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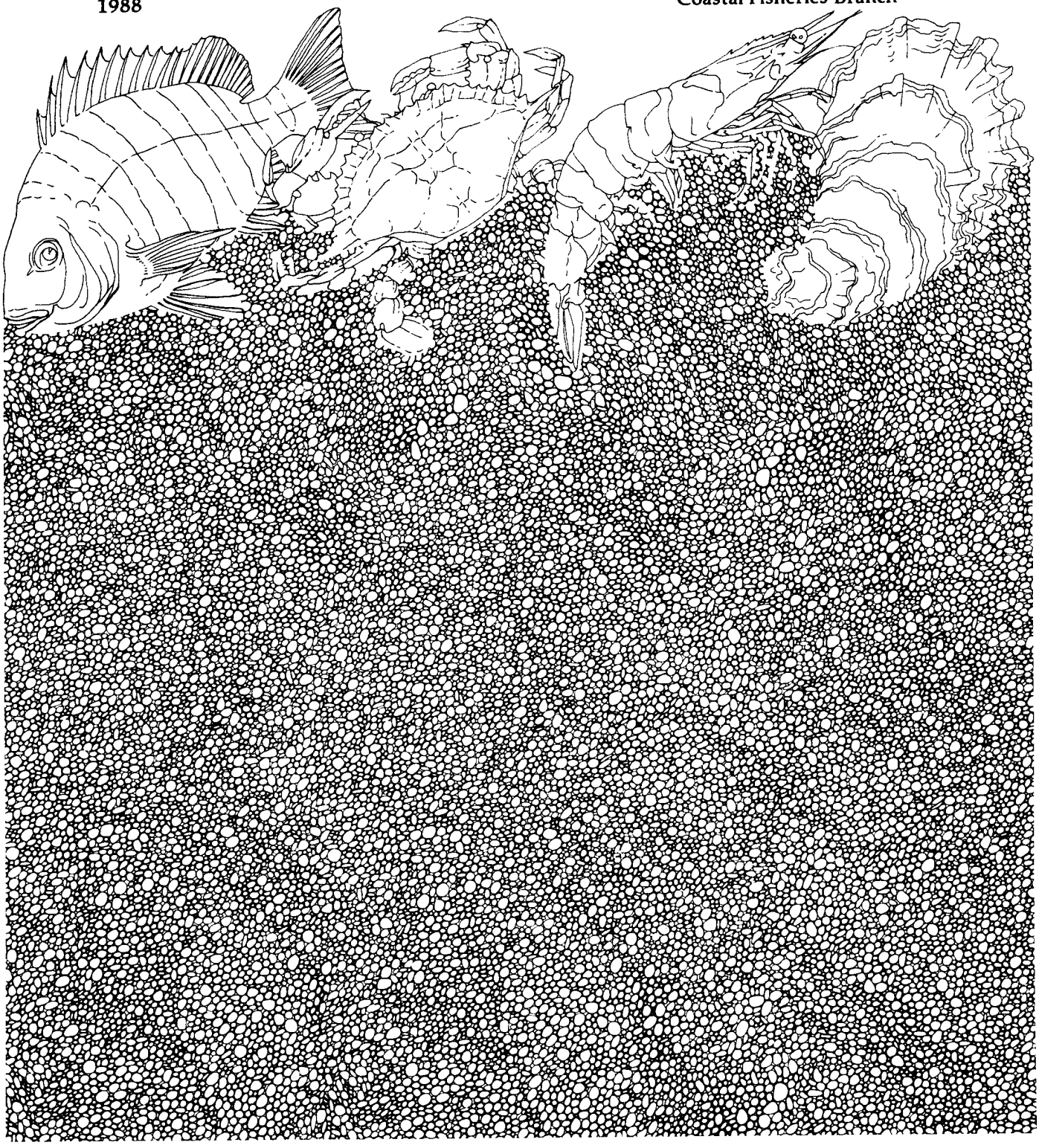

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ABSTRACT

Striped bass (Morone saxatilis) fingerling production was compared in freshwater and saltwater ponds. Two-day old fry were laboratory reared for 3 days in fresh water (0 o/oo) or salt water (10 o/oo). The 5-day old fry were stocked at 170,000 fry/ha into three 0.1-ha freshwater ponds and three 0.1-ha saltwater ponds. Survival after 28 days was 0 and 46% in freshwater and saltwater ponds, respectively. Striped bass fry in the freshwater ponds presumably died at stocking when temperature was 25 C. Striped bass fingerling production from hatcheries can probably be increased by rearing fry in salt water (10 o/oo) when temperatures exceed 24 C.

INTRODUCTION

The striped bass (Morone saxatilis) is an important anadromous sport fish in the United States (Bayless 1972). Although indigenous to the United States Atlantic and Gulf coasts, most Gulf coast populations have disappeared (Powell 1976, Perry et al. 1977). Natural reproduction of striped bass in Santee-Cooper Reservoir, South Carolina, disproved long-held assumptions that salt water was essential for life cycle completion (Scruggs 1957). Accordingly, striped bass have been widely cultured (Stevens 1966, Bonn et al. 1976), and stocked in reservoirs and much of its original Atlantic and Gulf coast range (Stevens 1984).

Current striped bass freshwater culture methods yield approximately 75,000 fingerlings/ha but production is highly variable (Stevens 1974, Parker 1979, Kerby et al. 1983). Generally, hatcheries having waters with salinities $\geq$ 0.5 o/oo are more productive than those having < 0.5 o/oo (Geiger and Parker 1985). Further, survival of laboratory reared striped bass fry is improved in approximately 10 o/oo salt water (Albrecht 1964, Bayless 1972, Lal et al. 1977). Striped bass have been cultured in 5-11 o/oo saltwater ponds (Powell 1976, Colura et al. 1976, Perry et al. 1977), but there are no direct comparisons of fingerling production in fresh and salt waters. The present study compares striped bass fingerling production and survival in freshwater and saltwater ponds.

MATERIALS AND METHODS

This study was conducted 11 April-25 May 1983 at the Texas Parks and Wildlife Department, Perry R. Bass Marine Fisheries Research Station (MFRS), Palacios, Texas. Two-day old striped bass fry (218,000) were obtained from the Louisiana Department of Wildlife and Fisheries Toledo Bend Hatchery and transported according to Bonn et al. (1976). Plastic shipping bags containing the fry were floated in culture tanks for 1 h to acclimate fry to laboratory conditions. Half the fish were placed in a 380-liter tank containing fresh water (0 o/oo) and the remainder in 10 o/oo salt water in an 1850-liter tank. Temperature was maintained at 20-22 C with water chillers (Model DE 100, Frigid Units, Inc., Toledo, Ohio). Salinity in the saltwater culture tank was maintained by combining well water and Matagorda Bay water to yield a final salinity of 10 o/oo. Total ammonia N was maintained at < 1 mg/l by exchanging 1-3 liters of water/minute.

Five-day old fry were removed from laboratory culture tanks and the number estimated according to Bonn et al. (1976). Fry were transported at night (2045 hours) to six 0.1-ha ponds in plastic bags, floated for 1 h to acclimate fry to 25 C pond temperatures and stocked into each pond at 170,000 fry/ha. Fry reared in fresh water were stocked into three ponds with initial salinities of 0 o/oo and fry reared in salt water into three ponds with 10 o/oo initial salinities.

Ponds were prepared 15 days before stocking by spreading 36 kg of cottonseed meal on each dry pond bottom. After initial filling an additional 36 kg cottonseed meal was applied in nine equal portions over a 3-week period.

One liter of phosphoric acid (55% P_2O_5) and 0.5 kg urea (45% N) was applied to each pond at initial filling and 3 days later. Three randomly selected ponds received fresh water, the remainder salt water. Freshwater ponds were filled with well water. In addition, approximately 400 m^3 of water from an MFRS freshwater pond with an established zooplankton population was added to each freshwater pond to accelerate zooplankton production. Saltwater ponds were adjusted to 10 o/oo salinity by mixing filtered (0.5-mm saran) Matagorda Bay water and well water.

Water quality determinations were performed daily at each pond drain box between sunrise and 0730. Dissolved oxygen was determined by the membrane electrode method (Delta 1010, Delta Scientific Corp., Lindenhurst, New York). Surface temperature and salinity were determined with a glass thermometer and refractometer (American Optical Instrument Company, Buffalo, New York), respectively.

Zooplankton were sampled 7 days after filling began and twice weekly thereafter. Twenty-five liters water samples were collected at the drain box of each pond using a 12-V flexible impeller pump apparatus (Farquhar and Geiger 1984). Zooplankton were concentrated in a 64-μm. Wisconsin plankton net and preserved in 4% buffered formalin-sucrose solution (Haney and Hall 1973) until analyzed. Each zooplankton sample was diluted in a graduated cylinder until it contained 200-500 organisms/ml, mixed to ensure homogeneity and a 1-ml subsample recovered with a Hensen-Stemple pipette. Organisms were identified and enumerated using a Ward plankton counting wheel and stereomicroscopy. Population densities (No. organisms/liter) of mixed rotifers, polychaete larvae, copepod nauplii, calanoid copepods, cyclopoid copepods, harpacticoid copepods, total copepods, and total zooplankton were determined.

Ponds were seined weekly to establish fish survival and harvested after 28 days. Fish recovered from each pond at harvest were weighed <u>en masse</u> with a dairy scale (Model 600, Hanson Co., Shubuta, Mississippi). Total number of fish recovered was determined by dividing the total pond biomass by the mean wet weight of 100 fish calculated from five 100-fish subsamples collected from each pond (Bonn et al. 1976). Mean (± SD) production (kg/ha/day), percent survival, dissolved oxygen, temperature, and salinity were calculated for each treatment.

Zooplankton densities for each sample date and each set of replicate ponds were transformed to common logarithms and compared by model I two-way analysis of variance (Sokal and Rohlf 1981). Statistical analyses were performed using the Statistical Package for the Social Sciences (Norusis 1986).

RESULTS

Striped bass fingerlings were collected from saltwater ponds on each sample date. At harvest, fingerling production averaged 1.3 ± 0.3 kg/ha/day in saltwater ponds, with a mean survival of 46 ± 4%. No fingerlings were recovered from any of the freshwater ponds during sampling or at harvest.

Weekly mean densities of total zooplankton in freshwater ponds, with the exception of weeks 2 and 5, exceeded densities in saltwater ponds throughout the study (Table 1). Total zooplankton densities were significantly affected by time, salinity, and the time and salinity interaction (Table 2). All zooplankton group densities were significantly affected over time. Polychaete larvae and calanoid copepod densities were significantly greater in salt water whereas, cyclopoid copepod, copepod nauplii, total copepod, and total zooplankton densities were significantly greater in fresh water. Salinity did not affect harpacticoid copepod and rotifer densities. Only total copepod and harpacticoid copepod densities were not significantly affected by the time and salinity interaction.

Salinity averaged 1.7 ± 0.1 and 11.4 ± 2.3 o/oo, respectively,in freshwater and saltwater ponds. Freshwater ponds increased from 0 to 3 o/oo over the study period. Morning pond temperatures averaged 24 ± 1 C in both freshwater and saltwater ponds and ranged 21 to 26 C over the study period reflecting seasonal ambient conditions. Mean dissolved oxygen in freshwater and saltwater ponds was 5.1 ± 1.1 and 5.1 ± 0.8 mg/l, respectively. Low dissolved oxygen concentrations occurred in one freshwater pond (1.1 mg/l) during the last week of culture and one saltwater pond (2.7 mg/l) during the second week of culture. No moribund or dead fish were observed during periods of low dissolved oxygen concentration.

DISCUSSION

Striped bass fingerling production can probably be increased by rearing fry in salt water (10 o/oo) when temperatures exceed 24 C. Complete mortality of striped bass in freshwater ponds during this study was probably due to reduced temperature tolerance of striped bass in fresh water. Bonn et al. (1976) reported 24 C as the upper limit for successful freshwater pond culture of striped bass. Although mean pond temperatures were 24 C in the morning, afternoon temperatures were presumably higher and temperature was 25 C when ponds were stocked. Temperature and salinity affect 24-hour survival of newly hatched striped bass, with optimum survival at 10 o/oo and 18 C (Morgan et al. 1981). Striped bass fry also tolerate higher temperatures with increasing total dissolved solids (Davies 1973), suggesting salinity affects temperature tolerances. Furthermore, striped bass fry survival in saltwater ponds has been reported when fry were stocked at 25-30 C (Perry et al. 1977, Minton 1983). It has also been suggested the greater saltwater pond zooplankton forage base produced at 25 C may override the benefit of stocking at temperatures < 25 C (Minton 1983).

The absence of fish in weekly collections from freshwater ponds suggests most mortality occurred soon after stocking. Initial population densities of copepods, a key factor in survival of pond cultured striped bass (Geiger 1983) were approximately twice as great in freshwater ponds throughout the study suggesting cropping never began. Furthermore, low dissolved oxygen concentrations appear unlikely to have contributed to the observed mortalities since problems occurred in only one freshwater pond (1.1 mg/l) during the last week of the study.

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Table 1. Weekly mean (± SD) organisms/liter and grand mean (± SD) organisms/liter of selected zooplankton groups and total zooplankton in freshwater and saltwater striped bass culture ponds at the Perry R. Bass Marine Fisheries Research Station, Palacios, Texas, 18 April-23 May 1983.

Week		Rotifers	Polychaete larvae	Copepods					Total zooplankton
				Harpacticoid	Cyclopoid	Calanoid	Unidentified	Nauplii	Total	
Fresh Water	1	2503 ± 3174	1 ± 3	0	20 ± 18	6 ± 13	9 ± 9	298 ± 334	333 ± 333	2836 ± 3487
	2	859 ± 524	0	4 ± 6	435 ± 174	10 ± 12	7 ± 11	1863 ± 327	2321 ± 427	3180 ± 616
	3	351 ± 339	0	13 ± 16	472 ± 374	31 ± 44	11 ± 13	646 ± 377	1037 ± 695	1602 ± 1125
	4	1465 ± 1151	8 ± 12	8 ± 10	747 ± 1051	6 ± 8	9 ± 10	348 ± 200	1117 ± 1222	2590 ± 1410
	5	5471 ± 5556	23 ± 13	8 ± 4	223 ± 344	0	0	775 ± 671	1007 ± 625	6501 ± 5446
	6	6169 ± 1543	3 ± 6	24 ± 42	180 ± 114	0	3 ± 5	825 ± 92	1031 ± 199	7203 ± 1706
x ± SD		2803 ± 2454	6 ± 9	10 ± 8	346 ± 258	9 ± 12	6 ± 4	793 ± 568	1141 ± 646	3985 ± 2293
Salt Water	1	177 ± 149	0	1 ± 2	22 ± 30	8 ± 10	3 ± 3	113 ± 110	148 ± 118	277 ± 224
	2	5625 ± 2922	0	37 ± 90	41 ± 57	580 ± 1128	7 ± 6	707 ± 326	1377 ± 1151	7002 ± 3064
	3	344 ± 349	16 ± 31	120 ± 126	16 ± 15	406 ± 466	5 ± 8	62 ± 64	609 ± 544	855 ± 878
	4	905 ± 1246	172 ± 155	75 ± 118	22 ± 24	190 ± 223	6 ± 8	150 ± 120	443 ± 318	1492 ± 1457
	5	3493 ± 4007	634 ± 613	65 ± 66	29 ± 17	5 ± 7	4 ± 5	527 ± 315	630 ± 317	6657 ± 5269
	6	2697 ± 3579	85 ± 148	13 ± 14	44 ± 59	7 ± 8	0	494 ± 191	557 ± 237	3648 ± 4223
x ± SD		2197 ± 2150	152 ± 246	52 ± 44	29 ± 11	199 ± 245	4 ± 2	342 ± 268	627 ± 408	3322 ± 2949

Table 2. Results of two-way analysis of variance of mean zooplankton densities from freshwater and saltwater striped bass culture ponds at the Perry R. Bass Marine Fisheries Research Station, Palacios, Texas, 18 April-23 May 1983.

Faunal group	Source of variation	df	SS	F	Probability
Total zooplankton	Time	10	16.252	18.042	0.000
	Salinity	1	0.933	10.362	0.002
	Time x salinity	10	2.267	2.516	0.017
Total copepods	Time	10	9.555	10.459	0.000
	Salinity	1	1.248	13.660	0.001
	Time x salinity	10	0.400	0.437	0.921
Rotifers	Time	10	31.268	13.363	0.000
	Salinity	1	0.590	2.523	0.119
	Time x salinity	10	6.538	2.794	0.009
Calanoid copepods	Time	10	25.862	9.946	0.000
	Salinity	1	16.105	61.939	0.000
	Time x salinity	10	8.032	3.089	0.005
Cyclopoid copepods	Time	10	9.394	2.713	0.011
	Salinity	1	14.299	41.303	0.000
	Time x salinity	10	9.482	2.739	0.010
Nauplii	Time	10	15.405	13.603	0.000
	Salinity	1	3.249	28.690	0.000
	Time x salinity	10	2.339	2.066	0.049
Harpacticoid copepods	Time	10	15.348	2.966	0.006
	Salinity	1	1.937	3.743	0.059
	Time x salinity	10	1.771	0.342	0.964
Polychaetes	Time	10	37.016	17.080	0.000
	Salinity	1	7.080	32.667	0.000
	Time x salinity	10	8.276	3.818	0.001

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