The Ichthyogram

December 2002 Volume 13 Issue 4

Beaver River Population Assessments

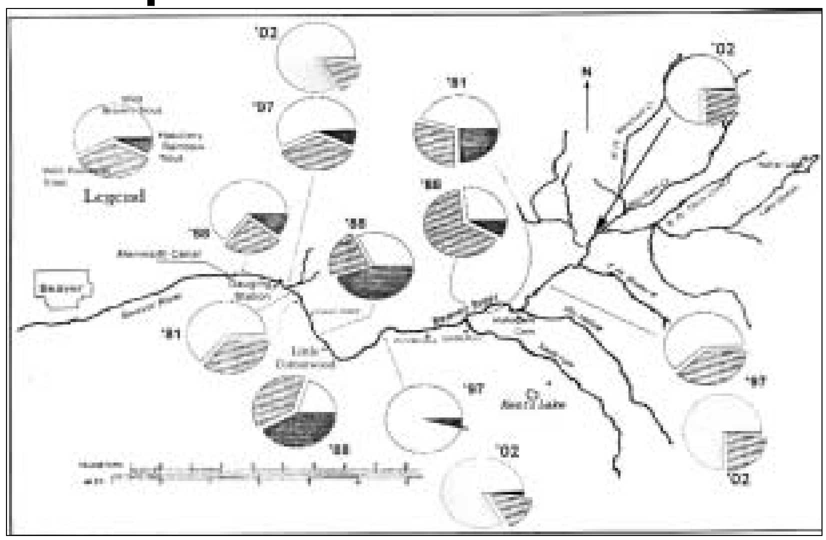

Figure 1. Percent composition of brown trout, wild and hatchery rainbow trout from electrofished samples from Section 4 of the Beaver River, Beaver County, Utah taken in 1981, 1988,1997, and 2002.

In 1996, fish in the Beaver River tested positive for *Myxobolus cerebralis*, the Myxozoan parasite responsible for whirling disease. A population assessment was conducted in 1997 at three sites above the town of Beaver, Utah [see Ichthyogram 8(3)]. The goal was to gain some insight into possible effects of the parasite on salmonid populations in the river and gather some good baseline data for fisheries management purposes. This was the same goal of population assessments conducted at the same three locations on October 23 and 24, 2002. In addition, populations estimates were made at a fourth site on the principal tributary to the river, Merchant Creek.

As in 1997, 100 m reaches were sampled by 2-pass electrofishing, using block nets to prevent fish from entering or leaving the reach. Population and biomass estimates were made using the POP-PRO software developed by Kwak (1992). Lengths and weights of the fish captured were compared to

UDWR crew electrofishes the Beaver River to collect samples and estimates abundance of trout.

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previous sampling in the river which was conducted in 1981, 1988, and 1997, but the 1981 sampling was only single-pass electrofishing. All the fish captured were also examined for deformities using the deformity index developed by Ron Goede. This method classifies a physical deformity as either vertebral, mandibular, cranial, opercular, fin, rakers, normal, or other and gives each deformity a severity ranking from 0 to 7. In this study, no rankings were made; instead, presence or absence of deformity was noted.

As part of the whole study, brown trout were sampled from each of the reaches for *M. cerebralis* testing. A total of 90 fish were sampled using one of three different methods: 1) whole head, 2) a core sample, and 3) a wedge. This was an experiment spearheaded by Anna Miller to determine what effect sampling technique might have on the ability to detect *M. cerebralis*. Assuming no effect, the techniques could be time saving innovations for laboratory assays. If there are biases, these should be pointed out and consistent sampling techniques should be applied nationwide.

Table 1. Stocking history of catchable rainbow trout in Section 4 of the Beaver River, Utah.

Year	Number stocked
1988	7,506
1989	6,957
1990	7,498
1991	7,383
1992	7,481
1993	6,983
1994	6,501
1995	6,617
1996	6,481
1997	6,051
1998	2,023
1999	1,986
2000	1,009
2001	866

Results

The proportion of brown trout, wild rainbow trout and hatchery rainbow trout has changed significantly over the years (Fig. 1). In 1988, the proportion of rainbow trout in the sample was much greater than in 1997 or 2002, largely due to the hatchery fish stocking at the time and probably due to less fishing pressure in 1988. Stocking of catchable rainbows continues to decline, dropping from 7,506 in 1988 to 866 in 2001 (Table 1). Upper reaches in 1988 also had higher wild rainbow trout abundance than observed in later years. Since 1997, there were more wild rainbow appearing in station 2, just downstream of the Ponderosa picnic area. However, reductions in wild rainbow abundance were seen further upstream at Station 3, not far below the E. Fork Beaver River confluence. Whether these changes are whirling disease related can not be determined for certain.

Wild rainbow trout from the Beaver River showing the deformed head clinical sign of whirling disease.

Deformities were observed for brown and rainbow trout, some of which were typical of whirling disease and others which were obviously related to catch-and-release angling. Data on deformities indicated that brown trout had low levels, ranging from 0% at the downstream station to 5.3% at Station 2. If only deformities that were consistent with clinical signs of whirling disease were included, that percentage dropped to 2% deformed. Rainbow trout had higher levels of deformities, ranging from 0 to 100% among hatchery fish, and from 0 to 33% among wild rainbow trout in the four reaches. For hatchery fish, sample sizes were small (n = 1 to 7), skewing interpretation of the deformity data. These fish primarily had hooking

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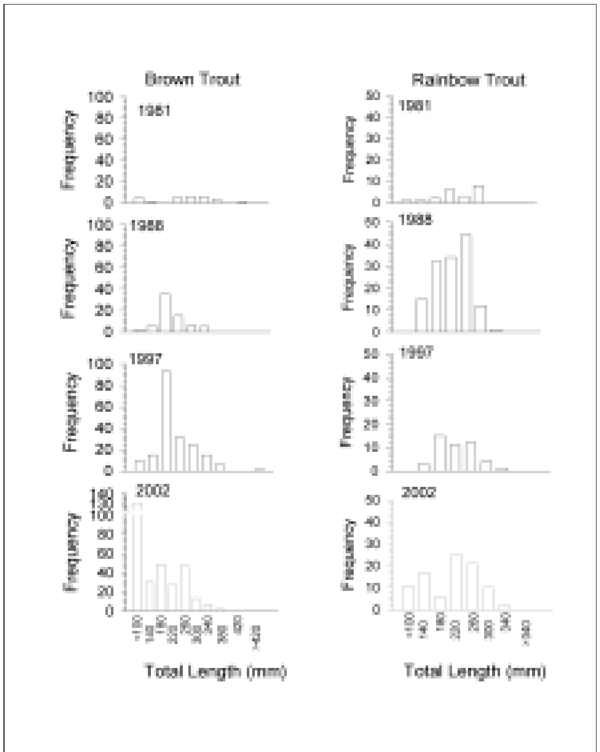

Figure 2. Length-frequency histograms (pooled across all sampling sites) for brown and rainbow trout from the Beaver River

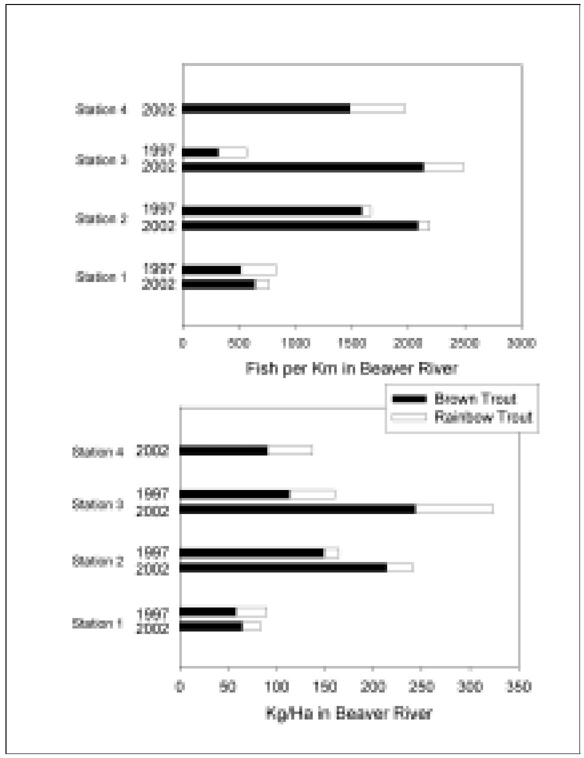

Figure 3. Comparison of biomass and abundance of rainbow and brown trout in the Beaver River between 1997 and 2002.

related deformities. Wild rainbow trout with clinical signs of whirling disease ranged from 0% to 33% (3 of 9 at Station 1). In 1997 the deformity rates were similar to 2002 for brown trout (1.5%) and the rainbow trout (10-12%).

One of the effects of whirling disease seen in other rivers is the high mortality of young of the year fish (YOY). In the 2002 sample, the length frequency data (Fig. 2) indicated that young-of-the-year fish were more abundant for both rainbow and brown trout than in years past. One factor in the increased abundance of YOY may have been the larger crew in 2002 (9 people vs. 5 to 7 in 1997), reduced water flows, and less turbid water due to the third straight year of drought. There were fewer brown trout in the larger size classes in 2002, which also may be indicative of increased susceptibility to angling pressure due to lower flows and reductions in habitat. The reduction in the abundance of larger fish may also have contributed to survival of YOY. Overall abundance was up in 2002, with more fish per river km in most reaches than in 1997 (Fig. 3). Despite stocking reductions, it was interesting to note that total biomass was also higher in 2002 than in 1997 in two of the three mainstem reaches (Fig. 3). In summary, the populations of brown and rainbow trout appear to be sustaining themselves in the Beaver River despite the presence of *M. cerebralis* in the system. The ratio of brown trout to rainbow trout appears to be shifting towards more brown trout, but it is not clear whether this is due to cropping of rainbow trout by angler harvest, reductions in rainbow trout stocking, shifting temperature regimes during drought, or by whirling disease.

Eric Wagner

The Team is Complete…(almost)

Once again, Technical Services at FES has added another member to their team. After many months of searching, we were able to find a very qualified biologist to fill the position vacated when Kent Thompson retired [see *Ichthyogram 13(1)]*.

David Thompson (no relation to Kent) is an experienced fish biologist with over seven years of experience performing fish and laboratory research related to aquatic animal health issues. He began working at the station at the dawning of the New Year. He just recently completed a Master's degree in Veterinary Medical Research from Mississippi State University. His project focused on the route of horizontal transmission of Channel Catfish Virus. Prior to his graduate work, David was employed as a senior wetlab technician at Alpharma, a pharmaceutical company in the Northwest that develops products for the aquaculture industry. David's breadth of experience in microbiological and molecular biological lab techniques along with his practical experience in the culture of fish will be a valuable asset in the growing fish health program at FES.

Outside of his studies, David has developed interests in backpacking, rock climbing, and cross-country skiing. Along with his wife and three year old daughter, David is looking forward to living in the west once again, and we are glad to have him on board. David can be reached at (435) 752-1066 extension 14.

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Ronney Arndt	26
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Eriek Hansen	19
David Thompson	14

Comparison of the Hatchery Performance, Behavior and Post-Stocking Survival of Diploid and Triploid FishLake-DeSmet Rainbow Trout

The recent advent of triploid rainbow trout for fisheries management has been an aid in the struggle to balance the needs of native fish and the desire of sport fishermen for a fast growing sport fish. The question that arises is 'Do triploids survive as well as diploids?' Some studies have been conducted elsewhere to examine the issue. Simon et al. (1993) found that triploid rainbow trout catches in three South Dakota ponds were significantly less, suggesting poorer survival. These results were based on small sample sizes (30 fish per pond). A study in Idaho concluded that there was no difference in catchability or survival between diploid and triploid rainbow trout stocked into 18 streams (Dillon et al. 2000).

Other studies have examined the physiological performance of triploids and the results have been mixed. Virtanen et al. (1990) found that 2-year-old triploid all-female rainbow trout that were exercised had higher plasma lactate concentrations and higher hematocrit values than diploids, indicating a reduced aerobic capacity. For coho salmon *Oncorhynchus kisutch*, Small and Randall (1989) found no difference in sustained swimming ability or hematocrit between diploid and triploid fish. Triploid rainbow trout reared at 21^{o}C for 28 days had significantly higher mortality (68.5%) than diploids (39%); growth was also reduced in triploids relative to controls (Ojolick et al. 1995).

In this study, the overall objective of the research was to see if there were any differences between triploid and diploid rainbow trout of three different strains reared in Utah that would influence their use for fisheries management and define aquacultural limitations, if any. For this article, we present results from a comparison of the hatchery performance of diploid and triploid Fish Lake-DeSmet rainbow trout. Also, post stocking survival differences were evaluated in 96-h tests and differences in aggressive behavior between diploid and triploid fish were evaluated in paired fish trials.

Methods

Hatchery Performance

Eggs of Fish Lake-DeSmet rainbow trout were pooled and fertilized before they were split into two groups, one of which served as a control. The other group was heat shocked at 26.2-27.0 C for 20 min at 20 min after fertilization to induce triploidy. At eyeup, the eggs were transferred to the Fisheries Experiment Station. On 14 June 2002, the fish were transferred to outdoor raceways, putting 1500 fish in each of three raceways for each ploidy group. Mean weights at the start of the experiment were 1.2 g for triploids and 1.3 g for diploids. Fish in both groups were initially reared in 0.42 m^3 of rearing space at 14.4 C, but rearing space was expanded as the fish grew, maintaining equal densities among raceways. The ration ranged from 3.87% of body weight initially (6 times/day) to 2.5% of body weight (4 times/day) at the end of the study.

Behavior Tests

The agonistic behavior differences between diploid and triploid rainbow trout were assessed by observation of paired diploids, paired triploids, and mixed pairs. The fish were size matched to avoid size being the determining factor in the establishment of social dominance. The fish were put into a 56 L glass aquarium in which fresh hatchery well water was added for each trial. A 2 h acclimation period elapsed before filming for 20 min

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with a video camera mounted on a tripod. When the camera was turned on, the person left the room during filming to avoid any disturbance of the fish. A total of 10 pairs were observed for each of the three treatments. The video tape was later reviewed and agonistic behavior classified as either attack, counterattack, or retreat.

Transport Stress Test

Fin clipping of the left or right ventral fin was conducted two weeks prior to the hauling test to differentiate between diploid and triploid fish. Triploid and diploid rainbow trout from each raceway replicate were dip-netted into 34 L of water in 2 separate plastic coolers (hauling tanks) at a density of 240 g/L (2.0 lb/gal), which is near the upper density limit for transport in Utah. One cooler was for triploids and the other for diploids. Each cooler had a mechanical aerator and supplemental oxygen distributed via a system with a separate flowmeter for each cooler and a long flat airstone. Flows of 0.75 to1.0 L/min of oxygen per tank were used during the 4 h haul. One replicate was conducted on 6 October 2002 and two more were conducted the following day. Different raceways were used for each replicate.

Upon return to the hatchery, 50 fish from each cooler were loaded into each of two circular tanks in the wetlab. One tank served as a control and contained hatchery well water at 16.5 ± 0.9^{o}C. The other tank was a mix of warm water (20^{o}C) and high pH (9.3). Diploids and triploids from a given haul were mixed in the same tank (50 of each) so that both groups received exactly the same water quality. The remainder of the fish in the hauling tanks were returned to their respective raceways, behind a screen to separate the transported fish from the others.

High pH was maintained by mixing NaOH in a raceway tank containing immersion heaters which were used to raise the water temperature to the target level. Once the proper mix of temperature and pH was made, it was pumped into the circular tank. Airstones delivered compressed air to each tank. A digital pH meter (Orion) was used to measure pH after daily calibration with standard buffers. Because the pH changed substantially during the course of the experiment, it was necessary to do water exchanges twice a day. For each water exchange, the tank was drawn down to half volume before pumping in the new water. Control tanks were also drawn down and fresh water added. Temperature and pH were measured before stocking, and before and after each water exchange. Oxygen concentrations were measured periodically with a calibrated oxygen meter (YSI), the accuracy of which was verified by Winkler titration. Ammonia was assayed using the nesslerization process (APHA 1989) at the end of the study at 96 h after stocking. Mortalities were weighed and measured and the ploidy status noted.

Results

Hatchery Performance

There were no significant differences in feed conversion rates or mortality rates between diploid and triploid rainbow trout (Table 1). However, specific growth rates were slightly, but significantly (P = 0.043), higher for triploids (2.79) than for diploids (2.60). Final weights averaged 20.2 g for diploids and 21.5 g for triploids, and did not significantly differ (P = 0.217). Early

Table 1. Comparison of the hatchery performance of diploid and triploid Fish Lake-DeSmet rainbow trout (*n* = 3). Means for a given variable that are significantly different are indicated with an asterisk.

Variable	Diploid	Triploid
Feed conversion	0.91 ± 0.06	0.83 ± 0.02
Final weight (g)	20.2 ± 1.53	21.5 ± 0.35
Mortality (%)	2.97 ± 1.51	2.8 ± 0.15
Specific growth rate	2.60 ± 0.07*	2.79 ± .02

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hatchery survival was similar between groups, with eye-up rates (77.3% diploid, 77.8% triploid) and hatching rates (96.8% diploid, 94.6% triploid) being nearly identical. Crippling rates were slightly higher among triploids (1.43%) than diploids (0.57), but both rates were within normal ranges for rainbow trout in Utah.

Behavior Tests

There were no significant differences in the number of attack, counterattacks, or retreats among diploid pairs, triploid pairs, and mixed pairs ($P > 0.410$; Table 2). When the diploids from all the trials were pooled and compared to the pooled triploid numbers, there were no significant differences either ($P > 0.703$).

Table 2. Comparison of the number of attacks, counterattacks, and retreats between diploid pairs, triploid pairs, and mixed pairs (mean ± SE) during a 20 min period (*n* = 20).

Agonistic behavior	Diploid pairs	Triploid pairs	Diploid-triploid pairs n = 10	Triploid n=10
Attack				
mean	3.25 ± 1.99	3.25 ± 1.38	0.70 ± 0.42	1.20 ± 0.73
median	0.0	0.0	0.0	0.0
Counterattack				
mean	0.15 ± 0.11	0.10 ± 0.07	0.30 ± 0.21	0.20 ± 0.13
median	0.0	0.0	0.0	0.0
Retreat				
mean	3.10 ± 1.99	3.15 ± 1.39	0.90 ± 0.69	0.60 ± 0.43
median	0.0	0.0	0.0	0.0

Transport Stress Test

There were no significant differences between triploid and diploid rainbow trout in mortality rates 96 h after hauling and stocking (Table 3). This was true for fish exposed to marginal water quality or to unmodified hatchery water and for analysis by either the chi-square test or the paired *t*-test. One control tank suffered a small amount of mortality (4.1 to 5.8%) attributed to low dissolved oxygen (2.1 mg/L) due to an insufficient quantity of air distributed via the airstones and compressed air system. One treatment tank shared the same air hose and suffered high levels of mortality (87 to 98%) not observed in the other treatment tanks. For fish returned to the tail end of the raceway they originated from, no mortality was observed for either triploid or diploid fish.

Total length and weight did not significantly differ between diploid and triploid mortalities within each tank, nor for pooled data. However, mortalities were significantly shorter for both diploid (120.4 mm; $P < 0.001$) and triploid (124.7 mm; $P = 0.014$) fish than the survivors (127.3 mm, diploid; 129.7 mm, triploid). Mean weight did not significantly differ between survivors and mortalities ($P > 0.40$). After combining the diploid and triploid data, there were still significant differences in length ($P < 0.001$), but not weight, between mortalities and survivors.

Table 3. Comparison of diploid and triploid Fish Lake-DeSmet rainbow trout mortality in tanks or raceways after transport and subsequent stocking into either water of the same water quality or water with high temperature and high pH.

receiving water condition	diploid mortality (%)	triploid mortality (%)
Indoor circular tanks pH 9.3, 20 C	6.4	9.6
	6.0	8.0
	97.9*	86.9
pH 7.6, 15 C	4.1	5.8
	0.0	0.0
	0.0	0.0
Outdoor raceway	0.0	0.0

***low dissolved oxygen in this tank**

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Discussion

The data indicated that there were few differences in hatchery performance between diploid and triploid Fish Lake-DeSmet rainbow trout. Triploid fish had slightly higher specific growth rates, but mean weights did not differ from diploid fish. Mortality rates were generally low for both groups during the grow-out phase. Early hatchery survival (eye-up and hatching rates) was also similar between the two groups. The behavior data indicated that the triploids were no different than diploids when it came to aggressive behavior. Both displayed agonistic behaviors at similar rates. This is contrary to results with fighting fish (*Betta splendens*) that indicated that triploids were less aggressive than diploids (Kavumpurath and Pandian 1992). The transport experiment also indicated there were no differences in post stocking survival as a result of stresses related to hauling. Even when water quality was marginal (low DO, high pH, and high temperature) in the receiving water, there were no significant differences in survival between diploid an triploid fish. The survival differences were size based, where smaller fish were significantly more likely to die after stocking in marginal water than larger fish. Overall, the data indicated that triploid Fish Lake-DeSmet rainbow trout perform equally as well as diploids. The fish were stocked into a small lake which will be sampled in the spring to compare overwinter survival.

Eric Wagner

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EVALUATION OF DIETS FOR FUTURE REARING JUNE SUCKER (*Chasmistes liorus)*

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. Plans are in place to build a native species hatchery and it is necessary to develop proper culture techniques prior to start up.

A diet has not been established for June sucker. Various diets have been used at the Fisheries Experiment Station (FES), but due to lack of space, replication has not been available to properly evaluate these diets. In January 2002, a new facility at FES went online with the space required for the tanks to run studies with replication. The first feed study was started at this time and will be used to refine future feed studies (Routledge, 2001).

Methods

The feed study consisted of five diet treatments with three replicates per treatment. Treatment 1 used the Bio Kyowa diet. This diet was used to feed all of the fish in the lot prior to the feed study. Treatment 2 was the Razorback diet formulated by the Bozeman Fish Technology Center and manufactured by Nelson & Sons. Treatment 3 was the Silvercup Trout diet manufactured by Nelson & Sons; this diet has been used previously. Treatment 4 was the Bio Vita FF diet, manufactured by Bio Oregon. Treatment 5 was the Bio Flake diet, manufactured by Bio Oregon, and has been used by the Klamath Tribe for Short-nosed suckers (Routledge, 2001). All treatments, except for the Bio Kyowa diet, were fed the same ratios of Bio Kyowa along with the treatment diet for the first 21 days. The first 7 days a 3:1 ratio of Bio Kyowa to treatment diet was fed, from day 8 to 14 a 1:1 ratio was fed, and from day 15 to 21 a 1:3 ratio was fed. After 21 days 100% of the diet for each treatment was fed. Tanks 1-7 started with 290 fish each and tanks 8-15 with 291 fish each. One lot from eggs spawned on the Provo River was used in the study. The study started with fish at nine months of age and continued until the fish reached twelve months of age. Prior to starting the study, sample lengths and weights were measured to determine the condition factor, and a deformity index was taken. During the study, parameters (flow, density and % body weight fed) were kept consistent relative to the number of fish.

The health condition profile (HCP) described by Goede and Barton (1990) and a deformity index were used to compare the replicates and treatments upon completion of the study. Due to small fish size not all variables were quantified and some observations discontinued after examining several tanks. HCP variables measured or observed in each tank included: total length (TL), weight, condition factor (weight x 10^5/length^3) eye condition and deformities. Deformities were categorized as vertebral, mandible, cranial, opercular, fin, gill rakers and other. Fin deformities were broken down into specific fin and left or right for applicable fins. Certain variables were made more specific to quantify observations in lots including: opercular (normal, sunken, shortened), hemorrhaging (none, fins, body) and nares (normal, enlarged).

The data was analyzed using SPSS. All variables, except percent mortality, used sample sizes of 60 fish on all treatments except for treatment 1 where a 47 fish sample was used.

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For percent mortality, each tank was used as a sample, so the sample size was three for each treatment. Analysis of variance (ANOVA) was used to test for differences in length, weight, condition factor (K) and percent mortality. Post hoc tests using the least significant differences method was calculated on variables with a significant difference. Maximum likelihood ratios were used to analyze the deformity, hemorrhaging and nares variables. For the variables with a significant difference maximum likelihood ratios were calculated between paired treatments. The level of significance 0.05 was used for all tests. The eyes were "normal" in all treatments according to HCP criteria, so no statistics were required.

Results

The variables length, weight, condition factor (K) and percent mortality differed significantly among diet treatments (Table 1). The mean total length (TL) among the diets ranged from 44.9 mm to 51.1 mm, with the fish on the Razorback and Bio Vita diets being significantly longer than those on the other three diets. The mean TL of the fish on Bio Flake diet was significantly longer than the mean length in the Bio Kyowa diet, but neither diet differed significantly from the Silvercup diet. The mean fish weight ranged from 0.61g to 1.10g; fish on Razorback and Bio Vita diets were significantly heavier than fish on the Bio Kyowa and Silvercup diets. The Razorback, Bio Vita and Bio Flake diets had a significantly higher condition factor (K) than the other two diets with a range of (0.6400 to 0.7973) x 10^5. Percent mortality ranged from 2.9 to 57.8. The Razorback, Bio Vita and Bio Flake diets had significantly less percent mortality than the other two diets.

Table 1. Comparison of hatchery performance of June suckers fed five commercial diets. Matching subscripts among treatment means depict no significant difference between treatments for a given variable.

Treatment	**1**	**2**	**3**	**4**	**5**
Diet	Bio Kyowa	Razorback	Silvercup	Bio Vita	Bio Flake
Length (TL)	44.9_{Z}	50.4_{X}	46.4_{ZY}	51.1_{X}	47.8_{Y}
S.D.	4.8	3.4	6.1	5.2	4.2
Weight	0.61_{Z}	0.99_{X}	0.69_{Z}	1.10_{W}	0.80_{Y}
S.D.	0.30	0.23	0.45	0.35	0.20
Condition Factor (K)	0.6400_{Z}	0.7569_{Y}	0.6077_{Z}	0.7973_{Y}	0.7265_{Y}
S.D.	0.1611	0.0680	0.2031	0.0740	0.0940
Mortality (%)	57.8_{Z}	8.6_{Y}	48.3_{Z}	8.4_{Y}	2.9_{Y}
S.D.	12.3	1.6	41.6	5.9	2.3

Using the maximum likelihood ratio tests, significant differences were found in the vertebral deformities, hemorrhaging fins and body (Table 2). No significant differences were found in the nares, sunken and shortened opercle variables. Vertebral deformities averaged from 0.0% to 3.1%, with fish on the Silvercup diet experiencing a significantly higher rate than the other four diets. Vertebral deformities were not found in treatments 2, 4 and 5. Hemorrhaging of the fins averaged from 0.0% to 4.5%, with a significantly higher occurrence in the fish on the Bio Kyowa and Silvercup diets. Hemorrhaging of the fins was not found in treatment 5. Hemorrhaging of the body averaged from 0.0% to 4.2%, with a significantly higher occurrence in the fish on the Bio Kyowa and Silvercup diets. Hemorrhaging of the body was not found in treatments 4 and 5.

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Conclusions

Table 2. Comparison of the percentage of deformed vertebrae and hemorrhaging in fins of on the body of June suckers fed one of five commercial diets. Matching subscripts among treatment percentages depict no significant difference between treatments for a given variable.

Treatment	1	2	3	4	5
Diet	**Bio Kyowa**	**Razorback**	**Silvercup**	**Bio Vita**	**Bio Flake**
Vertebral Deformities	$0.3\%_Y$	$0.0\%_Y$	$3.1\%_Z$	$0.0\%_Y$	$0.0\%_Y$
Hemorrhaging Fins	$4.5\%_Z$	$0.7\%_Y$	$4.5\%_Z$	$0.3\%_Y$	$0.0\%_Y$
Hemorrhaging Body	$4.2\%_Z$	$0.3\%_Y$	$3.1\%_Z$	$0.0\%_Y$	$0.0\%_Y$

According to the results from the data analyzed, the Razorback diet and the Bio Vita FF diet were the best feeds for use with June sucker. The fish were significantly larger in length and weight, had a significantly higher condition factor (K), and a significantly lower mortality rate. Vertebral deformities and hemorrhaging in the fins and body were also reduced in these diets. The Bio Flake diet was superior to Bio Kyowa and Silvercup for variables like length, weight, KTL, mortality, vertebral deformities and fin hemorrhages. The Bio Kyowa and Silvercup diets were found to be inferior diets in comparison to the other treatments. These two diets have been used previously where similar problems occurred that were quantified with the variables measured in this study. The Bio Flake, Razorback and Bio Vita FF diets are currently being compared along with other diets in a second feed study, which began at the initial feeding stage.

Eriek Hansen

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