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SUCCESS OF JUVENILE STRIPED BASS IN TWO BAY SYSTEMS IN MISSISSIPPI: 1980-1984

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ABSTRACT Success of a striped bass (*Morone saxatilis*, Walbaum) stocking program in the Biloxi Bay and St. Louis Bay systems in Mississippi was investigated by monitoring the occurrence of juveniles in bag seine collections in the Biloxi, Tchouticabouffa, Jourdan, and Wolf Rivers. A total of 554 juvenile striped bass were collected during the study. Hydrographic data and stomach analyses indicate that neither water conditions nor food was a limiting factor to juvenile striped bass survival. Appearance of juveniles subsequent to the stocking of Atlantic coast fry and fingerlings coupled with lateral line scale count data indicate that all juveniles collected were of Atlantic coast origin, originating from stocked fry and fingerlings. Absence of juvenile striped bass in samples when stocking did not take place indicates either

Introduction

Striped bass (*Morone saxatilis* - Walbaum) were indigenous to all major river systems along the Mississippi Gulf coast until the early 1950s (Wailes 1854, Pearson 1938, Raney and Woolcott 1955, Cook 1959, and McIlwain 1976). According to McIlwain (1976), the last recorded catch of a native striped bass in Mississippi (prior to any stocking efforts) occurred in the West Pascagoula River in 1967. Reasons for the decline of native striped bass in Mississippi are speculative, ranging from dam construction, to poor water quality, to pesticide pollution (Nicholson et al., 1986).

In 1969, a program was initiated to reestablish the striped bass population along the Mississippi Gulf Coast. Since the establishment of the restocking program, over 9 million striped bass fingerlings have been stocked into the tributaries of Mississippi Sound. A recreational fishery has developed as a result of the stocking effort. The size and value of this fishery is not known but the striped bass fishery is a recognizable segment of the total recreational fishery on the Mississippi Gulf Coast (Nicholson et al., 1986). A juvenile striped bass monitoring program was begun in 1973 in an effort to ascertain the effectiveness of stocking efforts and to attempt to document natural reproduction.

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Materials and Methods

Coastal Mississippi rivers which were sampled during 1980 through 1985 include the Biloxi and Tchouticabouffa Rivers of the Biloxi Bay system and the Jourdan and Wolf Rivers of the St. Louis Bay system. In 1980, station locations included estuarine waters, while in 1981-1984 only freshwater locations were sampled. Stations were selected by locating sand beach areas where a beach seine could be used effectively. At least one river mile separated stations, and station beaches were separated by a beach in between when possible. In 1980, 12 stations were sampled primarily on the Tchouticabouffa River, and eight stations were sampled on the Jourdan River. Beginning in 1981, estuarine stations were dropped and riverine stations on the Biloxi and Wolf Rivers were added (Figures 1 and 2).

A 15 x 2 meter bag seine with 6 millimeter bar, knotless, nylon mesh was used to sample ichthyofauna. If more than five striped bass were collected at any one station, five specimens were retained in a buffered formalin solution and later transferred to a 40% isopropyl alcohol solution for subsequent analysis. All other striped bass were counted and released alive. All fish other than striped bass which were collected were placed in plastic bags, held on ice, and later frozen for subsequent analysis. All sampling was conducted immediately following sunset and was usually completed before midnight. Sampling was conducted twice monthly from June through September for an annual total of eight sampling trips per river.

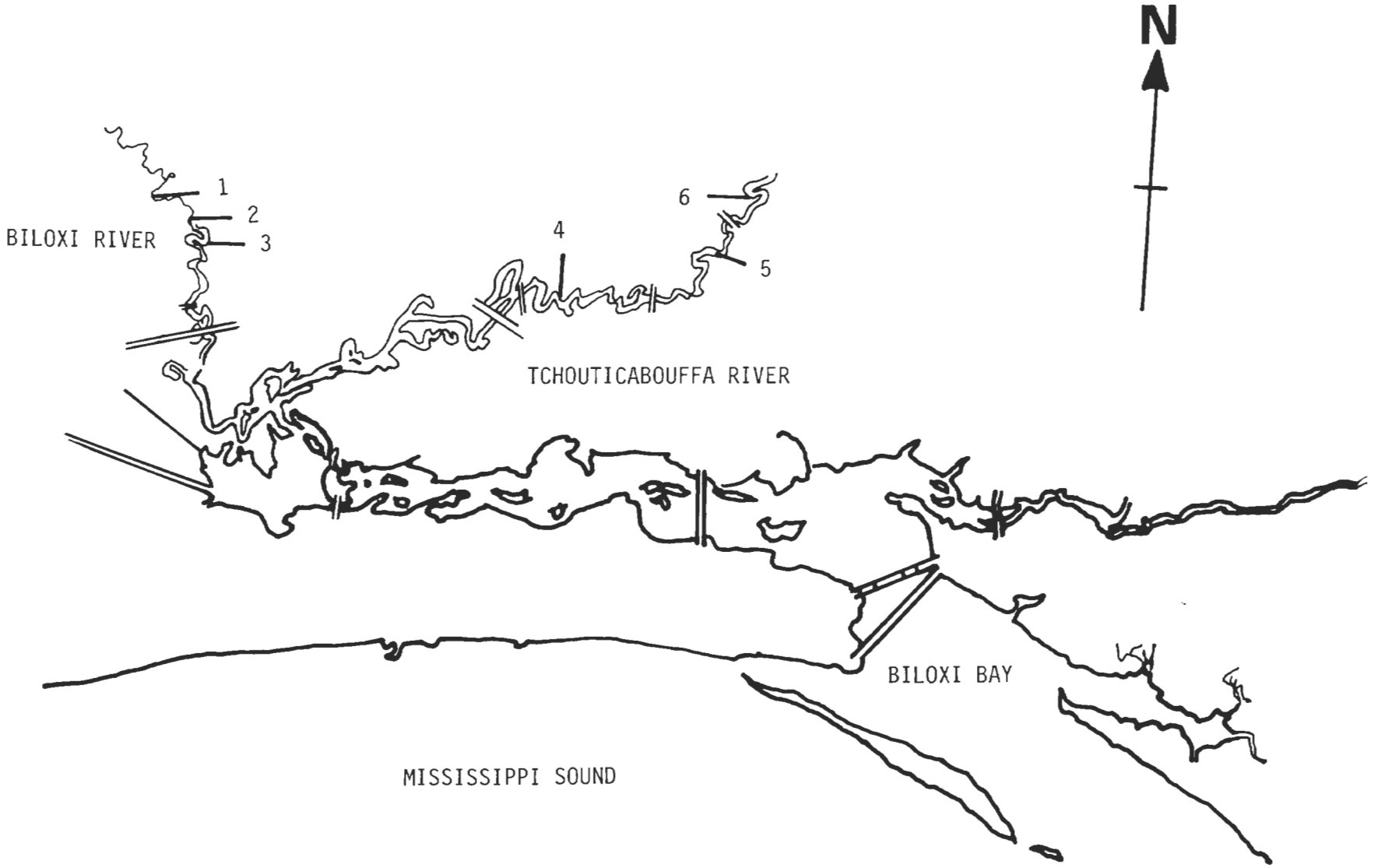

Figure 1. Station locations on the Biloxi and Tchouticabouffa Rivers.

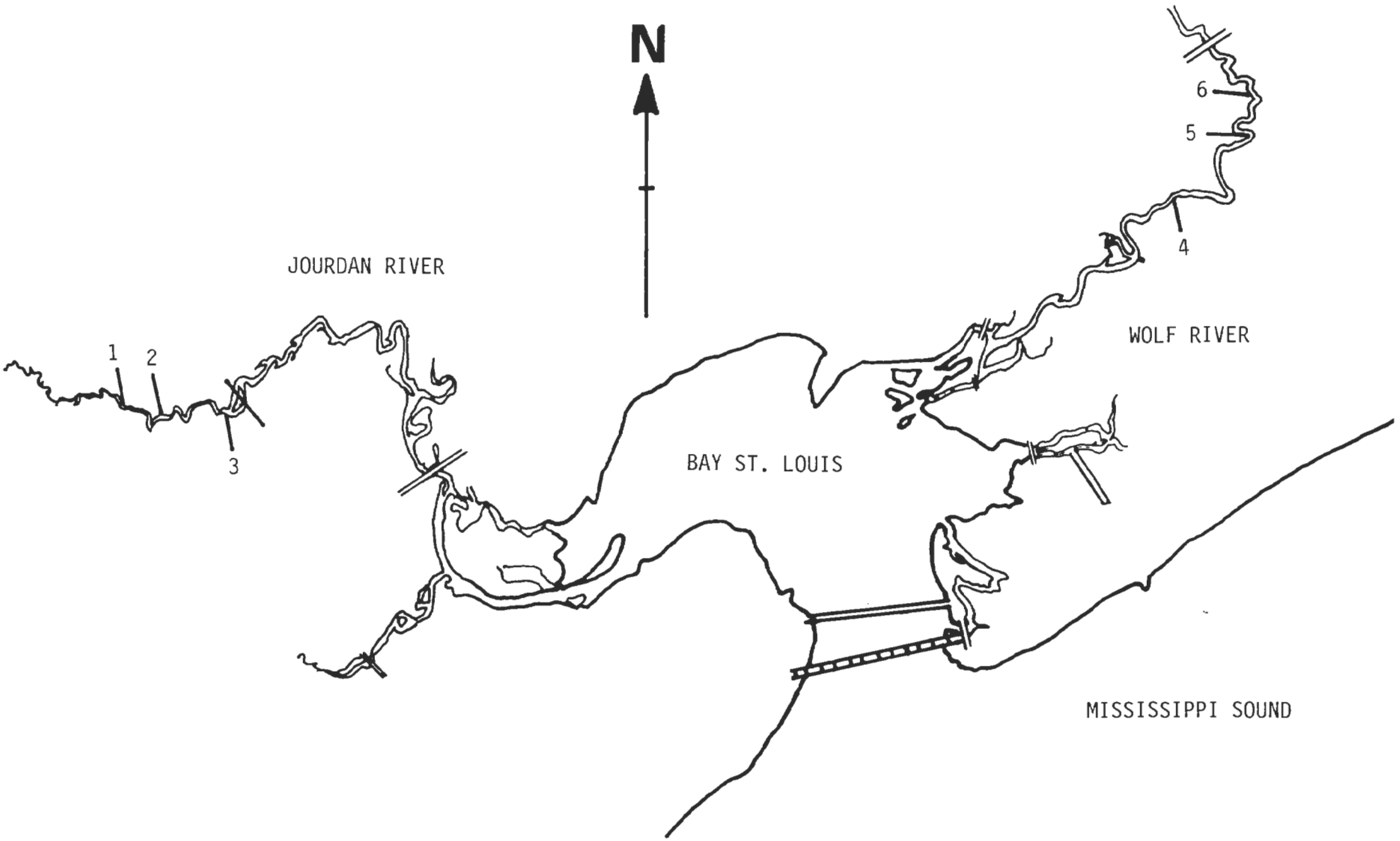

Figure 2. Station locations on the Jourdan and Wolf Rivers.

Growth rates were determined by calculating the difference between average length and weight of fish at the time of stocking with measured length and weight of juvenile striped bass collected over the time the fish were at large.

Food availability for all life stages of striped bass is an important habitat criteria in determining success of stocking activities. Of the juvenile striped bass which were retained and preserved in the 40% isopropyl alcohol solution, 217 were examined for stomach contents. Each stomach was removed, opened with a scalpel, and the contents identified and enumerated under a binocular microscope. Identification of stomach contents was not taken to the species level in most cases.

Lateral line scales, ie. scales with noticeable pores, were counted on all juvenile striped bass specimens retained in collection for the purpose of discriminating between specimens of Atlantic and Gulf of Mexico origin. Counts were made on both sides of the fish under a binocular microscope.

Hydrographic measurements taken concurrently with bag seine hauls, included water temperature (1980-1984), dissolved oxygen (1980-1983), conductivity and pH (1984), and salinity (1980). Instruments used to collect hydrographic data were an A/O Goldberg refractometer, a Yellow Springs Instrument (YSI) Model 51-B oxygen meter, a YSI TSC meter, and an Orion Research Model 221 pH meter.

RESULTS

Biloxi Bay System

A total of 179 juvenile striped bass were collected during the study. Positive collections occurred only during 1980-1982. No juvenile striped bass were collected during 1983 and 1984. Mean total length (TL) ranged from 68.54 millimeters (mm) to 98.02 mm, while mean weight ranged from 6.90 grams (g) to 9.91 g. Growth rates in mm per day and g per day ranged from 0.8 to 2.3 and 0.09 to 0.11, respectively (Table 1).

Measurements of hydrographic parameters for the Biloxi River (Table 2) resulted in temperatures ranging from 18.0° to 32.0°C, with mean values ranging from 25.6°C in 1982 to 27.5°C in 1981. DO values ranged from 4.6 ppm to 8.2 ppm, with mean values ranging from 5.8 ppm in 1981 to 6.9 ppm in 1983. Values for pH, measured only in 1984, ranged from 4.7 to 7.1 with a mean of 5.8.

Measurements of hydrographic parameters for the Tchouticabouffa River (Table 3) resulted in temperatures ranging from 17.5°C to 34.5°C, with mean values ranging from 22.8°C in 1983 to 27.8°C in 1980. DO values ranged from 3.4 ppm to 8.3 ppm, with mean values ranging from 5.1 ppm in 1981 to 6.3 ppm in 1980. Salinity values, measured only in 1980, ranged from 0 parts per thousand (ppt) to 22 ppt. Values for pH, measured only in 1984, ranged from 4.5 to 6.5 with a mean of 5.2.

TABLE 1
Frequency of striped bass, mean total length, mean weight, and growth rates per day for the Biloxi Bay System.

	Frequency	X TL (mm)	X Weight (g)	Growth Rate (mm/day)	Growth Rate (g/day)
1980	43	98.02	9.91	0.8	0.09
1981	63	70.25	6.90	1.3	0.11
1982	73	68.54	7.72	2.3	0.10
1983	0	–	–	–	–
1984	0	–	–	–	–

TABLE 2

Minimum, maximum, and mean values of temperature (°C) and dissolved oxygen (ppm) for the Biloxi River during June through September of 1980 through 1984. Measurements of pH are provided for 1984 only.

	TEMPERATURE			DISSOLVED OXYGEN			pH		
	MIN	MAX	X	MIN	MAX	X	MIN	MAX	X
1980	–	–	–	–	–	–	–	–	–
1981	23.0	32.0	27.5	4.7	6.7	5.8	–	–	–
1982	22.0	28.5	25.6	4.6	8.2	6.6	–	–	–
1983	18.0	22.2	27.0	5.7	8.0	6.9	–	–	–
1984	24.0	28.0	26.3	–	–	–	4.7	7.1	5.8

TABLE 3

Minimum, maximum, and mean values of temperature and dissolved oxygen for the Tchouticabouffa River During June through September of 1980 through 1984. Salinity is provided for 1980 and pH for 1984.

	TEMPERATURE			DISSOLVED OXYGEN			SALINITY		pH		
	MIN	MAX	X	MIN	MAX	X	MIN	MAX	MIN	MAX	X
1980	17.5	34.5	27.8	4.0	8.3	6.3	0	22	–	–	–
1981	25.0	30.0	27.6	4.0	6.6	5.1	–	–	–	–	–
1982	23.0	29.0	24.4	3.4	7.2	5.8	–	–	–	–	–
1983	18.5	28.0	22.8	3.8	7.6	6.2	–	–	–	–	–
1984	25.0	29.0	27.6	–	–	–	–	–	4.5	6.5	5.2

St. Louis Bay System

A total of 381 juvenile striped bass were collected from 1980 through 1983. None were collected in 1984. Mean TL ranged from 66.7 mm to 108.9 mm, while mean weight ranged from 4.33 g to 14.27 g. Growth rates in mm per day and g per day ranged from 0.82 to 1.30 and 0.07 to 0.17, respectively (Table 4).

Measurements of hydrographic parameters for the Jourdan River (Table 5) resulted in temperatures ranging from 17.5°C to 33.5°C, with mean values ranging from 23.8°C in 1983 to 27.6°C in 1981. DO values ranged from 4.0 ppm to 9.4 ppm, with mean values ranging from 5.4 ppm in 1981 to 6.5 ppm in 1983. Salinity values, measured only during 1980, ranged from 0 ppt to 15 ppt. Values for pH, measured only during 1984, ranged from 4.8 to 6.8 with a mean of 5.8.

Measurements of hydrographic parameters for the Wolf River (Table 6) resulted in temperatures ranging from 18°C to 31.5°C, with mean values ranging from 21.8°C in 1983 to 27.0°C in 1984. DO values ranged from 5.8 ppm to 8.6 ppm, with mean values ranging from 6.7 ppm in 1981 to 7.5 ppm in 1983. Values for pH, measured only during 1984, ranged from 5.0 to 6.4 with a mean of 5.9.

Description of Stomach Contents

The stomach contents of 217 juvenile striped bass were examined (Table 7). Of the 43 fish examined from the Biloxi Bay system in 1980, 20 contained unidentifiable digested material. Mysid shrimp (*Taphromysis louisiannae*) were found in 16 stomachs, while seven stomachs contained partially digested fish. From the St. Louis Bay system in 1980, all six fish examined contained mysid shrimp; however, two also contained partially digested fish, while one also contained insect larvae.

The stomach contents of 42 juvenile striped bass taken from the Biloxi Bay system in 1981 were examined. Fifteen stomachs were empty, while 18 contained mysid shrimp. Ten stomachs contained partially digested fish, one of which was identified as the bay anchovy (*Anchoa mitchelli*). Insect larvae were found in six stomachs, while amphipods were found in five. Two stomachs contained unidentifiable digested material. The stomach contents of 126 fish were examined from the St. Louis Bay system during 1981. Seventy-two stomachs contained mysid shrimp, while 32 contained unidentifiable digested material. Twenty-one stomachs contained insects and 15 contained amphipods. Five stomachs contained partially digested fish, two of which were of the genus Notropis, and one of which was identified as a hogchoker (*Trinectes maculatus*). Nineteen stomachs were empty.

Lateral Line Scale Counts

All striped bass fry and fingerlings stocked into the Biloxi Bay and St. Louis Bay systems were acquired from hatcheries in South Carolina and Virginia. Barkuloo (1967) used lateral line scale counts to separate striped bass of Atlantic and Gulf of Mexico origins. A total of 332 juvenile striped bass were examined for both right and left side lateral line scale counts in an effort to ascertain if any specimens were of Gulf of Mexico brood stock. The number of lateral line scales on the left side of the fish examined ranged from 46 to 64, while the right side count ranged from 47 to 65. The mean for both sides was 57 (Table 8), indicating that all collected specimens were of Atlantic stock origins.

Other Ichthyofauna

Data for ichthyofauna other than striped bass were collected for survey years 1981 through 1983. In the Biloxi Bay system, a total of 14,415 fish representing 43 species were collected. In the St. Louis Bay system 23,901 fish were collected, representing 40 species. In both cases, the ten most frequent species represented 87% of the total (Tables 9 and 10).

DISCUSSION

The two primary reasons for conducting the striped bass juvenile monitoring program were to assess the survival of juvenile striped bass stocked in the Biloxi and St. Louis Bay systems and to document natural reproduction. In the Biloxi Bay system, numbers of striped bass fingerlings stocked were 411,479 in 1980; 566,070 in 1981, and 85,000 in 1982. All fish during this period were stocked during the months of May or June as Phase I fingerlings, averaging 22.5 mm TL. In 1983 and 1984, all stocked fish were Phase II fingerlings, ranging from 100 to 150 mm TL and were stocked during November. Juvenile striped bass were found in rivers after stocking during early summer and were found to be of Atlantic stock origin. During 1983 and 1984 when stocking of fingerlings occurred in November, juvenile striped bass were not found in the June through September samples. The fact that juveniles collected in 1980-82 were of Atlantic stock origin and corresponded with stocking efforts and the absence of any juveniles in the years of November stocking indicate that either natural spawning did not take place or that eggs or larvae did not survive if spawning did occur.

Data gathered from examining the stomach contents of 217 juvenile striped bass during 1980 and 1981 indicate the occurrence of several types of food items. The mysid shrimp, *Taphromysis louisiannae*, was the

TABLE 4
Frequency of striped bass, mean total length, mean weight, and growth rates per day for the St. Louis Bay system.

	FREQUENCY	X TL (mm)	X WEIGHT (g)	GROWTH RATE (mm/day)	GROWTH RATE (g/day)
1980	6	108.9	14.27	1.12	0.17
1981	215	66.7	4.96	0.82	0.07
1982	115	72.1	4.33	1.30	0.09
1983	45	–	–	–	–
1984	–	–	–	–	–

TABLE 5
Minimum, maximum, and mean values of temperature and dissolved oxygen for the Jourdan River during June through September of 1980 through 1984. Salinity is provided for 1980 and pH for 1984.

	TEMPERATURE			DISSOLVED OXYGEN			SALINITY		pH		
	MIN	MAX	X	MIN	MAX	X	MIN	MAX	MIN	MAX	X
1980	17.5	33.5	26.3	4.2	9.4	6.4	0	15	–	–	–
1981	22.5	32.5	27.6	4.0	6.6	5.4	–	–	–	–	–
1982	23.5	29.0	26.6	4.4	6.9	5.9	–	–	–	–	–
1983	19.0	29.5	23.8	5.3	7.6	6.5	–	–	–	–	–
1984	25.0	28.0	25.2	–	–	–	–	–	4.8	6.8	5.8

TABLE 6

Minimum, maximum, and mean values of temperature and dissolved oxygen for the Wolf River during June through September of 1980 through 1984. Measurements of pH are provided for 1984 only.

	TEMPERATURE			DISSOLVED OXYGEN			pH		
	MIN	MAX	X	MIN	MAX	X	MIN	MAX	X
1980	–	–	–	–	–	–	–	–	–
1981	22.0	31.5	26.8	5.8	8.0	6.7	–	–	–
1982	24.0	29.0	26.2	6.8	8.6	7.2	–	–	–
1983	18.0	28.0	21.8	6.3	8.4	7.5	–	–	–
1984	26.0	29.0	27.0	–	–	–	5.0	6.4	5.9

TABLE 7

Food items found in the stomachs of juvenile striped bass from the Biloxi and St. Louis Bay systems in 1980 and 1981.

YEAR	MYSID SHRIMP	FISH	INSECTS	AMPHIPODS	UNIDENTIFIABLE DISGESTED MATERIAL	EMPTY	TOTAL EXAMINED*
Biloxi Bay System							
1980	16	7	–	–	20	–	43
1981	18	10	6	5	2	15	42
St. Louis Bay System							
1980	6	2	1	–	–	–	6
1981	72	5	21	15	32	19	126

TABLE 8

Frequency of right and left side lateral line scale counts for all juvenile striped bass collected from the Biloxi Bay and St. Louis Bay systems from June through September of 1980 through 1983.

SCALE COUNTS		46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	N
1980	Right						2	1	2	3	6	10	6	3	4	1	2	1				41
	Left						1	1	2	3	6	8	10	6	2		1		1			41
1981	Right						1	1	6	8	10	19	37	22	19	21	9	9	3	1	1	167
	Left					1	2	1	1	4	19	22	21	30	21	22	13	6	2	1		166
1982	Right		1		1	2	3	4	10	7	15	12	12	14	8	6	1	1				97
	Left	1		1		3	4	6	7	8	18	11	16	13	5	2		1				96
1983	Right								3		5	2	3	3	5	3		2	1			27
	Left									3	2	3	6	4	4	2	1	1		1		27

TABLE 9
The 10 most frequent species collected from the Biloxi Bay System, 1981–1983.

GENUS/SPECIES	FREQUENCY	%
Notropis texanus	2,989	24
Notropis venustus	2,748	22
Labidesthes sicculus	1,706	8
Hybopsis amblops	953	8
Micropterus punctulatus	945	7
Lepomis megalotis	890	6
Lepomis macrochirus	772	5
Notropis species	632	5
Leiostomus xanthurus	492	4
Ictalurus punctatus	408	3
TOTAL	12,535	87

TABLE 10
The 10 most frequent species collected from the St. Louis Bay system, 1981–1983.

GENUS/SPECIES	FREQUENCY	%
Notropis venustus	10,196	49
Hybopsis amblops	2,817	14
Notropis texanus	2,669	13
Notropis species	1,778	9
Labidesthes sicculus	726	3
Anchoa mitchelli	701	3
Ictalurus punctatus	593	3
Notropis longirostris	493	2
Notropis petersoni	416	2
Trinectes maculatus	405	2
TOTAL	20,794	87

predominant prey item, occurring in 52% of the stomachs examined. The remainder of the identifiable food items were found in 33% of the stomachs examined, while 25% of the stomachs contained unidentifiable digested material. Sixteen percent of the stomachs examined were empty. These data concur with Nicholson (1983), who stated that juvenile striped bass under 114 mm select small invertebrate organisms, such as the mysid shrimp, amphipods, and insects found in this study. As the fish grow larger, they begin to select soft-rayed fish as their primary food source. Based on the consistency of occurrence of food items and the relatively low frequency of empty stomachs encountered, it appears that forage for juvenile striped bass is not a limiting factor in the Biloxi and St. Louis Bay systems.

Further indications that either natural spawning did not occur or that eggs or larvae did not survive are evidenced in the results of the lateral line scale counts. Of the 332 fish examined from both the Biloxi and St. Louis Bay systems, all scale counts were distributed in concurrence with those reported by Barkuloo (1967) for striped bass from the Atlantic coast. The overall mean lateral line scale count of 57 is comparable to Barkuloo's overall mean of 59. Lateral line scale counts are not as reliable in separating races of striped bass as are newer genetic techniques; however, the technique has been used historically. It is expected that as the genetic technology becomes more refined, it will become a much more available management tool.

When determining the appropriateness of a given river system for stocking of any fish species, it is necessary to be aware of the competitors, predators, and prey species in the river into which fish are stocked. All fish collected while seining for striped bass at riverine locations were enumerated and identified in order to document the faunal complex of both bay systems.

The four most frequently collected species from the Biloxi Bay system (Table 8) and the five most frequently collected species from the St. Louis Bay system (Table 9) were relatively small, soft-rayed species identified by Nicholson (1983) to be primary prey species for juvenile striped bass over 100 mm TL.

Adult fish such as *Micropterus punctulatus* and the various *Lepomis* species could act as predators on juvenile striped bass; however, this has not been documented in Mississippi waters. It is likely that the juveniles of *Micropterus* and *Lepomis* function as competitors with striped bass, utilizing the same river areas (as evidenced by their capture in conjunction with striped bass), and possibly utilizing the same prey species. This possible competition should be minimized as the striped bass grow larger late in their first year, because at that time they begin to school in the open waters of the river, a behavior which is not known or documented for *Micropterus* or *Lepomis* in riverine systems.

The data reported herein on occurrence, growth rates, and stomach analysis for juvenile striped bass support the conclusion that both the Biloxi and St. Louis Bay systems provide suitable habitat for the survival of juvenile striped bass. Nicholson (1983) indicated that the overall goal of anadromous fish activities in Mississippi was to reestablish reproducing populations of striped bass in coastal Mississippi. It is imperative that a monitoring program be conducted concurrently with stocking to determine the degree of stocking success. Stocking of the Biloxi and St. Louis Bay systems during 1980 through 1984 resulted in survival of juvenile striped bass up to about 100 mm TL. Determination of the condition of the adult striped bass stock was beyond the scope of this study; however, data collected during this study support the conclusion that successful natural reproduction did not occur during 1980 through 1984.

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