment hatchery in Carlsbad, CA. First, Rotman established a comprehensive bacterial screening program to better understand what levels of bacteria were found in various culture systems, including those used for live feeds. In response to these screenings, we installed new ultra-violet light and micro-particulate water filtration equipment that now keeps brine shrimp production much cleaner than before. This cleanliness is very important, as larval fish have virtually no immune system

for the first few weeks of their lives and can have trouble fighting off bacteria and viruses normally present in coastal seawater. Additional improvements to *Artemia* production are underway as we install new, larger hatching tanks that will make the brine shrimp culture and harvesting processes even cleaner and more efficient. Lastly, large stainless steel temperature-controlled holding tanks will be installed to keep brine shrimp fresh for longer periods of time.

WSB Recovery Year-End Update

Institute researchers released over 88,000 juvenile WSB of about 18 cm in length into the ocean waters off southern California in 2010. Production was limited by larval mortality issues, which are still under investigation, and colder-than-normal ambient ocean temperatures. A total of 7,745 WSB from the U.S. and Mexico fisheries were scanned for coded wire tags in 2010.

From the scanning efforts, 14 tagged adult WSB were recovered, or one tagged fish for every 553 scanned. The fish recovered ranged in age from 4-12 years, with lengths of 83-123 cm and weights of 4.4-14.5 kg. The distances these fish were recovered from their release sites ranged from 8.0 to 180 km, with an average of 80 km (Figure 2). One fish released in Agua Hedionda Lagoon, the location of our WSB replenishment hatchery, was recovered from a commercial market whose employees were unable to identify if the fish was landed in domestic or Mexican waters. Two WSB released in embayments within San Diego city limits were caught near Santa Catalina Island, approximately 40 km offshore from Los Angeles. Finally, eight fish that were released at Santa Catalina Island were caught at various locations around the island, with liberties ranging from 46-66 months.

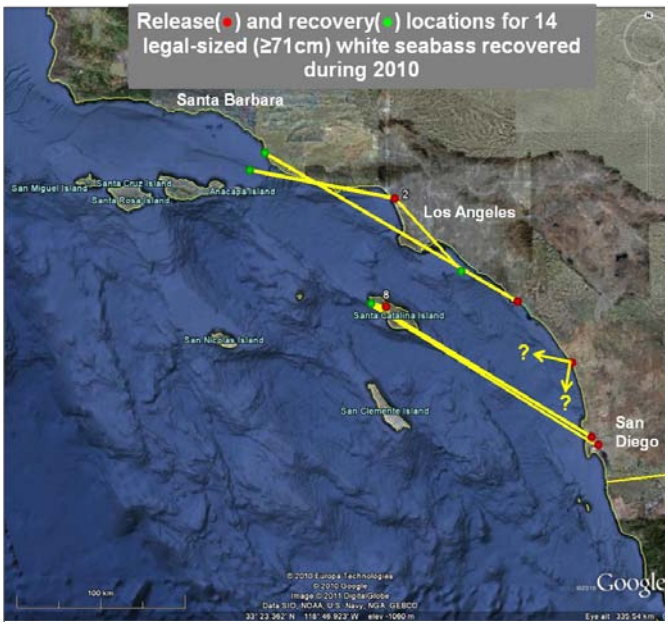

Figure 2. Release and recovery locations for adult WSB recovered during 2010.

SCORE One for Genetics and Acoustics Research

The Science Consortium for Ocean Replenishment (SCORE; www.stockenhancement.org) is a multi-institutional association of research laboratories, fisheries agencies, and scientists from all four corners of the United States and the Gulf of

Mexico. Participants include the Mote Marine Laboratory in Sarasota, FL; University of Southern Mississippi Gulf Coast Research Laboratory in Ocean Springs, MS; NOAA NMFS Northwest Fisheries Science Center in Seattle, WA; University of New Hampshire in Durham, NH; and Hubbs-SeaWorld Research Institute in San Diego, CA. The mission of SCORE is to develop "responsible, effective, and scientifically-based marine stock enhancement and restocking technologies." Funding for the SCORE research program is provided by NOAA Aquaculture. Research within the consortium is currently focused on a wide range of topics including species selection, systems design, larval and juvenile rearing, genetics, environmental impacts, dispersal, and mortality.

Current SCORE research at the Institute is focused on genetics and acoustic tracking in order to refine rearing and release strategies for California's WSB stock enhancement program. Research Scientist Dr. Kristen Gruenthal is leading a study to quantify differential survival between two culture stages in the hatchery: yolk sac larvae and release-ready juveniles (Figure 3). Differential survival (DS) is a change in frequency of one or more traits in a population over time (e.g. developmental stages, generations) in response to an environmental cue (e.g. temperature, pH, nutrition, tank effects). DS can occur when a trait offers a significant survival benefit, reaching higher frequency due to its advantage, and it is the basic means by which any selection – natural, sexual, or domestication – operates. Understanding DS in the hatchery environment is important relative to its potential effects on the survival of released animals their interactions with wild conspecifics.

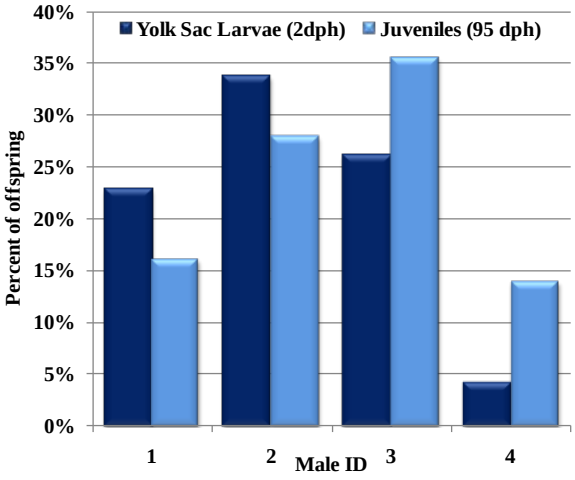

Figure 3. Male WSB parental contribution to two culture stages of offspring spawned on 9 Sep 2008. Preliminary evidence of DS is shown by the significant positive shift in contribution between the two stages for male #4, for example.

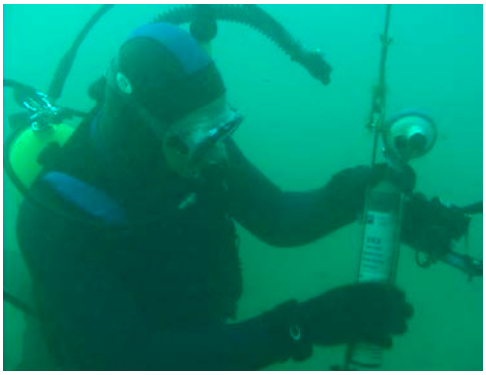

Figure 4. An HSWRI researcher services a hydrophone moored off the coast of San Diego, CA.

Research Scientist Mike Shane is preparing to deploy an acoustic array for tracking cultured WSB after release. The array of underwater hydrophones will be deployed along 120 km of the San Diego County coastline (Figure 4). It will be used to identify trends in seasonal movement, mortality/predation, and habitat use by cultured WSB along the coast. The research is designed to help HSWRI scientists evaluate existing hatchery release protocols (e.g. optimal size and age, season, coastal location).

The results of these combined studies will facilitate HSWRI's ability to adaptively manage the WSB program as our understanding of movement, mortality, and the potential for domestication in captive-bred fish increases. This approach is consistent with the SCORE vision that marine stock enhancement must be advanced responsibly using a science-based approach.

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. This information was contributed by HSWRI staff and compiled by Aquaculture and Fisheries Research Coordinator Dr. Kristen Gruenthal under the direction of Senior Research Scientist and Aquaculture Program Manager Mark Drawbridge.

The Aquaculture Research Program has been active for more than 30 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 traditional aquatic farming. Please direct any questions to Dr. Kristen Gruenthal at kgruenthal@hswri.org.

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

- Cabrillo Power/NRG
- California Sea Grant
- Chevron Corporation
- Cruise Industry Charitable Foundation
- Darden Restaurants Foundation
- Indian River Lagoon National Estuary Program
- National Institute of Food and Agriculture
- NOAA Fisheries
- NOAA's Saltonstall-Kennedy Program
- San Diego County Fish and Wildlife Advisory Commission
- SeaWorld Parks and Entertainment
- SeaWorld San Diego
- The California Department of Fish and Game'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

Hubbs-SeaWorld Research Institute is a 501(c)(3) non-profit charity. If you would like to become a financial supporter of the Institute's aquaculture research, please contact Karen Terra at (619) 226-3870. You can also make an online donation by clicking here: Donate Now.

For more information on the Institute visit www.hswri.org or become a fan at www.facebook.com/hswri.