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

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Introduction

This is the third study in a series evaluating diets for rearing juvenile June sucker (*Chasmistes liorus*), an endangered fish species endemic to Utah Lake, Utah. This study along with previous studies was conducted to meet a recovery goal of propagating June sucker for the subsequent stocking into Utah Lake (Hansen, 2002).

The previous study showed that a feed regime of brine shrimp and the Razorback diet formulated by the Bozeman Fish Technology Center and manufactured by Nelson & Sons, Inc. is the best regime for rearing June sucker that has been evaluated. The study also indicated that Bio Diet manufactured by Bio Oregon and Zeigler Z+ diet needed additional evaluation (Hansen, 2003). The design of this study was based on results of the previous two studies.

Methods

The study began at initial feeding (swim up) and was conducted for 235 days, June 10, 2003 through January 15, 2004. Fish used in this 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, "Razorback", was fed the Razorback diet. Treatment 2, "Brine Shrimp 28A", was fed brine shrimp from day 1 through day 28 and the Razorback diet from day 15 through day 235. This treatment was the same as in the second feed study. Treatment 3, "Brine Shrimp 56", was fed brine shrimp from day 1 through day 56 and fed the Razorback diet from day 29 through day 235. Treatment 4, "Zeigler", was fed brine shrimp from day 1 through day 28 and the Zeigler Z+ diet from day 15 through day 235. This feed regime was designed to switch to the Razorback diet at 0.45 grams per fish (1000 fish per pound) but the study was scheduled to end approximately one month after the replicates reached this size. The switch was not made due to the possibility that the results would not have been accurately quantified within the study days remaining. Treatment 5, "Brine Shrimp 28B", was fed brine shrimp from day 1 through day 28 and the Razorback diet from day 15 through day 235. This feed regime was designed to switch to Bio Diet at 0.76 grams per fish (600 fish per pound) but the fish in the replicates never reached this size. Brine shrimp were decapsulated prior to hatching and rinsed with fresh water prior to feeding. Razorback feed is received at a 1mm size and is ground and sized prior to feeding. During the study, parameters (flow, density and percent body weight fed) were kept consistent relative to the number of fish. Flows were higher than requirements during brine shrimp feeding to mitigate the increased bacteria load. During the second study month (July), possible heat degradation of the Razorback fee occurred; several times suspect feed was discarded and new feed prepared. Mortalities were recorded daily excluding weekends.

Table 1. Diets used for June sucker by treatment and study days.

Treatment	Feed Type	Study Days	Feed Type	Study Days
Razorback	Razorback	1-235	N/A	N/A
Brine Shrimp 28A	Brine Shrimp	1-28	Razorback	15-235
Brine Shrimp 56	Brine Shrimp	1-56	Razorback	29-235
Zeigler*	Brine Shrimp	1-28	Zeigler Z+	15-235
Brine Shrimp 28B*	Brine Shrimp	1-28	Razorback	15-235

*Additional diet in study design not used.

To quantify feed regime effects, the health condition profile (HCP; Goede and Barton 1990), Deformity Index, Skin Lesion Index, and Fin Deformity Index were used to compare among the replicates and treatments upon completion of the study. The HCP variables quantified in each replicate include length, weight, condition factor (Ktl x 10^5), eye condition, fin erosion, and opercle shortening. The HCP fin index was not appropriate for June sucker at this size and needs to be modified because active erosion is not occurring, but fin condition possibly varies between treatments and currently is not quantified. The Deformity Index classifies fish deformities as normal (0) or as an anomaly (1): vertebral, mandibular, cranial, opercular, and other. Fin aberrations were quantified using the Fin Deformity Index. The Fin Deformity Index classifies fish fins as normal or as an anomaly. 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 bilateral black spots quantified in the previous study were classified under the Skin Lesion Index "other" variable (Hansen 2003). Additional variables quantified included percent mortality and mean weight; these were also broken down by month.

Data was analyzed using SPSS® (SPSS 1993). A twenty fish sample from each replicate was used to quantify HCP and index variables. Analysis of variance (ANOVA) was used to test for significant differences among diets in total percent mortality, mean length, mean weight, mean condition factor, percent cumulative mortality by month, and mean weight by month. Post hoc tests using the least significant difference method were used to compare between treatments for the variables with a significant difference. The chi-square test using maximum likelihood ratios was used to analyze the variables: eye, opercle shortening, Fin Deformity Index, Skin Lesion Index and each variable within the Deformity Index for the occurrence (presence/absence) of anomalies. Variables with a significant difference were subsequently analyzed in paired treatments (partial tables) with chi-square maximum-likelihood ratio statistics. The level of significance 0.05 was used for all tests. There was no variation in the fin erosion variable, so no statistics were required.

Results

Significant differences using ANOVA were found in the mean length, weight, condition factor (Ktl), total percent mortality (Table 2), within the percent cumulative mortality by month (Figure 1), and mean weight by month (Figure 2). The mean length ranged from 37 to 47 mm with fish fed Brine Shrimp 56 being the longest. Mean weight ranged from 0.32 to 0.82 g with fish fed Brine Shrimp 56 being the heaviest. The mean condition factor (Ktl x 10^5) ranged from 0.6725 to 0.7350 with suckers fed Brine Shrimp

56 being the largest. The total mean percent mortality ranged from 38.16% to 75.93% with the lowest percentage occurring in Brine Shrimp 56.

Table 2. Comparison of fish performance between study feed regimes. Matching subscripts depict no significant difference for a given variable.

Feed Regime	Razorback	Brine Shrimp 28A	Brine Shrimp 56	Zeigler	Brine Shrimp 28B
Length (TL)	37.18_{y}	39.39_{y}	46.97_{z}	38.01_{y}	41.09_{y}
S.D.	6.36	7.9	6.29	25.27	7.82
Weight	0.39_{xw}	0.48_{yx}	0.82_{z}	0.32_{w}	0.54_{y}
S.D.	0.22	0.29	.30	0.15	.30
Condition Factor ($K*10^5$)	0.6822_{zy}	0.6731_{y}	0.7350_{z}	0.7000_{zy}	0.6725_{y}
S.D.	0.2184	0.1625	0.0993	0.1647	0.1620
Mortality (%)	72.97_{x}	71.61_{x}	38.16_{z}	53.82_{y}	75.93_{x}
S.D.	.05	.03	.05	.04	.02

Figure 1. Comparison of cumulative percent mortality between feed regimes by study days. Matching letters depict no significant difference among treatments within a given month.

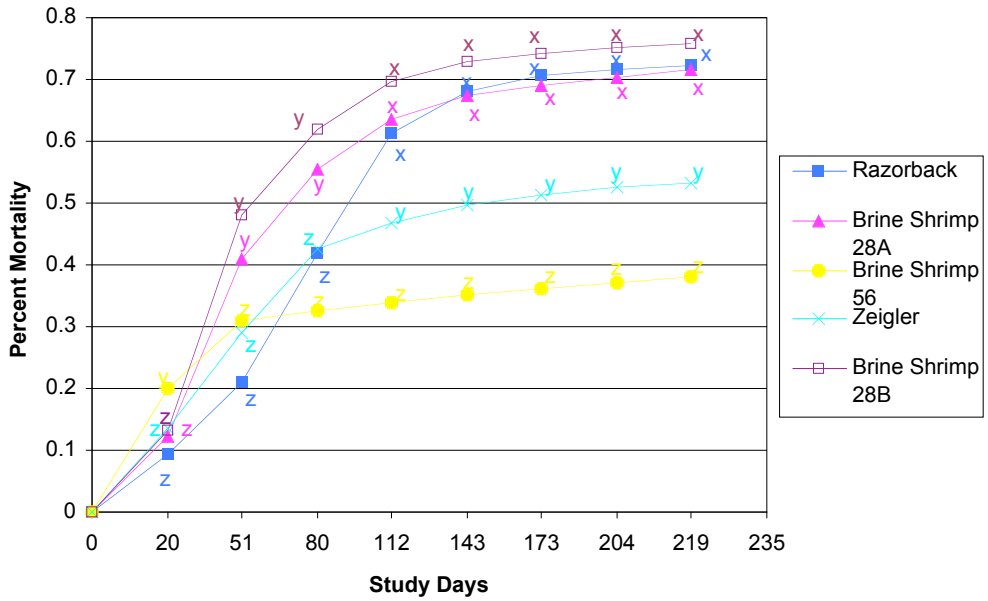
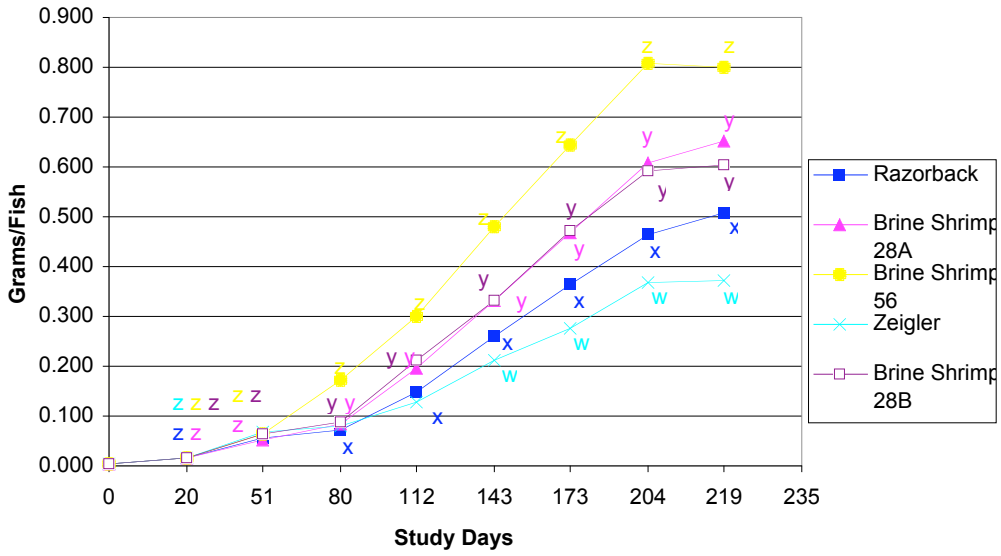


Figure 2. Comparison of mean weight among feed regimes by study days. Matching letters depict no significant difference among treatments within a given month.



Significant differences using chi-square tests were found in the variables eye anomalies, opercle shortening, fin deformities (Fin Deformity Index), opercular deformities (Deformity Index), vertebral deformities (Deformity Index), and Deformity Index (Table 3). The percentage of eye anomalies ranged from 1.7% to 23.3%, with the fewest occurring in Zeigler. The percent opercle shortening ranged from 80.0% to 95.0% with the lowest occurrence in Razorback. The percent fin deformities ranged from 1.7% to 23.3 with fewest occurring in Brine Shrimp 28A and Brine Shrimp 56. The percent opercle deformities ranged from 0.00% to 10.00% with no occurrence in Brine Shrimp 56, Zeigler, and Brine Shrimp 28B. The percent vertebral deformities ranged from 0.0% to 30.0% with no occurrence in Zeigler. The percentage of deformities in the Deformity Index ranged from 6.70% to 45.00% with the lowest occurrence in Brine Shrimp 56.

Table 3. Comparison of the percentage occurrence of eye anomalies, opercle shortening, vertebral deformities, opercular deformities, and fin deformities

Feed Regime	Razorback	Brine Shrimp 28A	Brine Shrimp 56	Zeigler	Brine Shrimp 28B
Eye Anomalies (%)	23.30_{x}	10.00_{y}	5.00_{zy}	1.70_{z}	8.30_{zy}
Opercle Shortening (%)	80.00_{z}	88.30_{zy}	93.30_{y}	83.30_{z}	95.00_{y}
Fin Deformities (%)	15.00_{yx}	1.70_{z}	1.70_{z}	23.30_{x}	8.30_{zy}
Opercular Deformities (%)	10.00_{y}	1.70_{z}	0.00_{z}	0.00_{z}	0.00_{z}
Vertebral Deformities (%)	30.00_{w}	8.30_{yx}	5.00_{y}	0.00_{z}	16.70_{xw}
Deformity Index (%)	45.00_{x}	15.00_{zy}	6.70_{z}	23.30_{y}	23.30_{y}

Conclusions

The results show that Brine Shrimp 56, i.e., brine shrimp for 56 days with the Razorback diet, was the significantly better diet in the study. Primarily the length and weight were significantly larger and the mortality was significantly lower than the other four diets. This regime also performed well for the other variables in comparison to the other diets. Overall, fish on the feed regime Brine Shrimp 56 out performed the other regimes and should be incorporated into future production procedures for juvenile June sucker. This diet, as well as others evaluated, are still lacking in the reduction of opercle shortening (Figure 3). Due to this result, feed trials should be continued to address this condition. The diet regimes Brine Shrimp 28A and B did not perform as well as in the previous study, in particular the percent mortality more than doubled. It is not known whether this is a lot difference or lower feed quality due to heat degradation during the diet switch to Razorback.

Figure 3. Photo depicts the occurrence of an opercular deformity and an eroded (shortened) opercle in a juvenile June sucker.

Literature Cited

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