BRACKISH WATER CULTURE OF STRIPED BASS IN LOUISIANA

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ABSTRACT

Striped bass (Morone saxatilis) have been cultured in brackish water ponds since 1972 as part of Louisiana's Anadromous Fisheries project. Over the past five years, 648,872 fingerlings have been reared to stocking size in ponds with salinities ranging up to 10.8 ppt. Annual percent survival from fry to fingerling ranged from .03% in 1972 to 34.0% in 1976. Increased survival is attributed to improvements in nursery and pond rearing techniques.

A bioassay in 1976 indicated two-day old fry were dead at 30 hours in 24.5 ppt salinity. Fry in 10, 15 and 20 ppt survived two weeks with no apparent harmful effect.

INTRODUCTION

Stocking of striped bass (Morone saxatilis) fingerlings in Louisiana reservoirs for control of gizzard shad (Dorosoma cepedianum) was initiated by Louisiana Wildlife and Fisheries Commission in 1965. This stocking and subsequent stockings were possible by virtue of South Carolina's Wildlife Resources Department furnishing fry to states in the southeast United States in exchange for culture data (Steven, 1965).
With congressional passage of the Anadromous Fish Act in 1967, Louisiana became eligible for funds under this program because of a historical run of striped bass in streams tributary to Lake Pontchartrain. Chipman (1956) presented data on occurrence of striped bass in these streams, but no records since 1956 document the presence of these fish.

The initial objective under the Anadromous Fish Program was to reestablish the striped bass fishery to historical levels. In 1967, the first project under this program inventoried the anadromous fishery in coastal Louisiana east of the Mississippi River (Davis et al., 1970). This study indicated that the previous striped bass fishery formerly present in fishable numbers was extinct. However, a reproducing population of Atlantic sturgeon (Acipenser oxyrhynchus) was found. Davis et al. (1970) were unable to explain the striped bass depletion, but theorized intense coastal stream channelization in the late 1940's and early 1950's resulted in habitat alteration and destroyed most of the traditional spawning areas. They concluded that water quality had improved during the past 10 years and a plentiful supply of forage organisms existed to support an introduced striped bass fishery. Recommendations were given that attempts to reestablish an anadromous striped bass population commence in the fishes' historical range.

Fisheries biologists in Louisiana concluded the best approach to reestablishing the striped bass was to obtain fry from truly anadromous fish. Striped bass from Chesapeake Bay was the best source for these fish and arrangements were made with Maryland Fish and Wildlife personnel to obtain fry. The first year of hatchery operations in Maryland produced 800,000 fry that were shipped to Huey P. Long Fish Hatchery at LaCombe, Louisiana. No striped bass fingerlings were recovered from the ponds. Failure was attributed to the poor condition of the hatchery (Williams, 1971).

During the striped bass hatching operations in Maryland, it was observed that salinity in the river during spawning ranged from 0.5 to 2.0 ppt. Based on this, we decided it would be desirable to culture fry in brackish water. Ponds located on Rockefeller Refuge offered this possibility, thus the beginning of brackish water culture of striped bass in Louisiana.

MATERIALS AND METHODS

Striped bass have been cultured since 1972 in coastal ponds at Rockefeller Wildlife Refuge. This state-owned area is located in southwest Louisiana between the Grand Chenier-Pecan Island beach ridge complex and the Gulf of Mexico.

Fry Nursery

The fry nursery in 1973 consisted of four 284-liter asphaltum coated
galvanized stock tanks and one 454-liter fiberglass rectangular tank. In addition to tank units, a 1 m³ saran cage was submerged in a 0.12 ha pond. Brackish well water was circulated through each tank unit at approximately 1.9 liters per minute. Water temperature remained constant at 19.5° C, salinity 1.2 ppt and dissolved oxygen ranged from 4.0 to 8.0 ppm in the tanks. Drains consisted of 2.5 cm standpipes with saran filters attached. Aeration was supplied to each tank. An aquarium pump supplied air and turbulence to the cage.

The fry nursery was altered in 1974 to include six 265-liter round fiberglass tanks, five 263-liter rectangular fiberglass tanks and the 454-liter fiberglass tank. Water used in 1974, 1975 and 1976 was taken from a canal complex connecting with the Gulf of Mexico. Salinities ranged from 1.8 to 4.0 ppt. Canal water pumped with a 3.8 cm electric pump and filtered through a 5 micron Asco filter was stored in two 2,727-liter reservoir tanks for settling. An electric 2.5 cm jet type pump supplied water at 4.5 liters per minute to each of the small fry tanks and 5.3 liters per minute to the 454-liter tank. Aeration was supplied by a 3/4 hp compressor to maintain a small degree of turbulence in each tank. Standby pumps, compressors and generators were maintained in case of equipment failure.

The ponds used for striped bass culture were constructed in 1966 and ranged in size from 0.04 ha to 0.6 ha. Water for the ponds was obtained by mixing brackish deep well water (1.4 ppt) with water obtained from a canal complex connecting to the Gulf of Mexico. The canal received run-off from a 32 ha goose pasture periodically holding 2,500–3,000 Canada geese. Fertilisation was not added to the ponds because of nutrient enrichment from the goose droppings.

Nursery techniques varied tremendously over the five-year period. Initially in 1972, 145,000 striped bass were obtained from Vienna, Maryland, and shipped to Rockefeller Refuge. After 14 hours in transit, the fry were acclimated for approximately 45 minutes. Shipping mortality for the 3–6 day old fry was estimated at 60%. Water temperature in the shipping boxes was 20.5° C and 24° C in the ponds. Three 0.12 ha ponds were stocked at a rate of 143,000 per ha.

In 1973, fry were again shipped from Vienna, Maryland to the refuge. Upon arrival, 950,000 3-day old fry were placed in previously described metal nursery tanks at a density of 597 per liter and 250,000 placed in a 1 m³ saran cage. Water temperature was 18° C in the shipping boxes, 19.5° C in the tanks and 27.0° C in the pond containing the cage. Shipping mortality was approximately 5%. Twenty-four hours after the fry were received, an extensive die-off occurred in the tanks.

Fry were periodically offered brine shrimp (Artemia sp.) until active feeding was noted on the fifth day (120 hrs. old). Thereafter, brine shrimp were offered every 4 hours until the fry were stocked when approximately 190 hours old. One 0.12 ha pond was stocked with approximately 40,400 fry and the 0.12 ha pond in which the cage was placed was stocked with approximately 14,000 fry. Approximately 71,000 fry from the tanks were stocked in a 0.6 ha pond. Water temperature and salinity in the small ponds and tanks were identical (22.0° C, 1.4 ppt). Salinity
in the large pond was 1.6 ppt. Additional Maryland fry (50,000) from Louisiana's Monroe striped bass nursery were received and stocked directly into a 0.12 ha pond on the afternoon of May 9, 1973. The shipping box water temperature was 22.0 °C, pond temperature 27.0 °C and pond salinity 1.4 ppt.

In 1974, 10 boxes containing approximately 500,000 2 day-old fry were received from the Lynchburg, Virginia, State Hatchery and stocked in Rockefeller's tank and nursery systems. Upon arrival at the hatchery, 50,000 fry were stocked in the saran box. Water temperature in the shipping boxes was 20.0 °C and pond water was 26.0 °C. Acclimation was achieved by floating the plastic bags containing fry inside the cage. Numerous holes were punched in the bags with an ice pick, permitting a gradual exchange of water.

As a result of the unexplained fry die-off in the nursery tanks in 1973, an attempt was made to determine if well water and brackish canal water could be used in the nursery tanks. Five 265-liter tanks were supplied with aerated canal water (1.9 ppt). Six 265-liter tanks and a 454-liter tank received aerated well water (salinity 1.4 ppt). Fifty thousand fry were divided between the tanks receiving canal water (approximately 353/liter) and the remainder between the tanks with well water (1,827/liter). After 11 hours, mortality was noted among fry in well water and canal water was introduced. Noticeable mortality ceased. Fry began feeding when approximately 108 hours old and a 4-hour feeding schedule commenced. Pond stocking began 20 hours later.

In 1975, fry were obtained from within Louisiana. Santee-Cooper strain brood fish were taken from D'Arbonne Lake, Louisiana. On April 8, 1975, 1,200,000 two day-old fry were shipped to the Rockefeller facilities. Upon arrival, water temperature in the shipping boxes was 19.0 °C and dissolved oxygen was 25.3 ppm. Tank water temperature was 20.0 °C and salinity 2.8 ppt. After 45 minutes of acclimation, 91,000 fry were placed in each of six 265-liter tanks (3,210/liter), 90,000 in each of five 265-liter tanks (3,160/liter) and 180,000 were placed in the 454-liter tank (3,704/liter). Water temperature varied between 20.0 °C and 21.0 °C and the dissolved oxygen remained above 6 ppm during the nursery period. After 11 hours in the tanks, fry began to actively feed. Stocking of the ponds commenced at 10:00 P.M.

Fry in 1976 were obtained from brood fish taken from Toledo Bend Reservoir in Louisiana and stocked into identical nursery systems used in 1975. Approximately 990,000 2-3 day old Santee-Cooper strain fry were received April 10, 1976 and acclimated to the tanks. Shipping water temperature was 23.0 °C, dissolved oxygen 10.8 ppm. The nursery tanks were supplied with circulating canal water with a salinity of 4 ppt, dissolved oxygen 6.4 ppm, temperature 22.0 °C and secchi disc reading of 24 cm. During this period, temperature varied from 22.0 °C to 24.5 °C, dissolved oxygen ranged from 6.4 to 9.0 ppm and the salinity remained constant. Stocking rates in the tanks ranged from approximately 3,210 to 6,420 fry per liter. The fry began feeding on brine shrimp after 76 hours in the tanks (approximately 116 hrs. old) and stocking commenced midnight April 14, 1976 (approximately 160 hrs. old).
In an effort to determine tolerance of striped bass fry to salinity, aquaria were filled with 10, 15, 20 and 24.5 ppt salinity gulf sea-water. Each was stocked with approximately 20 2-3 day old fry and checked periodically for mortality.

Pond Preparation, Stocking and Grow Out

Initially in 1972, three 0.12 ha ponds were filled with brackish deep well water (1.8 ppt) one day prior to the arrival of the fish. Although some water had been standing in potholes in the ponds, no attempt was made to poison predators present. Each pond was stocked with approximately 19,300 fry omitting a nursery period. The ponds were periodically monitored for low oxygen and proper water levels were maintained. In addition, Purina size 2 trout chow was fed twice daily for 7 days after stocking and continued for 2 months. Observations from feeding and seine checks revealed very few fish and feeding was therefore discontinued.

Beginning in 1973 and each year following, the ponds were drained at least one week prior to stocking. Any potholes remaining were treated with formalin (concentration of at least 10%), and the ponds then filled with canal water filtered through 20 mesh to the cm saran. Vegetation in the ponds which could not be removed prior to flooding was sprayed with Karmex while the ponds were dewatered. Fry were stocked at rates ranging from 172,800 per ha in 1973 to 493,800 per ha in 1975. Little acclimation was required as water qualities in tanks and ponds were identical.

Each year, fry were stocked at night to avoid light and excessive water temperatures and were released in several areas of each pond. Brine shrimp were dumped at each stocking site. At daylight following stocking, all ponds were treated with a mixture of 27 liters diesel fuel and 0.2 liter motor oil per ha for control of air breathing predacious insects. This treatment was repeated every 4 days for 3 weeks. Ponds containing crawfish (Procambarus sp.) were treated with 148 cc of Baytex per ha approximately 10 days before harvest.

RESULTS

Water temperature ranged from 10.0 C to 32.0 C during the 1972 striped bass culture period. Pond salinities were stable at 1.8 ppt. Oxygen measurements indicated lows of 0.0 ppm and highs of 11.0 ppm. Secchi measurements ranged from 15 to 30 cm. Measurements for the growing periods of 1973-76 revealed temperatures ranging from 20.5 C to 33.0 C. Dissolved oxygen varied from 0.0 ppm to 15.0 ppm and salinity from 1.4 ppt to 10.8 ppt. Pond waters were characteristically turbid with secchi disc readings ranging from 7.5 cm to 30.0 cm.

Production of striped bass fingerlings in the brackish water ponds at Rockefeller Refuge increased from 47 fish per ha in 1972 to 129,115 per ha in 1976 (Table 1). In 1972, only 0.04 ha was stocked with 145,000 3-6 day old fry which had not been started on food. Although the fish
were initially fed twice daily after stocking, sampling indicated that survival was poor. Upon draining the ponds in 1973, only 19 fish averaging 302 mm total length were recovered.

Ponds were again stocked with Maryland fry in 1973. However, this year the fry were held in nursery tanks prior to stocking. An unexplained die-off in the tanks resulted in the stocking of only 172,000 of approximately 1,000,000 fry received. \(^1\) The ponds were partially harvested June 7, 1973, and the remaining fingerlings left to grow larger for tagging in November of 1973. Total production in 1973 was 82 kg per ha of fingerlings which averaged 81.3 per kg. Pond production for the fish obtained in June was 1.9 kg per ha per day and 0.4 kg per ha per day for the entire growing period. A total of 130,000 fingerlings was harvested for an overall survival of 13%. Best survival of 92% was recorded for the 0.12 ha pond in which the fry were held in the saran box during the nursery period. The poorest survival was 8% for the fry from the Monroe facility stocked in a pond with water temperature of 27.0°C.

In 1974, survival was 7% for a harvest of 30,920 fingerlings. The initial harvest of 26,000 fingerlings was after 62 days in the ponds and yielded 50 kg of fish per ha averaging 52 mm total length and 335 fingerlings per kg. Production was 137 kg per ha or 1.7 kg per ha per day.

Total fingerlings produced in 1975 was 153,400 for a 13.0% survival. Of this a partial harvest of 145,700 fingerlings averaging 45 mm total length and weighing 544 per kg was obtained after 58 days. The remainder were held in ponds until December, 1975, at which time they were tagged and stocked.

Best production was obtained in 1976 when 142 kg per ha of fish were harvested representing 129,115 fingerlings per ha. Initially, after 45 days, the ponds yielded 136 kg per ha of fish averaging 1,020 per kg. The fish had gained 3.0 kg per ha per day. Survival for the entire culture period was 34.0%, for a total fish production of 335,690 fingerlings.

The aquarium bioassay to determine tolerance of striped bass fry to salinity revealed that 100% of the fry stocked in 24.5 ppt salinity (22.5°C) died in less than 30 hours. Checks throughout the remainder of the nursery period and periodically thereafter indicated that the fry in salinity of 10, 15 and 20 ppt survived up to two weeks without any apparent harmful affects. This test was only to get a relative idea of salinity effects and was not replicated.

DISCUSSION

Our data, based on five years of striped bass culture indicate a definite advantage toward holding fry in nursery facilities until they are actively feeding. This usually takes about five to six days depending

\(^1\) Survival for the growing period was determined using total number of fry received and not actual number stocked per pond, for each year.
upon water temperature. During the first year of culture at Rockefeller Refuge, all ponds stocked with 3-6 day old fry resulted in poor production. Although, ponds were not treated initially for predators and the fry were in poor condition due to shipping, a nursery period would possibly have increased production.

Circulating brackish canal water through the nursery system produced better results than brackish deep well water. Water chemistry data on well water indicated the water to be acceptable for fish culture and this water has often been used for holding other species such as catfish (Ictalurus sp.), buffalo (Ictiobus sp.), and mullet (Mugil sp.) for weeks without any mortality. Fry held in the turbid, brackish canal water were much more energetic possibly because of the presence of small nutrient particles which passed through the filter system. Turbidity seemed to buffer the "shocking effect" of light and movement on fry.

Stocking rates varied from 172,800 to 493,800 per ha. Survival rates and production, though quite variable, indicated the higher stocking rates acceptable for the fertile refuge waters. Transfer of fry from the nursery tanks to the ponds for stocking seemed best accomplished during pre-dawn hours, providing pond oxygen was adequate. Water temperatures were lower and stocking effect due to light was avoided. Experience has indicated a poor survival from ponds stocked with striped bass fry after water temperatures exceed 30.0 °C.

Fertilization was not practical in the Rockefeller research ponds. Due to the natural fertility of the area and run-off from nearby goose pastures, problems were often had with over enrichment. Dissolved oxygen was the main concern with readings varying from 0.0 ppm to 11.0 ppm in the fingerling ponds. Ponds which dropped to 2.0 ppm for short periods experienced 10% survival. Dissolved oxygen concentrations in the fertile ponds at Rockefeller Refuge are not comparable to those at more inland locations. Concentrations of approximately 4.0 ppm that remained relatively constant were acceptable. Once the concentrations began fluctuating drastically, problems arose.

Salinity has proven to be beneficial in striped bass hauling (Hughes, 1968). S. Stokes (Personal Communication) reported hauling fry in 1% solution of salt increased survival. Two to three-day-old fry observed in nursery tanks with 4 ppt showed tremendous vigor and practically no mortality. Fingerlings were cultured in ponds with salinities ranging from 1.0 ppt to 10.8 ppt. Although the best survival (92%) was experienced in a pond averaging 1.6 ppt, 64% survival was recorded for a pond averaging 9.6 ppt, 53% for 5.3 ppt, and 47% for 10 ppt. Powell (1976) reported salinities reached 10 ppt in ponds at the Claude Peteet Marine Culture Center in which fingerling striped bass were cultured. However, he was unable to include any correlations between water quality and survival though overall survival was 32.2%. As indicated from the non-replicated bioassay with the fry and data reported by Otwell and Merriner (1979), fry are relatively tolerant to abrupt changes in salinity. Talbot (1966), in a detailed review of requirements

and limiting factors for striped bass indicated that except during spawning, salinity does not seem to be critical.

The number of grow-out days are important. Sampling has indicated after a certain length of time, an inverse pyramidal effect is experienced in relation to survival. Certainly after the food requirements change to more advanced forms, ponds tend to be overgrazed. At Rockefeller, efforts have been made to lessen mortality by "phase harvesting" beginning after the fry are approximately 40 days old. This permits the production of larger fingerlings which are harder and suitable for tagging.

Finally, we are concerned that little data exist evaluating stocking success of various size fingerlings in natural water systems containing existing fish populations. Fishery workers may be sacrificing hardiness, survival and ultimately the success of their programs by placing too much emphasis upon numbers.

LITERATURE CITED


Table 1. - Average growth data of striped bass fingerlings cultured at Rockefeller Wildlife Refuge, 1972-76.

<table>
<thead>
<tr>
<th>Year &amp; Strain</th>
<th>Ha Stocked</th>
<th>Age (Days)</th>
<th>Weight Gain (Kg/ha/day)**</th>
<th>Size at 1st Harvest (No/kg)</th>
<th>Survival (%)</th>
<th>Total No/ha Harvested</th>
<th>Total Kg/ha Harvested</th>
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<tr>
<td>1972 M</td>
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<td>--</td>
<td>---</td>
<td>59</td>
<td>0.03</td>
<td>47</td>
<td>15</td>
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<tr>
<td>1973 M</td>
<td>1.0</td>
<td>42</td>
<td>1.9</td>
<td>813</td>
<td>13.00</td>
<td>128,400</td>
<td>82***</td>
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<tr>
<td>1974 V</td>
<td>1.5</td>
<td>62</td>
<td>2.2</td>
<td>335</td>
<td>7.00</td>
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<td>2.6</td>
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<td>13.00</td>
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<td>3.0</td>
<td>1,020</td>
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<td>129,115</td>
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</table>

*M - Maryland strain, V - Virginia strain, SC_d - Santee-Cooper strain from D'Arbonne Lake, Louisiana and SC_t - Santee-Cooper strain from Toledo Bend Reservoir, Louisiana.

**Considers only weight and number of days at first partial harvest of ponds, entire figure would equal 0.4 kg/ha/day for 1973, 1.7 kg/ha/day for 1974, 0.6 kg/ha/day for 1975 and 0.6 kg/ha/day for 1976.

***Does not include weight for approximately 30,000 harvested 9/3/73 due to hurricane evacuation.