EVALUATION OF FEED REGIMES FOR REARING JUNE SUCKER (*Chasmistes liorus*)

Fisheries Experiment Station, Utah Division of Wildlife Resources,
1465 West 200 North, Logan, Utah 84321, USA

Introduction

The June sucker (*Chasmistes liorus*) is an endangered fish species endemic to Utah Lake, Utah. A recovery program has been implemented with a goal of propagating June sucker for stocking into Utah Lake. The development of proper culture techniques is needed prior to the construction of a native species warm water hatchery necessary to meet recovery goals (Routledge, 2001).

This study is second in a series of studies to establish a diet for use in culturing June sucker. The first feed study began with fish nine months old and continued until fish were one year old. The results from the first study identified three diets for potential use for rearing June sucker: Razorback, Bio Vita and Bio Flake (Hansen, 2002).

Methods

The study began at initial feeding (swim up) and ran for 236 days. Fish used in the study were from one lot of eggs collected from the Provo River. The study consisted of five feed regime treatments with three replicates per treatment (Table 1). Treatment 1 was fed brine shrimp, and the Bio Flake diet, manufactured by Bio Oregon. Treatment 2 was fed rotifers, Zeigler AP 100 and Z+ larval diets and Finfish Meal. Due to problems with the availability of Zeigler AP100, the Zeigler diets Z+ and Finfish Meal were substituted. Treatment 3 was fed brine shrimp and the "Willow Beach" diet used for razorback sucker, and Bio Diet, which replaced Silvercup due to results from the first feed study. Treatment 4 was fed brine shrimp and the Razorback diet formulated by the Bozeman Fish Technology Center and manufactured by Nelson & Sons. Treatment 5 was fed brine shrimp and the Bio Vita diet manufactured by Bio Oregon. Brine shrimp were decapsulated, and fed for twenty-eight days; at day fifteen, brine shrimp were supplemented with the treatment feed. Rotifers were fed for fifty days, where upon feeding ended due to population crash; at day fifteen, rotifers were supplemented with Zeigler AP 100 larval diet. During the study, parameters (flow, density and percent body weight fed) were kept consistent relative to the number of fish. Due to low numbers of fish in treatments 3 and 5 after 146 days into the study, densities were kept consistent between replicates within the treatment. Due to high gas saturation levels, degassing columns were installed to reduce the total gas saturation; this did not appear to affect the different treatments.

Table 1. The sequence of diets used by treatment for June sucker.

Treatment	Study Days						
	0-14	15-28	29-49	50-100	101-142	143-149	150-236
1	Brine Shrimp	Brine Shrimp/ Bio Flake	Bio Flake	Bio Flake	Bio Flake	Bio Flake	Bio Flake
2	Rotifers	Rotifers/ AP 100	Rotifers/ AP 100	AP 100	Z+	Z+	Fin Fish Meal
3	Brine Shrimp	Brine Shrimp/ Willow Beach	Willow Beach	Willow Beach	Willow Beach	Willow Beach/ Bio Diet	Bio Diet
4	Brine Shrimp	Brine Shrimp/ Razorback	Razorback	Razorback	Razorback	Razorback	Razorback
5	Brine Shrimp	Brine Shrimp/ Bio Vita	Bio Vita	Bio Vita	Bio Vita	Bio Vita	Bio Vita

In order to evaluate diet effects on fish health, the health condition profile (HCP; Goede and Barton 1990), Deformity Index, Skin Lesion Index, and Fin Deformity Index were used to compare the replicates and treatments upon completion of the study. Due to small fish size not all variables in the HCP were quantified. The HCP variables quantified in each replicate include: length, weight, condition factor (Ktl), eye condition, fin erosion, and opercle shortening. The Deformity Index classifies fish as normal or as an anomaly: vertebral, mandibular, cranial, opercular, fin, rakers, and other. The Skin Lesion Index classifies fish as normal or as an anomaly: red lesion, open lesion, fungus, loss of scales, tumor/neoplasm, and other. The Fin Deformity Index classifies fish fins as normal or as an anomaly: pectoral, pelvic, anal, ventral, caudal, adipose, dorsal, and other. Additional variables were quantified, (hemorrhaging, the presence of “black spots”, crippling and mortality), that were not specifically addressed in the HCP or indices. An external examination of the fish was used to verify if hemorrhaging was present or absent. The formation of “black spots”, two bilateral darkened areas on the sides anterior and posterior to the dorsal fin, were an abnormality found in fish, which eventually developed vertebral deformities resulting in the fish being immobilized. These types of cripples were culled after 188 days and included as mortalities. Daily records on mortality in the replicates were recorded.

The data was analyzed using SPSS. The Bio Vita feed regime treatment was not included in statistical analysis for HCP and indices, due to low survival. A twenty fish sample from each replicate of four treatments was used to quantify most variables. The percent mortality and crippling was calculated for each replicate, providing for a total of three samples per treatment. The mean weight, percent mortality and crippling were log transformed to normalize the data. Analysis of variance (ANOVA) was used to test for significant differences in percent crippling, percent mortality, mean length, mean weight, and mean condition factor. Post hoc tests using the least significant differences method was used to compare between treatments for the variables with a significant difference. Chi squared tests using maximum likelihood ratios were used to analyze the eye, opercle, fin deformity index, and hemorrhaging variables. Variables with a significant difference were subsequently analyzed in paired treatments with maximum likelihood ratios. The level of significance 0.05 was used for all tests. There was no variation in the fin erosion and the skin lesion indices, so no statistics were required.

Results

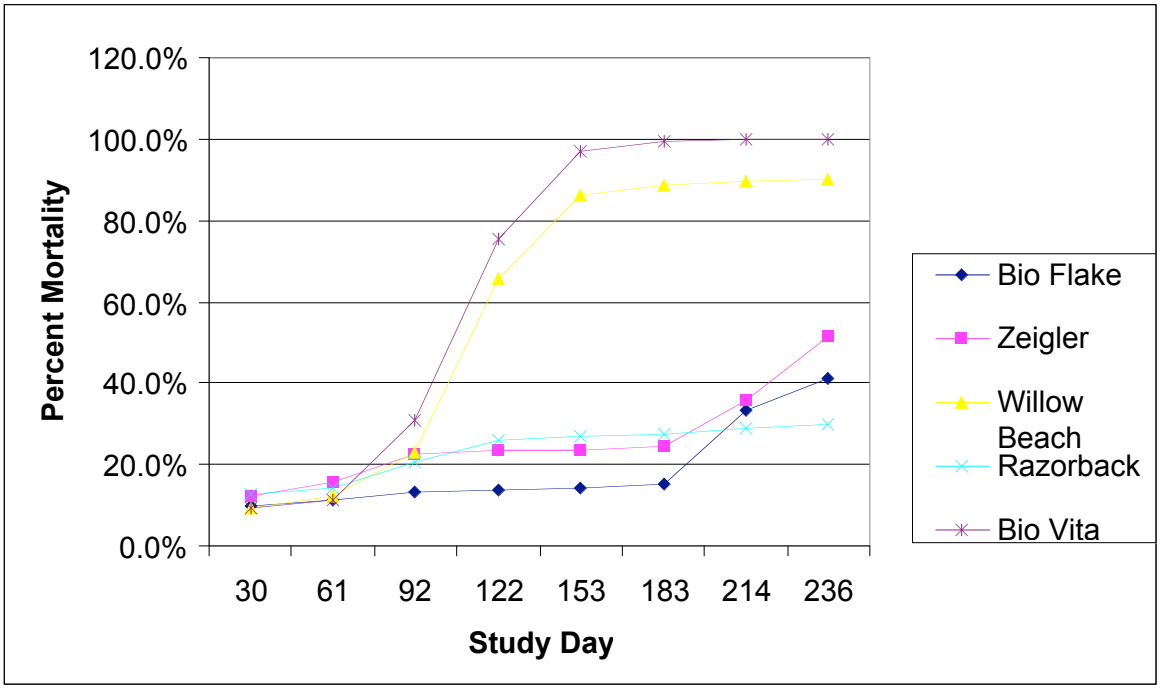
By the end of the study there were significant differences in fish performance between feed regime treatments. Crippling, mortality, length, weight, and condition factor differed significantly among feed regime treatments (Table 2). The percent mortality ranged from 30.1% to 99.9%. Mortality was significantly higher in the Bio Vita and Willow Beach feed regimes than in the other three treatments and began to increase after the feeding of brine shrimp had ended. The percent mortality in the Bio Flake feed regime was not significantly different than the Zeigler or Razorback regimes, but mortality in the Razorback feed regime was significantly lower than the Zeigler feed regime (Figure 1). The percent crippling ranged from 0.0% to 18.3% with the Bio Flake and Zeigler feed regimes having a significantly higher rate of occurrence than the other feed regimes. The amount of crippling in the Willow Beach feed regime was not significantly different from the Razorback and Bio Vita feed regimes, but the Razorback feed regime had a significantly higher occurrence of crippling than the Bio Vita regime where no crippling was observed. The mean total length ranged from 33.1 to 44.4 mm with significantly longer fish in the Razorback and Bio Flake feed regimes. The weights ranged from 0.27 to 0.76 g. Fish were significantly heavier in the Razorback and Bio Flake feed regimes, and fish were significantly lighter in the Zeigler feed regime. The mean condition factor ranged from 0.6239 to 0.8347 with significantly larger fish in the Razorback and Bio Flake feed regimes and the significantly smaller fish found in the Zeigler feed regime.

Table 2. Comparison of hatchery performance of June sucker fed five feed regimes. Matching subscripts among treatment means depict no significant difference between treatments for a given variable.

Treatment	1	2	3	4	5
Diet	Bio Flake	Zeigler	Willow Beach	Razorback	Bio Vita

Mortality (%)	41.1_{yx}	51.5_{y}	90.3_{z}	30.1_{x}	99.9_{z}
S.D.	0.055	0.078	0.035	0.1289	0.00075
Crippling (%)	18.3_{z}	10.7_{z}	0.4_{yx}	0.3_{y}	0.0_{x}
S.D.	0.059	0.027	0.0053	0.0025	0.0000
Length (TL)	42.7_{z}	33.1_{y}	34.3_{y}	44.4_{z}	------
S.D.	5.0273	6.1075	5.4159	6.0329	------
Weight	0.69_{z}	0.27_{x}	0.33_{y}	0.76_{z}	------
S.D.	0.6925	0.2733	0.3315	0.7640	------
Condition Factor (K) 10^5	0.8347_{z}	0.6239_{x}	0.7543_{y}	0.8207_{z}	------
S.D.	0.1170	0.1242	0.0890	0.0940	------

Figure 1. The comparison of cumulative mortality in feed study treatments.



Using chi squared test maximum likelihood ratios, significant differences were found in the eye condition, opercle shortening, hemorrhaging, and fin deformity index variables (Table 3). The percent of eye anomalies ranged from 0.0% to 6.7% with the Willow Beach and Zeigler feed regimes having a significantly higher occurrence than the Bio Flake and Razorback feed regimes wherein no anomalies occurred. The percent occurrence of shortened opercles ranged from 20.0% to 55.0% with a significantly higher occurrence in the Zeigler, Razorback and Willow Beach feed regimes than in the Bio Flake feed regime. The percent occurrence of hemorrhaging ranged from 1.7% to 23.3%, with the Zeigler feed regime exhibiting a significantly higher occurrence than the Bio Flake, Razorback and Willow Beach feed regimes. The percent of fin deformities occurring ranged from 0.0% to 21.7% with a significantly higher occurrence in the Willow Beach feed regime. The Bio Flake feed regime was not significantly different than the Razorback and Zeigler feed regimes, but the Razorback feed regime had a significantly higher occurrence than the Zeigler feed regime where no fin deformities were observed.

Table 3. Comparison of the percentage of hemorrhaging, eye anomalies, opercle shortening and fin deformities. Matching subscripts among treatment percentages depict no significant difference between treatments for a given variable.

Treatment	1	2	3	4	5
Diet	Bio Flake	Zeigler	Willow Beach	Razorback	Bio Vita
Eye anomalies	$0.0\%_{y}$	$5.0\%_{z}$	$6.7\%_{z}$	$0.0\%_{y}$	------
Opercle shortening	$20.0\%_{y}$	$55.0\%_{z}$	$40.0\%_{z}$	$53.3\%_{z}$	------
Hemorrhaging	$6.7\%_{y}$	$23.3\%_{z}$	$1.7\%_{y}$	$5.0\%_{y}$	------
Fin deformities	$3.3\%_{yx}$	$0.0\%_{x}$	$21.7\%_{z}$	$5.0\%_{y}$	------

Conclusions

The Razorback feed regime was determined to be the best diet for June sucker in comparison to the other four feed regimes in this study. Though fish fed this regime had a significantly higher occurrence of opercle shortening than the Bio Flake feed regime, it is not as detrimental of a problem at this time as the crippling levels found in the Bio Flake diet. The Bio Flake feed regime was found to be better than the other three diets. Fish in the Bio Flake feed regime experienced a significantly higher percent crippling than three of the other four feed regimes. The crippling did not begin occurring until 126 days into the study. The type of crippling experienced was preceded by the appearance of two bilateral black spots occurring in the same area on all fish in which this abnormality was found. The fish with these spots went on to develop the spinal deformities lordosis and scoliosis to the severity of immobilization. All fish were from the same lot, so the problem appears to be feed related rather than genetic. Further research needs to be conducted to determine if this diet is lacking in something required at certain point in development and would be sufficient during other stages of June sucker development.

The Zeigler feed regime did not appear to be appropriate for June sucker due to poor fish condition and growth, but certain aspects of the regime should be evaluated with further research. The rotifer population was never at a production level to meet fish requirements. The Willow Beach feed regime was not a sufficient regime in the study due to high mortality in addition to poor fish condition and growth. The Bio Diet feed needs further research due to the fish condition prior to switching feeds. The Bio Vita feed regime was the most inferior diet due to the high level of mortality. In the first feed study Bio Vita was a good diet. However in study #1, fish started on study feeds at nine months old and this study started at initial feeding. Bio Vita is likely a sufficient diet at certain developmental stages of June sucker.

Future research for diets used with June sucker should focus around the Razorback and brine shrimp feeds. The Zeigler larval diets should be evaluated with the use of brine shrimp. Bio Diet needs to be evaluated with feeds which have been successful before fish reach a size that Bio Diet can be fed. Rotifers still have the potential use for rearing June sucker after more work is done to produce larger numbers for feeding.

Literature Cited

Goede, R.W. & Barton, B.A. 1990. Organismic indices and an autopsy-based assessment as indicators of health and conditions of fish. p.93-108. Biological indicators of stress in fish. Adams, S.M. editor. American Fisheries Society Symposium 8, Bethesda, Maryland.

Hansen, E. 2002. Evaluation of diets for rearing June sucker (*Chasmistes liorus*). Ichthyogram 13-4:9-11. Utah Division of Wildlife Resources: Fisheries Experiment Station, Logan, Utah.

Routledge, D. 2001. June sucker feed studies. June sucker recovery program OY-2002 proposed scope of work. Utah Division of Wildlife Resources, Logan, Utah.

Eriek Hansen