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THE EFFECTS OF ADDED HARDNESS, SALINITY, AND SOURCE OF FRY ON THE SURVIVAL AND GROWTH OF STRIPED BASS FRY IN HATCHING JARS[1]

by

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ABSTRACT

The effects of increased water hardness, salinity, and source of fry on the survival and growth of striped bass fry from three females from the Cooper River, South Carolina, and two females from the Savannah River, Georgia, were studied at the Fisheries Research Unit, Auburn University, from 6 April to 11 June, 1971. Fry were stocked in one of three water treatments: control with a total hardness of 30 to 40 ppm; added hardness, 125 to 175 ppm; and added salinity, (chlorides) 1,100 to 1,500 ppm. Variance tests for homogeneity and contingency tables were employed for data analysis. Survival of striped bass fry was increased in the added salinity treatment. Fry survival in the control and added hardness treatments appeared to be dependent on the fry groups rather than the effects of the treatments. The survival of Cooper River fry appeared to be more variable in water with added hardness; Savannah River fry survival was more variable in the control treatment. The effects of added hardness and added salinity treatments on Savannah River fry survival were similar. Growth of fry in the added hardness and added salinity treatments was slightly greater than growth of fry in the control. The cause of the growth increase was not known.

INTRODUCTION

Research on the intensive culture of striped bass, *Morone saxatilis* (Walbaum), fry has been conducted at the Fisheries Research Unit, Auburn University, since 1966. During the period 1966 to 1969, 15 groups of striped bass fry were utilized in intensive culture experiments. All fry of 11 of these groups died at or before 29 days of age (Kelly, 1969). Intensive culture experiments performed in 1970 were hindered by 98% mortality of fry before 25 days of age (Powell, 1970).

Factors believed to contribute to the low survival of striped bass fry during the early stages of development have been cited by Regan, Wellborn and Bowker (1968), Hughes (1968), Kelley (1969), and Powell (1970). Two factors have been cited which apparently enhance the survival of striped bass fry. Albrecht (1964) indicated that water of low and moderate salinity (containing chlorides of 920 to 948 and 4,595 to 4,740 ppm, respectively) contributed to fry survival. Powell (1970) suggested that the survival of striped bass fry was enhanced in water with increased total hardness (150 to 500 ppm).

The objectives of this experiment were: to determine if increasing the total hardness or the salinity of water flowing through hatching jars would result in increased survival of striped bass fry; to compare survival rates of fry from Cooper River, South Carolina, and Savannah River, Georgia; and, to determine if water hardness and salinity have an effect on the growth of fry in hatching jars.

[1]This paper is based on theses submitted to the Graduate Faculty of Auburn University in partial fulfillment of requirements for the degree of Master of Science in Fishery Management. This research was funded jointly by Auburn University and the National Marine Fisheries Service (Andromous Fish Project (71), Contract Grant No. 14-17-002-572).

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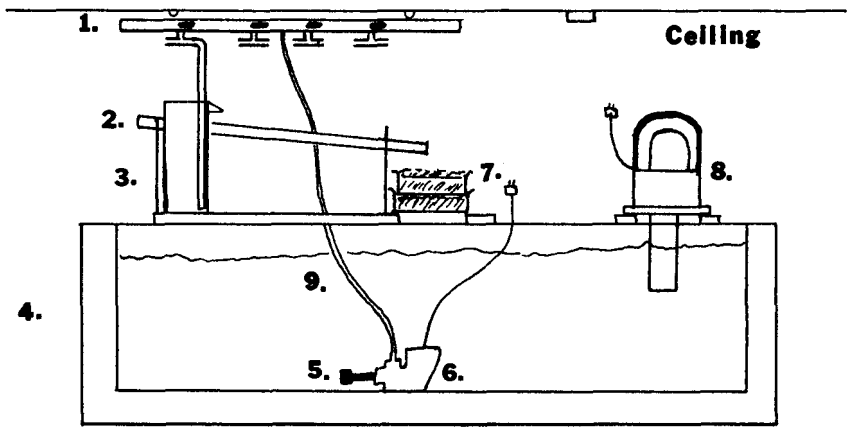
MATERIALS AND METHODS

Recirculating flowing water systems were prepared in the holding house, Fisheries Research Unit, Auburn University, Auburn, Alabama (Figure 1).

Three 1,779 l concrete tanks were cleaned and filled with creek water which passed through the primary filter plant serving the research unit before it entered the holding house. The water in each tank was recirculated through a charcoal-floss dishpan filter (Powell, 1970) to remove suspended matter.



Legend:

1. Water delivery system
2. Sluice
3. McDonald hatching jar
4. Concrete tank (1,779 l)
5. Foot valve
6. Little Giant submersible electric pump, Model No. 2E-14NDVR
7. Charcoal floss-dishpan filter
8. Living Stream Frigid Unit, Model LS-700
9. Tygon plastic tubing

Figure 1. Recirculating flowing water system used in experiment.

Eight McDonald hatching jars (7.6 l), an air system, and a recirculating water system were set above each of the tanks. Micro-Por 100[4] tubing was used as an air "stone" to supply air to the hatching jars. The air supply to each jar was regulated so that only the bottom third of the tubing emitted compressed air. Water flow of each system was adjusted to maintain a flow rate of 2 l per minute when all eight jars were in use. Cooling units which were placed on each system on 19 April were used to maintain water temperature in each tank at 18-20 C.

Because of the accumulation of excess feed from feeding, the charcoalfloss dishpan filter was replaced with 30.5 cm x 30.5 cm x 35.6 cm charcoalfloss nalgene filter during the experiment.

The total hardness of the water in the three systems was determined to be 30 to 40 ppm. The control system was operated without the addition of any chemicals. The total hardness of the water in a second recirculating system was increased to 150 ppm + 25 ppm by the addition of 430 grams of calcium sulfate ($CaSO^4$). The total salinity of the water in the third recirculating system was increased to 1,300 ppm + 200 ppm chlorides by the addition of 2.03 kg of Marine Mix-Solar salt.

Table 1. Summary of data of Striped Bass Fry stocked into intensive culture systems.

Source of fry	Date Received	Age in days at stocking	Stocking Method	# Stocked/ jar	# Stocked/ treatment
Cooper River					
Female 1	6 April	3	Visual comparison	4,000	8,000
Female 2	6 April	1	Visual comparison	4,000	8,000
Female 5	25 April	2	Volumetric	4,000	8,000
Savannah River					
Female 3	19 April	6	Volumetric	5,000	10,000
Female 4	19 April	2	Volumetric	3,000	6,000

Striped bass fry from two sources were utilized in the experiment (Table 1). Fry from three females were obtained from the State Striped Bass Hatchery, Moncks Corner, South Carolina. Fry from two females were received from the State Striped Bass Hatchery, Richmond Hill, Georgia. Fry were hatched from brood fish collected from the Cooper River, South Carolina, and the Savannah River, Georgia, respectively.

Fry from two of the Cooper River females and from two of the Savannah River Females were transported by motor vehicle 6 April and 19 April, respectively. These fry were placed in plastic bags at 50,000 fry per bag. Each bag contained 6 l of water. The remaining space was filled with oxygen. The bags were sealed with a rubber ring and transported in styrofoam containers. The fry from the third Cooper River female were transported by plane 25 April in two plastic bags and styrofoam containers at 100,000 per container. All containers were labelled to distinguish fry from the separate females.

Upon arrival, the fry were acclimated to temperature (Table 2) in partitioned receiving tanks for 20 minutes before they were stocked.

Table 2. Temperature of water in the receiving tanks and in the plastic bags prior to acclimation of Striped Bass Fry.

Source of fry	Date received	Temperature in receiving tanks (C)	Temperature in bags (C)
Cooper River			
Female 1	6 April	14.2	19.7
Female 2	6 April	14.2	19.7
Savannah River			
Female 3	19 April	18.6	19.7
Female 4	19 April	18.6	19.7
Cooper River			
Female 5	25 April	19.7	19.7

The Cooper River fry from females 1 and 2 were stocked into hatching jars by the visual comparison method utilizing white plastic pans. The Savannah River fry and the Cooper River fry of female 5 were stocked into hatching jars by a volumetric procedure. Stocking rank was randomly selected. Two hatching jars in each treatment were stocked with fry from each female.

The effect of water treatments on the survival of fry was to be investigated throughout the first 25 days of fry development. However, since fry from several of the jars in the study were removed for use in a related project, the results of the effect of water treatments on survival of fry were reported through the 11th day after stocking.

Fry of the five females were fed brine shrimp, zooplankton, Oregon Moist Pellet, Purine Trout Chow Developer, and combinations of these feeds.

Washed shrimp were poured into a 1,000-ml graduated cylinder. The water level of the cylinder was adjusted so that each hatching jar received a specific volume (50 ml) of water and brine shrimp. Brine shrimp was the principal food throughout the survival study.

Zooplankton (composed primarily of ostracods, copepods, cladocerans, phantom larvae, and chironomid larvae) were collected from several of the ponds on the station with a large Wisconsin-type plankton net and were fed to the fry in a similar manner as were the brine shrimp.

Ground Oregon Moist Pellet and Purina Trout Chow were fed to fry at different stages of their development. The pellets were ground into fine particles with a Micro Mill[5] before feeding.

Fry were fed daily every 3 hours beginning at 0600 and ending at 2400 from 9 April through 31 May. Daily feeding was changed to 5-hour intervals from 0600 to 2100 from 1 June through 14 June, at which time the remaining fry were removed from the hatching jars.

Weekly samples of live fry from the second female fish of the Cooper River were preserved in 10% formalin for growth measurements. Total and standard length in millimeters were measured using a Filar micrometer in a dissecting microscope.

Water temperature, pH, total hardness, salinity, dissolved oxygen, and carbon dioxide were monitored throughout the study.

RESULTS AND DISCUSSION

Treatment effects

Overall survival of striped bass fry on the eleventh day after stocking was 51,613 fish (Table 3) or 43% of the total number stocked into the intensive culture systems.

[4]Micro-Por 100, Micro-Por Products, Borg Warner. Colwich, Kansas.

[5]Chemical Rubber Company, Cleveland, Ohio.

Table 3. Percentage of surviving Striped Bass Fry on the eleventh day after stocking into hatching jars.

Source of fry	Age (days)	Water Treatment: Untreated	Added Hardness	Added Salinity	Female Means
Cooper River					
Female 1	14	62	16	61	
		32	32	70	45
Female 2	12	52	44	78	
		55	60	76	61
Female 5	13	17	19	51	
		10	0.4	60	26
Means		38	29	66	
Savannah River					
Female 3	17	5	33	37	
		34	37	38	31
Female 4	13	66	61	62	
		53	54	60	59
Means		34	45	46	
Treatment means		36	35	58	
Overall survival					43

Visual analysis of the data (Table 3) suggested that fry survival was increased in the added salinity treatment. Fry survival appeared to be similar in the control and the added hardness treatments. A variance test for homogeneity (Snedecor and Cochran, 1967) was employed to determine if survival in the added salinity treatment was similar among fry groups. The resulting X^2 value of 16.35 with 4 d.f. was significant (P 0.05). The resulting X^2 values with 4 d.f. for the control and added hardness treatments (764.6139 and 160.7631, respectively) were extremely high. These values suggested that the control and added hardness treatment effects on survival varied among fry groups. Fry survival appeared to be dependent on the fry groups rather than on the effects of the treatments.

Although the X^2 value on the added salinity treatment was significant, we believed that with such large cell numbers, the value did not constitute a reasonable difference. Hence, the effects of the added salinity treatment did appear to enhance fry survival.

One of the original assumptions of this study was that fry from an individual female would have similar survival in the replications of a given treatment. However, fry survival in the replicates (Table 3) was generally not homogeneous in the control or added hardness treatments. Some of this discrepancy could be attributed to stocking error and probably to insufficient replications. Cannibalism was noted among fry, but the degree of cannibalism did not appear to vary sufficiently enough among treatments to result in such replicate differences. Deformed fry were observed from all female groups in all treatments. Numbers of surviving fry in replicates in the added salinity treatments differed by no more than 350 fish; the number of fry surviving overall in three of the fry groups differed by less than 100 fish. The reason for these differences was not fully understood.

Female effects

The chi-square test of independence (Snedecor and Cochran, 1967) using 3 X 3, 2 X 2 contingency tables was employed to determine if survival among fry groups was unassociated in the water treatments. A 3 X 3 contingency table was employed for Cooper

River females. The resulting X^2 value with 4 d.f. was 930.0. The fry of female 5 contributed 530.69 to the X^2 value. Because of this, these fry were excluded and a second test was made. The X^2 value was 199.14 with 2 d.f.

In both tests, P was much less than 0.01 and the deviation from independence was significant for fry groups from Cooper River females. Survival of fry from individual females was associated with water treatments.

The fry groups from Cooper River females in the added hardness treatment contributed the largest proportions to the X^2 values. In this treatment, the survival of Cooper River fry, for respective females, varied more than it did in the other two treatments. This was one factor which caused such high test values. Apparently fry survival in the added hardness treatment was related to parental attributes.

A 2 X 3 contingency table was used for survival of fry from the Savannah River females. The X^2 value of 188.87 with 2 d.f. was very high and suggested that survival of fry from individual females was associated with water treatments. In this test, the fry groups in the control contributed 136.47 to the X^2 value of 188.87. The values contributed by the fry groups in the added hardness and added salinity treatments were similar. Therefore, a 2 X 2 contingency table was employed to determine if these treatment effects on survival were similar.

The X^2 value of 0.330 with 1 d.f. indicated that the treatment effects were similar. Survival of fry from Savannah River females was associated with treatment effects. The effects of the added hardness and added salinity treatments on survival were similar for fry of these females.

Growth

Total and standard lengths were obtained from female 2 fry (Table 4). Fry from this female were used because these fry were stocked in all water treatments. Fry in the added hardness and added salinity treatments were larger than the fry in the control at age 7 days. Between 17 and 24 days of age fry in these treatments began to show greater growth rates than the control fry. At 39 days of age, fry in the added hardness and added salinity treatments were 1.08 mm and 3.61 mm (TL) larger, respectively, than fry in the control. Generally, growth increases were minimal among treatments. The reason for the slight increase in growth of fry in the added hardness and added salinity treatments was not known.

Table 4. Mean total length (TL) and standard length (SL) in MM of Striped Bass Fry from F-2 during early stages of development.

Source of fry	Age (days)	Water treatment: Control Number measured	Control TL	Control SL	Added hardness Number measured	Added hardness TL	Added hardness SL	Added salinity Number measured	Added salinity TL	Added salinity SL
Cooper River										
Female 2	7	14	4.90	4.81	20	5.21	4.98	10	5.33	5.12
	13	17	5.37	5.11	10	5.39	5.16	14	5.56	5.30
	17	16	5.60	5.30	6	5.67	5.45	16	6.40	6.09
	24	10	6.55	6.29	10	9.34	8.09	10	9.37	8.08
	27	1	6.93	6.55	3	8.75	7.81	8	11.47	10.05
	31	14	9.63	8.13	14	11.46	9.59	17	12.62	10.55
	33	5	10.39	8.94	10	10.89	9.36	10	13.41	11.31
	39	3	12.45	10.55	8	13.53	11.54	6	16.06	13.59

CONCLUSIONS

1. Added salinity (1,300 ppm + 200 ppm chlorides) appeared to have contributed to fry survival.
2. Fry survival in the control and added hardness treatments appeared to be dependent on the fry groups rather than on the effects of the treatments.
3. Survival of Cooper River fry appeared to be more variable in water with added hardness of 150 ppm + 25 ppm as $CaCO^3$. Survival of Cooper River fry in the added hardness treatment seemed to be related to parental attributes. Savannah River fry survival was more variable in control water with total hardness of 30 to 40 ppm as $CaCO^3$.
4. The effects of added hardness and added salinity treatments on Savannah River fry survival were similar.

ACKNOWLEDGEMENTS

We are grateful to Malcolm Braid for his assistance with editing and final preparation of this paper.

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WINTER FEEDING OF CHANNEL CATFISH

by

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ABSTRACT

On November 24, 1973, pound-size channel catfish, which had previously been fed intensively for 6 months, were weighed and measured and placed back into nine 1/10-acre earthen ponds at the rate of 2,000 per acre. The fish were managed through the winter until the following March 4 on one of three feeding regimes; no feeding; feeding 1% of fish weight on alternate days; and feeding 1% of fish weight only on "warm" days or when water temperature at a 3-foot depth was above 54 F. Fish not fed lost 9% of their weight during the 100-day over-winter period, those fed on alternate days received feed on 51 days and gained 23%, and those fed on the "warm" days received feed on 52 days and gained 19%. Condition factors increased for both groups of fed fish but decreased for the nonfed fish. Length increased slightly for all groups. Although the nonfed fish lost weight, they had the highest percentage of body fat indicating that a significant amount of tissue protein was degraded for energy needs.