HSWRI Aquaculture Program Research Report
**** October & November 2011 ****

Soy-based Diets for Carnivorous Marine Finfish Closer to Reality

HSWRI is conducting research to identify suitable replacements for fishmeal and fish oil in practical diets for cultured carnivorous marine finfish in order to make the diets more affordable and less dependent on harvesting wild forage species. Here, we report on an exciting group of projects supported by the United Soybean Board that use soy-based ingredients. First, working collaboratively with Southern Illinois University, we recently completed a trial on white seabass (*Atractoscion nobilis*; WSB), exploring the efficacy of soy-based lipids to replace fish oil. Graded levels of either standard soy oil or saturated fatty acid rich soy oil were substituted for 0-100% of fish oil in test diets. Interestingly, there were no significant differences in WSB survival among treatments, although growth slowed overall with increasing levels of either soy lipid.

Figure 1. Research Scientist, Kevin Stuart, holds a CYT that was just weighed and measured as part of an extended soy-based feeding trial.

We are also conducting an eight-month trial with California yellowtail (*Seriola lalandi*; CYT) and WSB to determine potential long-term effects of our most successful soy-based diets to date on fish performance (Figure 1). Six months into testing, both species are doing as well or better on the soy formulations versus the commercially-available diets used as controls. At the conclusion of this trial, growth will be assessed and tissue samples will be taken for fatty acid analyses and human palatability tests – it's not enough to just grow the fish; they must also meet the high standards for taste and human health benefits for which marine fish are known.

A third research aspect recognizes that high inclusion levels of soy can reduce the palatability of the feeds for the fish. We are in the midst of a trial with CYT, testing a series of 0% fishmeal, 34% soy protein concentrate diets with different attractants (krill, squid, and sea urchin) against the

basal formulation with no attractant.

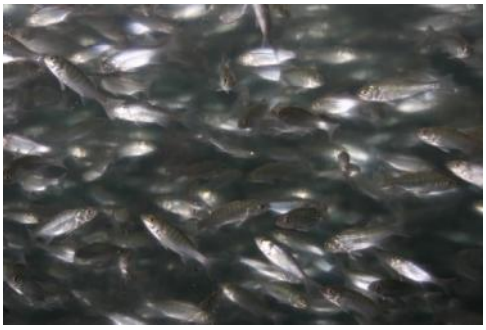

Figure 2. Juvenile striped bass school up at HSWRI.

Finally, although there is abundant commercial farming and associated research on hybrid striped bass (*Morone saxatilis x Morone chrysops*) in freshwater, very little has been done with pure-strain striped bass (*Morone saxatilis;* SB) reared in seawater. To fill the gap, we are developing soy-based diets for this "emerging" aquaculture species. Pure-strain SB fingerlings are being used to test: 1) graded replacement of fishmeal (40-0%) with soy meal (0-52%) and 2) amino acid supplementation with methionine, lysine, and taurine. As with WSB and YT, the ultimate goal is to develop commercial soy-based feeds to rear this high value specie.

Responding to Stress: Cortisol Levels in Juvenile White Seabass

The stress response can be defined as the sum of physiological responses by which an animal tries to maintain or reestablish normal metabolism in the face of environmental perturbation (e.g. temperature shift, handling, disease, aggression). Under stress, blood plasma cortisol increases to meet the energy demands associated with adapting to a stressor (primarily through triggering glucogenesis, which raises blood sugar). When cortisol increases, however, other energy-intensive physiological functions are reduced, including but not limited to somatic growth and immune function. Chronically, these physiological changes can become maladaptive and detrimental to animal health.

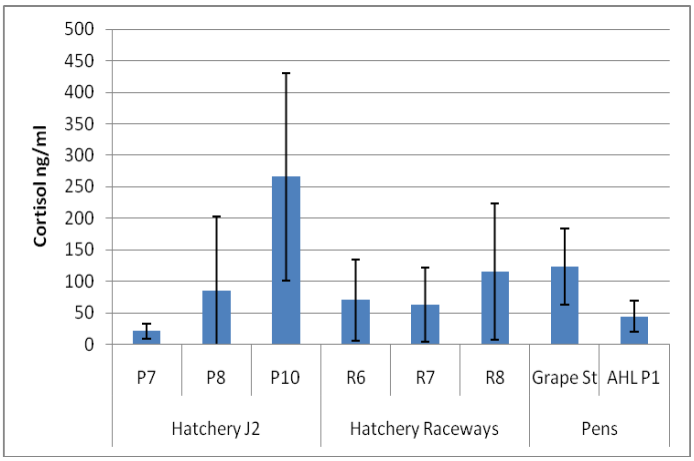

Figure 3. Background mean cortisol levels (ng/mL) and standard deviations for 10 fish sampled in each tank. J2 fish are usually <100 days post hatch (dph), raceway fish are generally >100 dph, and net pen fish can be up to 200-300 dph.

In efforts to begin understanding the cortisol response in white seabass (*Atractoscion nobilis*; WSB), we completed a study on background (intrinsic) cortisol levels in various groups of fish in the hatchery and net pens. Ten fish were randomly sampled from separate rearing units in each system listed in Figure 3. Whole blood was collected from each set of 10 fish in under five minutes to minimize the chances of detecting the cortisol response elicited from basic handing. Each blood sample was centrifuged to obtain plasma and frozen for analysis. The plasma was sent to collaborators at California

State University Long Beach, where radioimmunoassay testing was used to quantify the amount of cortisol in each tube.

The cortisol values for each group were averaged and are shown in Figure 2. Average cortisol levels ranged from 21.0 ± 12.1 ng/mL (P7) up to 265.8 ± 164.4 ng/mL (P10). Our initial testing indicates that variation in cortisol is significant among rearing conditions, as well as among individual fish taken from the same culture unit. Current efforts are underway to identify associations between elevated cortisol levels in WSB and husbandry conditions, such as temperature, pH, diet, and density. Our hope is to pinpoint how external factors affect stress (as measured by cortisol levels) in WSB and other species and to use this information to optimize culture conditions.

Ocean Health Postdoc Rounds Out the Aquaculture Team

Dr. Constance Silbernagel joined HSWRI's research team in July 2011 as a post-doctoral research associate and veterinarian. After receiving her veterinary degree in 2007, Dr. Silbernagel practiced small and exotic animal medicine for over three years before returning to school to pursue a Master's degree in Preventive Veterinary Medicine at the University of California Davis. Preventive medicine includes identifying risk factors for disease outbreaks, identifying potential causative factors for infectious and non-infectious diseases, and implementing methods of preventing the spread of disease within and among populations. Aside from working with a variety of terrestrial companion animals and wildlife species, she has behavioral and clinical research experience with marine mammals and freshwater turtles. Dr. Silbernagel is excited to have the opportunity to expand her knowledge in the aquaculture community.

As an aquaculture veterinarian, Dr. Silbernagel's responsibilities include routine diagnostic health assessments of the species currently cultured at HSWRI (Figure 4). In addition, routine consultation with hatchery management and husbandry teams is necessary in order to maintain healthy populations. Dr. Silbernagel advises aquaculture staff on appropriate biosecurity measures at the aquaculture facilities to prevent the introduction or spread of potential pathogens among fish or to the humans working with them. She also works in conjunction with research scientists to maintain high welfare standards for fish used in research trials, such as those for nutrition and stress physiology. Dr. Silbernagel is planning to initiate some of her own research in the near future, including developing a baseline of biomedical parameters measured from healthy cultured fish and wild fish.

Figure 4. Dr. Constance Silbernagel at work performing a necropsy on a WSB brood fish.

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 Director 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 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
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- NOAA Fisheries
- NOAA's Saltonstall-Kennedy Program
- San Diego County Fish and Wildlife Advisory Commission
- Santa Monica Seafood
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- SeaWorld San Diego
- The Boeing Company
- 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
- USDA National Institute of Food and Agriculture
- Western Regional Aquaculture Center (WRAC)

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