and shallow rocky areas as far upstream as possible in Clark Hill) when the surface water temperature ranged from 54° to 60°F.

On April 19 at the height of the spawning run, an apparent spawning act of the hybrid was observed. This was in the same area with white bass and was in clear, rocky bottom shoal water from one to three feet deep. The surface water temperature was 59°F and one large hybrid (presumed to be a female) was observed closely attented by five or six smaller fish nudging at her sides. They swam in a group and would occasionally violently break the surface and splash in much the same manner as striped bass. Since it was impossible to accurately identify all the smaller fish (presumably males) around the female hybrid, some could have been white bass. No eggs were observed. Therefore, notes concerning their adhesiveness were not taken at that time.

Several years ago, however, personnel at this Department's striped bass hatchery at Moncks Corner, Bayless (1971) did artificially induce a two year old hybrid to spawn successfully and indicated that, while all eggs were cohesive in the ovary, when spawned into water, some were adhesive as with the white bass and some floated like the striped bass.

CONCLUSIONS

Although these findings give indications of age and size at maturity as well as ova production, no concrete evidence of successful natural reproduction by the hybrid has been found.

Many questions, therefore, remain to be answered concerning fecundity of the hybrid, some of which are: Does, is, or will the hybrid spawn in the wild? Is this spawning successful? Will the progeny breed true? Will they backcross in a natural habitat with fish or their parent species?

Future management plans include further investigation of these subjects.

ACKNOWLEDGMENTS

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EFFECTS OF INCREASED WATER HARDNESS, SOURCE OF FRY AND AGE AT STOCKING ON SURVIVAL OF STRIPED BASS FLY IN EARTHEN PONDS

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ABSTRACT

Research on the extensive culture of striped bass, *Morone saxatilis* (Walbaum), was conducted in ponds at Auburn University Fisheries Research Unit in the spring of 1971. Investigations were conducted to determine the effect of water hardness, source of fry and immediate versus delayed stocking on the survival of striped bass fry.

Twelve 0.10-acre earthen ponds were used. Six ponds were treated with calcium sulfate to raise the hardness to 150 ppm. The hardness of the remaining ponds was approximately 20 ppm. Striped bass fry from two sources (Cooper River, South Carolina, and Savannah River,

Georgia) were stocked immediately after receiving them from the hatchery or after they began feeding. Stocking rates varied from 60,000/A to 210,000/A.

There was no difference in survival between sources of fry. Delayed stocking increased the survival rate of striped bass once they were stocked in the ponds; however, many fry from each source died in holding prior to stocking into the ponds. Increasing the water hardness did not increase the survival of striped bass. On the contrary, survival of striped bass in soft water ponds was higher than the survival in hard water ponds.

INTRODUCTION

Investigations in to factors affecting the survival of striped bass, *Morone* saxatilis (Walbaum), in extensive culture were carried out at Auburn University's Fisheries Research Unit in the Spring of 1971. Striped bass research in previous years at this Station has indicated that water hardness, age at which the fry are stocked and strain of fry may influence the survival of striped bass fry in pond culture (Kelley, 1969 and Powell, 1971).

With these factors in mind, the objectives for this research were to determine the effect of increased water hardness, source of fry (Cooper River, South Carolina, and Savannah River, Georgia) and immediate versus delayed stocking on the survival of striped bass fry in ponds.

MATERIALS AND METHODS

Experimental ponds

Twelve 0.1-acre earthen ponds located at the Fisheries Research Unit of the Auburn University Agricultural Experiment Station were chosen for this research. These adjoining ponds are in the "E" series and have concrete rip-rap around the edges. They are 5 to 6 feet deep at the standpipe and have an average depth of 3 feet. Water is supplied by a small creek and enters the ponds through saran filters (100 mesh per in.).

Preparation of experimental ponds for stocking

All ponds were drained March 15, 1971, and allowed to dry 8 days before refilling. Drying was incomplete because of heavy rains during this period.

Growth of filamentous algae in the ponds before draining varied from heavy to light. All pond bottoms were raked by hand with garden rakes and the filamentous algae was removed. This was done to reduce variation among ponds and to retard return growth of algae.

Upon refiling on March 23, 1971, the ponds were disinfected with 10 pounds per acre potassium permanganate. The interval between pond refiling and the stocking of fish varied from 13 days to 38 days.

Control of filamentous algae growth was attempted by two methods. First the ponds were stocked with Chinese grass carp, *Ctenopharyngodon idella* Valenciennes, at 30 fish per acre. The fish weighed between 1 and 2 pounds at stocking. Second, each pond was treated with Diquat or Paraquat at 1 ppm. Applications were made at least 1 week prior to stocking fry, except for the first Cooper River fish, to allow for the breakdown of the herbicide. The fish were 9 days old when the treatment was applied. The ponds were treated at the 96-hour LC_{50} of striped bass fry reported by Hughes (1968) and well below the 96-hour LC_{50} reported by Regan, Wellborn, and Bowker (1968).

Bermuda hay at a rate of 420 pounds per acre and meat scraps at 100 pounds per acre were added to all ponds 1 week prior to stocking to stimulate the growth of zooplankton. Additional applications of meat scraps and Auburn No. 2 fish feed as organic fertilizer and 8-8-2 inorganic fertilizer were applied individually to ponds as deemed necessary to maintain abundant zooplankton populations. Zooplankton abundance was determined by sampling with a Kemmerer Water Sampler and a plankton bucket and observation at night with spotlights.

Increasing the water hardness

Calcium sulfate (commercial grade gypsum) was added to 6 of the 12 ponds on April 2, 1971, to increase the total hardness to approximately 150 ppm. The rate of application as suggested by Powell (1971) was 3,000 pounds per acre.

Water quality

Total hardness was checked every 14 days with a Hach Chemical Kit (model DR-EL). The surface temperature (F) was recorded at sunrise and at midafternoon to ascertain the daily temperature range. Water sample for pH determination were collected weekly. Samples were taken from the ponds to the laboratory and checked on a Photovolt Electronic pH Meter (model 125). Samples were taken at sunrise and midafternoon to determine the daily pH range. Dissolved oxygen was checked with a YSI Oxygen Meter (model 51). Because of the low B.O.D. of all ponds, oxygen determinations were made at irregular intervals.

Experimental fish

Larval striped bass were obtained from two sources; the Cooper River strain from Moncks Corner, South Carolina, and the Savannah River strain from Richmond Hill, Georgia. The fry from both sources were from two females and were transported separately in sealed plastic bags with an oxygen atmosphere. The bags were placed and sealed in styrofoam containers. Stocking density of fish in each plastic bag varied from approximately 50,000 to 100,000 fish per bag. The fish were transported by car from the hatcheries to the Fisheries Research Unit at Auburn University. Both trips took approximately 6 hours.

Upon arrival at the Fisheries Research Unit on April 6, the bags of Cooper River larvae were placed in a fiberglass trough above a 470-gallon reservoir of water. Water was pumped from the reservoir into the trough and drained back into the reservoir through a standpipe encicled by a small mesh brass screen. Aeration in the trough was provided by compressed air flowing through two, 6-foot lengths of micropore tubing. Holes were punched in the pastic bags below and above the water line and when water completely filled the bag, the fish were released into the trough. This acclimation process took approximately 30 minutes. The larvae of separate females were mixed before siphoning them from the trough into white, plastic dishpans. Five thousand fish were counted into one dishpan and another pan of the same dimensions was filled with water and fish to equal, by sight, the 5,000 counted fish. These pans were combined and used as a 10,000-fish standard. Fish were siphoned into similar pans until the same density of fish was obtained. Dishpans of 10,000 fish each were carried immediately to the ponds and stocked after a 20-minute acclimation period. The water temperature in the trough was 57 F and the temperature in the ponds was 58 F. The larval striped bass were stocked in "E" ponds number 4, 14, 18, and 27 at a rate of 200,000 per acre. Two of the ponds, E-18 and E-27, were hard water ponds and other ponds, E-4 and E-14, were soft water (untreated) ponds. The larval fish were 2 and 4 days old at stocking.

The fish for delayed stocking were held in the fiberglass trough. For unknown reasons, within 2 days, all had died. Substitute fish were obtained from McDonald hatching jars from another phase of this project. In the hatching jars, the fish were fed brine shrimp and zooplankton. On April 22, at 17 and 19 days of age, they were stocked into hard water pond E-17 at a rate of 58,550 fish per acre and into pond E-30, a soft water pond, at a rate of 123,430 fish per acre.

Savannah River larvae were received on April 19 at ages 3 to 7 days. They were held overnight in Nalgene plastic containers (12 x 12 x 14 inches) in 6 gallons of water with constant aeration from air stones. The fry were stocked at dawn on April 20. The ponds stocked were E-2 and E-29 (hard water ponds) and E-16 and E-25 (soft water ponds). All ponds were stocked at a rate of 213,770 fish per acre.

TABLE I. Summary of stocking and recovery data of striped bass fry in twelve, 0.1-acre ponds

"E" pond number	Source of fry	Water hardness	Immediate or delayed stocking	Age at stocking	Fry stocked	Fry recovered	Survival rate
				Days	No.	No.	Pct.
2	Savannah R.	Hard (Treated)	Immediate	3 and 7	21,337	292	1.4
29	Savannah R.	Hard (Treated)	Immediate	3 and 7	21,337	978	4.6
13	Savannah R.	Hard (Treated)	Delayed	13 and 17	7,052	1,750	24.8
15	Savannah R.	Soft (Untreated)	Delayed	13 and 17	11,833	2,020	17.0
25	Savannah R.	Soft (Untreated)	Immediate	3 and 7	21,337	3,030	14.2
16	Savannah R.	Soft (Untreated)	Immediate	3 and 7	21,337	852	4.0
27	Cooper R.	Hard (Treated)	Immediate	2 and 4	20,000	6	0.03
18	Cooper R.	Hard (Treated)	Immediate	2 and 4	20,000	0	0.00
17	Cooper R.	Hard (Treated)	Delayed	17 and 19	5,855	956	16.3
30	Cooper R.	Soft (Untreated)	Delayed	17 and 19	12,343	484	3.9
4	Cooper R.	Soft (Untreated)	Immediate	2 and 4	20,000	5,111	25.6
14	Cooper R.	Soft (Untreated)	Immediate	2 and 4	20,000	2,911	14.6

Stocking rates were estimated by taking two, 250 ml samples from the Nalgene containers, preserving them with formalin and counting the fry.

Fry for delayed stocking were held in McDonald hatching jars and fed brine shrimp and zooplankton. They were stocked into hard water pond E-15 and soft water pond E-13 on April 30 at 13 and 17 days of age. The stocking rate for E-13 was 70,520 fish per acre and 118,330 per acre for E-15. All ponds were stocked from 5:00 to 7:00 a.m. or 7:00 to 9:00 p.m. to take advantage of the cooler water temperatures. In each case, larval fish were acclimated to the pond by slowly adding pond water to the water containing the fry until the temperatures were equal. The fish were then released into the ponds. No noticeable mortality occurred during the stocking procedure. A summary of stocking data is given in Table I.

Draining

All ponds were drained between May 27 and June 27, 1971. The unusually long length of time required for draining all ponds was in part because of a lack of manpower and the lack of available holding space for fingerlings removed from ponds. The water level of the ponds was dropped approximately half way the night prior to draining as recommended by Regan et al (1968). Removal of the fish took place the next morning from 6:00 to 9:00 a.m. to take advantage of the cooler water temperatures. A 0.25-inch mesh screen was placed over the drain to prevent the smaller fingerlings from being sucked through the pipe. The fingerlings were removed by seining with a 50-foot 3/8-inch mesh seine and a 15-foot minnow seine. The number of days in the experiment varied from 43 to 63.

RESULTS AND DISCUSSION

Data on the number of fish recovered from each pond are presented in Table I. Survival rates in the 12 experimental ponds ranged from 0 to 25.6 per cent. A total of 202,431 fish was stocked and 18,390 fish were recovered upon draining. This resulted in an overall survival rate of 10.5 per cent. There appeared to be obvious differences in treatment means but because of the small number of replications and the experimental error involved the means were not different.

There was no significant difference in the overall survival between sources. Overall survival of the 104,233 Savannah River fry and the 98,198 Cooper River fry was 11.0 and 10.1 per cent, respectively. However, the Savannah River larvae appeared to have been in better condition than the Cooper River larvae upon arrival at the Fisheries Research Unit. The Savannah River fish were darker pigmented and showed more directed movement for a longer period of time. The two sources were approximately the same age at the time of observation.

Increasing water hardness by the addition of $CaSo_4$ did not increase the survival of striped bass fry. Survival in the hard water treatment was 7.8 per cent; whereas, survival in the untreated, soft water was 13.2 per cent.

Delayed stocking of striped bass fry increased the survival rate. However, almost one half of the original 75,000 fry held for delayed stocking died in the hatching jars. A total of 37,083 fry remained for delayed stocking. Of this total 5,210 fingerlings were recovered from the ponds giving a mean survival rate of those fish stocked of 15.5 per cent. Mean survival in the immediately stocked ponds was 10.7 per cent. However, if the original 75,000 fry for delayed stocking are considered in the survival rate, the overall survival of the delayed stocked fish is 6.9 per cent which is lower than the survival of the fish that were stocked immediately, 10.7 per cent. Table 2 compares the survival of striped bass fry in the three treatments.

Total hardness in all ponds ranged from 15 to 30 ppm prior to the addition of $CaSO_4$. One week after the application of $CaSO_4$ total hardness in the six treated ponds ranged from 110 ppm to 159 ppm. Total hardness

TABLE 2. Comparison of per cent survival of striped bass fry in three treatments: water hardness, source of fry and stocking technique

Water hardness	Source: Savannah River, Immediate stocking	Source: Savannah River, Delayed stocking	Source: Cooper River, Immediate stocking	Source: Cooper River, Delayed stocking	Mean
Hard	1.4	24.8	0.03	16.3	7.8
	4.6	...	0.00	...	
Soft	14.2	17.0	25.6	3.9	13.2
	4.0	...	14.6	...	
Mean	11.0		10.1		

Mean survival for immediate stocking 10.7
Mean survival for delayed stocking 15.5

never exceeded 190 ppm. The concentration of sulfate in the treated ponds was below the 96-hour LC_{50} for striped bass fry reported by Hughes (1968). Subsequent applications of calcium sulfate were unnecessary for the duration of the experiment. Water temperatures in the ponds stocked immediately ranged from 60 F to 67 F, and in those ponds where delayed stocking was used, from 67 F to 71 F. Dissolved oxygen levels in all ponds were always above minimum levels (2 to 3 ppm) and consistently ranged from 6 to 8 ppm. The pH values remained within the desired range for fish culture prescribed by Swingle (1964).

Survival of striped bass fry in previous years at this station have ranged from 3.3 per cent (Powell, 1971) to 6.1 per cent (Kelley, 1969). The increase in overall survival from previous years at this station is believed to be the result of low temperatures at the time of stocking. Larval striped bass were received over a month earlier than in previous years; therefore, the water temperatures ranged 10 to 15 degees (F) lower than before and closer to the temperatures of the water where the fish were hatched.

Insect populations were controlled indirectly by draining the ponds prior to stocking and by treating with potassium permanganate to kill any remaining insects not killed by draining. Stocking the fish soon after refilling allowed them to grow to a size larger than the insects could prey upon before the insects re-established themselves. This method of draining, refilling and disinfecting of ponds before stocking is recommended by Ray and Wirtanen (1970).

Filamentous algae remained a problem in several ponds throughout the experiment. Ponds E-18 and E-27 had the heaviest growths of algae. Treatment with 1 ppm Paraquat was necessary 6 days after stocking the Cooper River fish. To reduce variation between ponds, all ponds were treated with Paraquat or Diquat at 1 ppm. Survival in ponds E-18 and E-27 were zero and 6 fish, respectively. Paraquat is not considered to be responsible for the low survival in these because of the survival rate (14.6 and 25.6 per cent) in the other two replications in which Cooper fish were stocked immediately and which also received the herbicide on the same day. Ponds E-18 and E-27 remained exceptionally clear throughout the experiment and the addition of organic and inorganic fertilizers at the recommended concentrations failed to produce large quantities of either phytoplankton or zooplankton.

Grass carp were ineffective in controlling filamentous algae in all ponds. The fish were observed feeding on algae in several ponds but were never able to eliminate or control its growth. It is not felt that this species adversely affected the survival of striped bass larvae or fry.

CONCLUSIONS

1. There was no difference in the survival of striped bass fry from Cooper River, South Carolina and Savannah River, Georgia in 12, 0.1-A. earthen ponds.
2. Increasing water hardness by the addition of $CaSO_4$ to half of the ponds did not increase the survival of striped bass fry.
3. Delayed stocking of the fry increased the survival rate in ponds, but many fry died in holding prior to stocking.
4. Low water temperatures at stocking apparently increased the survival of striped bass fry when compared to the results obtained in previous years at this station.

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SUMMARY REPORT
SOUTHERN DIVISION OF AMERICAN FISHERIES SOCIETY—TWENTIETH ANNUAL MEETING

The Southern Division of the American Fisheries Society met in conjunction with the 25th Annual Conference of the Southeastern Association of Game and Fish Commissioners in Charleston, South Carolina on October 17-20, 1971. Seventy-two members in good standing attended the first business meeting, and 99 attended the second business meeting. The total paid fishery registrants numbered 158.

Thirty-eight fishery papers were presented during the technical sessions. Included on the program was a symposium entitled "Potential Management of Basses by Species Selection."

President Barkley opened the second business session with a brief address to the members. He pointed out the cooperative action which is prevalent throughout the Division and reviewed activities of the past year.

All committees submitted their annual reports. One resolution was approved by the membership. This resolution shows the Southern Division's endorsement and support for the extension and full funding of Public Law 88-309, as amended, "The Commercial Fisheries Research and Development Program."

New officers elected were: President, Archie Hooper, Alabama, President-elect, Jim Clugston, Georgia; Secretary-treasurer, Glen McBay, Georgia; and National Nominating Committee Member, Barry Freeman, Mississippi.