United Soybean Board
Final Report Form – Technical Bulletin

Project # and Title	Project #2463 Use of soy-based products in practical diets for striped bass
Organization & Project Leader	Organization: Hubbs-SeaWorld Research Institute Project Leader: Mark Drawbridge
Reporting Period	1/1/2012-12/31/2012

Introduction: Statement on the rationale and background for the studies

The overall objective of this project is to build demand for U.S. soy in aquaculture markets by developing soy based feeds for striped Bass (SB; *Morone saxatilis*). SB is a highly valued sport fish along the east and west coasts of the United States and is considered an excellent food fish. Commercial culture of hybrids of this species (*Morone saxatilis* x *Morone chrysops*) is widespread throughout the U.S. However, aquaculture of pure SB is limited. Hubbs-SeaWorld Research Institute (HSWRI) has been culturing SB on an experimental scale in tanks and cages since 2004. HSWRI has test-marketed seawater-reared SB in various U.S. markets with very positive feedback. We believe there is great potential for commercial culture of this species in both the U.S. and Mexico. HSWRI is currently working with cage farmers in Baja Mexico who are growing SB supplied by HSWRI. The use of alternate ingredients such as soy protein could greatly improve profitability, while simultaneously addressing issues associated with the long term sustainability of fish meal and fish oil resources. A good opportunity exists to demonstrate the effectiveness of SB diets based on soy protein as the offshore aquaculture industry expands.

Since 2008, HSWRI has been conducting research to develop practical soy- based diets white seabass (WSB; *Atractoscion nobilis*) and California yellowtail (YT; *Seriola lalandi*) for the United Soybean Board (USB) with promising results. HSWRI is utilizing the same methodology to develop practical soy-based diets for WSB. In the fall of 2011 we ran two trials with SB. The first trial tested graded levels of soy protein replacing fish meal from 40% to 0% and the second tested various combinations of supplements at 0% fish meal. Palatability problems in diets below 20% fish meal resulted in the early termination of these trials. We reformulated diets and ran two more trials in 2012.

Studies completed - brief summary of the number and type of studies conducted, including general study design and approach on how and where the studies were conducted, but without details of the materials and methods

Study 1– Graded replacement of fish meal with soy (HSWRI/Auburn, HSWRI Carlsbad).

An 11 weak trial was run with SB testing graded levels of either soybean meal or soy protein concentrate replacing fish meal from 40% to 20%. We increased the level of fish meal in these diets since we saw palatability problems in diets below 20% fish meal in 2011.

Study 2 – Effectiveness of and attractant and/or taurine (HSWRI/Auburn, HSWRI Carlsbad).

An 11 week trial was run with SB testing an attractant (squid meal) and taurine individually and in combination in a 30% fish meal diet.

Study 3 – Acceptance of low fish meal formulations vs. commercial formulations (HSWRI/Auburn, HSWRI San Diego).

A feeding trial was begun with SB testing three experimental formulations with 20,12 and 0% fish meal and two commercial formulations with varying levels of fish meal.

Results - sequential summary of results, ending with recommendations on soy diet formulations, feeding protocols, economics and other related recommendations

Studies 1 and 2 – Graded replacement of fish meal with soy and the effectiveness of an attractant and/or taurine (HSWRI/Auburn, HSWRI Carlsbad).

Two 11 week trials were run with SB. The first (Study 1) tested graded levels of either soybean meal or soy protein concentrate replacing fish meal from 40% to 20% and the second (Study 2) tested an attractant and taurine individually and in combination in a 30% fish meal diet (Table 1). We saw no palatability problems with any of these diets nor did we find any significant differences between any of the treatments (Table 2). Furthermore we ran the diets from the two trials run in 2011 (40-0% fish meal) on the same fish to test whether or not larger fish would find lower fish meal diets more palatable and found the same results. The SB did not find diets below 20% fish meal palatable. Therefore, in 2013 we will attempt to hone in on the minimal fish meal level that SB will find palatable.

Table 1. Studies 1 and 2 diet formulations for SB (g/100g as is).

Ingredient (g/100g as is)	FM40	FM30-SBM13	FM20-SBM26	FM30-SPC10	FM20-SPC19	SPC + Taur	SPC + Squid	SPC + Squid + Taur
Menhaden fishmeal	40.00	30.00	20.00	30.00	20.00	30.00	30.00	30.00
Soybean meal solvent extracted	0.00	12.80	25.50	0.00	0.00	0.00	0.00	0.00
Poultry by product meal	10.70	10.70	10.70	10.70	10.70	10.70	10.70	10.70
Soyprotein concentrate (63% CP)	0.00	0.00	0.00	9.70	19.40	9.70	9.70	9.70
Corn gluten meal	10.00	10.00	10.00	10.00	10.00	8.65	9.10	7.75
Corn starch	22.43	17.70	12.84	20.61	18.58	20.84	20.58	20.77
Whole wheat	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Menhaden fish oil	4.82	5.71	6.61	5.84	6.86	5.89	5.83	5.88
CaP-diebasic	0.00	0.70	1.60	0.80	1.80	0.80	0.80	0.85
Lecithin	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
ASA vitamin premix	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
ASA trace mineral premix	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Choline chloride	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
Stay C 35%	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Squid meal	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1.00
Methionine	0.00	0.05	0.10	0.06	0.12	0.09	0.05	0.07
Taurine	0.00	0.05	0.11	0.05	0.11	1.07	0.05	1.07
Lysine	0.00	0.24	0.49	0.19	0.38	0.21	0.14	0.16
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Table 2. Growth performance of SB in Studies 1 and 2.

Diet	Initial WT (g)	Final WT (g)	WT Gain (%)	Survival (%)	FCR
FM40	38.7	83.9	117.1	100	1.71
FM30-SBM13	38.5	87.7	127.8	100	1.61
FM20-SBM26	38.0	84.7	123.0	100	1.67
FM30-SPC10	38.5	86.3	124.1	98	1.64
FM20-SPC19	38.5	85.3	121.5	100	1.69
SPC + Taur	38.6	85.1	120.6	100	1.69
SPC + Squid	38.5	85.3	121.5	100	1.70
SPC + Squid + Taur	38.7	83.6	116.1	98	1.73

Study 3 – Acceptance of low fish meal formulations vs. commercial formulations (HSWRI/Auburn, HSWRI San Diego).

The feeding trial with SB was discontinued after 4 weeks due to a poor feeding response. The only diet that was accepted by the fish was a commercial formulation (EWOS Dyna Seabream) that contains a high level of fish meal. Although these fish

were much larger (600g) than fish we tested previously, they showed a poor feeding response to all experimental feeds as well as the low fish meal commercial formulation.

Conclusions - summarize overall value of research results and application opportunities by industry

There is very limited work on SB and reports seem to be quite variable in terms of tolerance of low fish meal diets. Based on industry input and what has been shown with hybrid striped bass, we expected SB to be more tolerant of reduced fish meal diets. However, this is not proving to be the case. We will need to determine the minimum level of fish meal that SB will accept and then determine ways to reduce fish meal from that level as we have with other species.

The feed manufacturing industry will be able to use the data to identify the maximum level of inclusion of soybean meal and soy oil in production diets for SB. It will also target a developing commercial offshore aquaculture industry in northern Baja California, Mexico by demonstrating that the fish can be grown to marketable size using relatively high levels of soybean meal and soy oil in the diet. California has already legislated a mandate to "minimize the use of fish meal…", and this research will build on research conducted from 2008-2012 to clearly demonstrate how that may be practically accomplished.