Production of Phase I and II Hybrid Striped Bass in Mississippi[1]

H. R. Robinette, *Department of Wildlife and Fisheries, P.O. Drawer LW, Mississippi State, MS 39762*

C. H. Young, *Department of Wildlife and Fisheries, P.O. Drawer LW, Mississippi State, MS 39762*

Abstract: Nine-day-old hybrid striped bass (*Morone saxatilis* × *M. chrysops*) were stocked into fertilized 0.04-ha freshwater ponds at 3 densities with 3 replications each and fed a 55% crude protein feed at 0.45 kg/day/pond divided equally into 4 daily feedings for 33 days. There were no significant ($P > 0.05$) differences for average weight gain or survival among the densities: 123,500 fish/ha, 1.2 g, 57.4%; 247,000 fish/ha, 0.7 g, 41.2%; and 370,500 fish/ha, 0.8 g, 31.8%. Fingerlings averaging 0.75 g were subsequently stocked into 0.04-ha fresh water (alkalinity ca. 100 mg/liter, hardness 42 mg/liter as $CaCo_3$) ponds at 37,050/ha and 74,100/ha (3 replications each). Brackish water (4–5 ppt) 0.1-ha ponds were stocked with fingerlings averaging either 0.6 g or 1.4 g (3 replications each) at 9,880/ha. Fish were fed a 38% crude protein feed at 5% of body weight and were sampled monthly for 5 months. Fish stocked at 37,050/ha were significantly larger (83.6 g) than those stocked at 74,100/ha (66.0 g), but there were no significant differences in feed conversion or survival. Survival in brackish water was significantly less for the smaller fish (80.4%) than for the larger fish (102.0%), but there were no significant differences in final average weight or feed conversion.

Proc. Annu. Conf. Southeast Assoc. Fish and Wildl. Agencies 44:45–52

During the 1980s, research in South Carolina (Smith and Jenkins 1985, Smith et al. 1985, Smith et al. 1989) and North Carolina (Kerby et al. 1983, Kerby et al. 1987) demonstrated the potential for commercial rearing of hybrid striped bass (*Morone* species). Hybrid striped bass appears to be a highly desirable substitute for striped bass (*M. saxatilis*) in traditional seafood markets (Hodson and Hayes 1989). Because of the magnitude of the Mississippi channel catfish (*Ictalurus punctatus*) farming industry (37,078 ha in production in 1989, Miss. Coop. Ext. Serv. 1989), an in-state aquaculture infrastructure exists that includes production of most of the

[1]Publication No. 7535 of the Mississippi Agricultural and Forestry Experiment Station.

feedstuffs for fish feeds, local farmer-owned feedmills, fish processing plants, and national marketing distribution systems. Aquacultural products other than catfish could provide the Mississippi fish farming community with opportunities to diversify and to take additional advantage of the existing infrastructure.

However, no information exists relative to the commercial suitability of hybrid striped bass culture in Mississippi. Additionally, comparative growth and survival data from controlled nursery trials for fingerling production are lacking (Smith et al. 1989), as well as information concerning the relationship between density, survival, growth, and feed conversion for production of advanced fingerlings (Phase II fish). Thus, the objective of this study was to determine the relationship between density and growth of Phase I and Phase II hybrid striped bass (*M. saxatilis* × *M. chrysops*) production in Mississippi.

This research was funded by Special U.S. Department of Agriculture Grant MIS–0813 and by the Mississippi Agriculture and Forestry Experiment Station. We thank the manager, Gary Fornshell, and the staff of the Mississippi State University Aquaculture Unit and the manager, Michael Murphy, and the staff of the Mississippi State University Coastal Aquaculture Unit for conducting the daily operational procedures used in this study and graduate students who helped collect harvest data. We also thank the Louisiana Department of Wildlife and Fisheries for providing the hybrid striped bass larvae.

Methods

Phase I Production

Newly-hatched hybrid striped bass larvae were obtained on 24 April 1988. Upon arrival at the Mississippi State University Aquaculture Unit (MSUAU) at Starkville, larvae were held at 93/liter in 75-liter aquaria. Fish began feeding at 5 days of age and were fed *Artemia* and zooplankton (collected from a pond). Fry were stocked into fertilized 0.04-ha ponds at 11 days of age (4 May) just before dawn. Cottonseed meal (112 kg/ha) was applied to the ponds weekly for 2 weeks prior to stocking and rotifers and cladocerans were inoculated from an adjacent pond.

Fry were stocked at each of 3 densities (123,500/ha, 247,000/ha, or 370,500/ha) into 3 replicate ponds (9 ponds total). Fish in each pond were fed 454 g/day of salmon starter mash (55% protein) divided into 4 feedings (0600, 1200, 1800, and 2400 hours). Each feed allotment was broadcast in a wide arc over the pond. After 2 weeks the starter mash was replaced with No. 1 salmon starter and the same feeding regime was followed. Fish were harvested 33 days after stocking.

Dissolved oxygen concentration, temperature, and pH were monitored daily. Dissolved oxygen and temperature were measured with a YSI dissolved oxygen meter and pH was measured with a Fisher Accumet pH meter. Air-o-later Corporation 1/3 hp electrical aerators were employed if dissolved oxygen fell below 4.0 mg/liter. The pond was flushed with well water if pH exceeded 9.5.

Phase II Production

After harvest and grading of Phase I fish, hybrid striped bass averaging 0.75 g were stocked on 6 June 1988 into triplicate 0.04-ha ponds at 37,000/ha and 74,100 fish/ha. Also on 6 June 1988, Phase I fingerlings averaging 0.6 g and 1.4 g were transported to the Coastal Aquaculture Unit (CAU) at Gulfport, Miss., and were each stocked into triplicate 0.1-ha ponds at 9,880 fish/ha. Salinity in the CAU ponds averaged 4–5 ppt throughout the culture period.

Fish at both locations were fed daily rations approximately equal to 5% of body weight, with a 38% crude protein sinking trout feed and with appropriate changes in pellet size as the season progressed. Feeding rate was reduced to 3% of body weight on 10 October 1988. Fish samples consisting of at least 10% of each pond population were taken monthly to evaluate growth and adjust feeding schedules. Feed allotments were also adjusted every 2 weeks between monthly samples with a conversion factor of 2.5:1.0. Dissolved oxygen concentration and temperature were measured at least twice daily and pH twice weekly at both CAU and MSUAU. Total ammonia and nitrite were measured twice weekly only at the MSUAU. Ammonia and nitrite levels were measured with a Hach water analysis kit. Ponds were flushed with well water if ph was > 9.5 or unionized ammonia was > 0.4 mg/liter. Fish were harvested 16 November 1988 at the MSUAU and 19–21 November 1988 at the CAU.

Data Analysis

Analysis of variance was used to test for significant ($P < 0.05$) differences among treatments. Analysis of co-variance was used to test for effect of initial weight on final weight. Fisher's Protected Least Significant Difference (LSD) test was used to separate significantly different means when they occurred. Data were analyzed with the Statistical Analysis Systems (SAS) computer package (SAS Inst. Inc. 1988).

Results and Discussion

Phase I Production

There were no significant differences in average weight or survival among the 3 densities of fish stocked (Table 1). However, there was a significant negative relationship ($r^2 = -0.68$) between the actual number of fish harvested and their average weight (based upon 3 subsamples of 100 fish each) at harvest (Fig. 1), suggesting that lower stocking densities may yield larger fingerlings. Temperature, pH, dissolved oxygen, total ammonia, and nitrite averaged, respectively, 25 C (range = 22–29 C), 8.9 (range = 8.1–9.5), 8.1 mg/liter (range = 4.8–12.2 mg/liter), 0.5 mg/liter (range = 0.3–0.6 mg/liter), and 0.01 mg/liter (range = 0.0–0.03 mg/liter). Fish mortalities did not appear to be directly attributable to poor water quality (Brewer and Rees 1990).

Survival and average harvest weights compared favorably with similar densities

Table 1. Harvest weight and survival (mean ± SE) of Phase I hybrid striped bass reared in 0.04-ha ponds at 3 densities. There were no significant ($P > 0.05$) differences for weight or survival among the 3 densities.

Density (fish/ha)	*N*	Weight (g)	Survival (%)
123,500	3	1.2 ± 0.3	57.4 ± 24.9
247,000	3	0.7 ± 0.0	41.2 ± 6.6
370,500	3	0.8 ± 0.1	31.8 ± 0.8

in previous studies (Table 2). Fish that received supplemental feeding were larger at harvest (Fitzmayer et al. 1986, this study) than those that depended entirely upon zooplankton, except when survival was low (Kerby et al. 1985).

Phase II Production

MSU Aquaculture Unit.—Fish stocked at 37,050/ha gained significantly more weight (83.6 g) than fish stocked at 74,100/ha (65.0 g) (Table 3). Because there was no difference in average weight at stocking, increased density resulted in

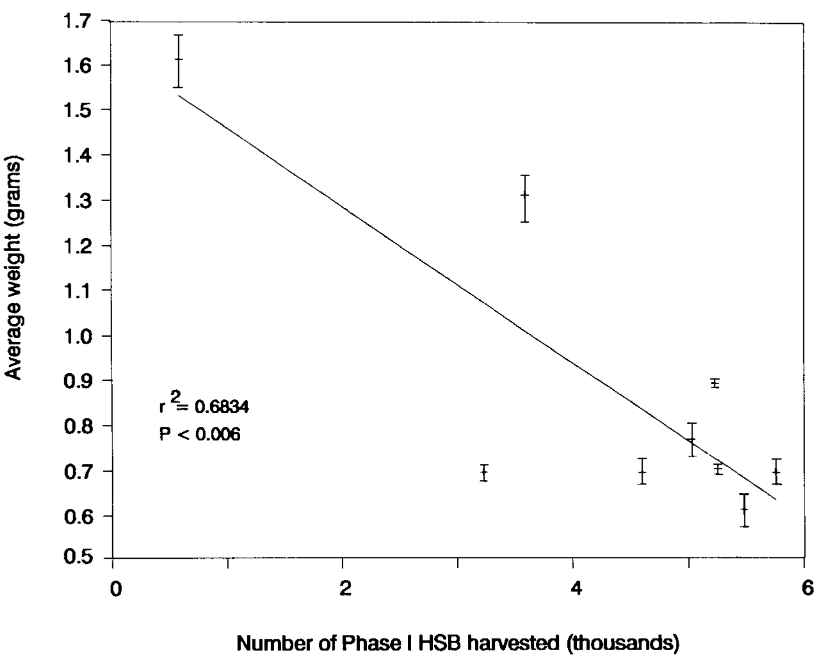

Figure 1. Relationship between average weight (g) and number of Phase I hybrid striped bass (HSB) reared for 33 days in 0.04-ha ponds. Data presented are means ± SE.

Table 2. Stocking density, survival, and final average weight of Phase I striped and hybrid striped bass in recent studies.

Stocking density (*N*/ha)	Survival %	Average weight (g)	Author(s)
1,875,000	29	0.19	Rees and Cook (1983)
247,000	17	0.50	Geiger (1983)
247,000	45	0.26	
371,000	63	0.21	Geiger et al. (1985)
371,000	46	0.17	
371,000	53	1.22	Fitzmayer et al. (1986)
371,000	35	1.25	
500,000	10	1.64	Kerby et al. (1985)
500,000	13	0.22	
123,500	58	1.20	Robinette and Young
247,000	41	0.70	(this study)
370,500	32	0.76	

decreased growth (Fig. 2). There were no significant differences in survival or feed conversion between fish stocked at the 2 densities. Temperature, pH, dissolved oxygen, total ammonia, and nitrite averaged, respectively, 26 C (range = 13–32C), 9.6 (range = 7.7–10.1), 9.9 mg/liter (range = 3.6–19.0 mg/liter), 0.5 mg/liter (range = 0.2–3.0 mg/liter), and 0.02 mg/liter (range = 0–0.1 mg/liter.

Coastal Aquaculture Unit.—After 166 days of growth, there were no significant differences in weight gains (136 g for 0.6-g fry, and 167 g for 1.4-g fry) or feed conversions (Table 3), but survival was significantly less for smaller (80.4%) than for larger fish (102.0%). Initial weight did not have a significant effect on final weight. Temperature, pH, and dissolved oxygen averaged, respectively, 25.5 C (range = 15.5–33.2 C), 8.1 (range = 7.1–8.8), and 7.8 mg/liter (range = 7.0–9.5 mg/liter).

Table 3. Survival, feed conversion, initial weight, and final weight of Phase II hybrid striped bass stocked in fresh and brackish water. Means (± SE) within either fresh water or brackish water followed by different letters are significantly ($P < 0.05$) different.

Stocking density (fish/ha)	Survival (%)	Feed conversion (feet/wt. gain)	Initial $\bar{x}$ weight (g)	Final $\bar{x}$ weight (g)
		Fresh Water		
37,050	59.8 ± 5.1 A	3.32 ± 0.10 A	0.75	83.6 ± 2.0 A
74,100	57.1 ± 2.9 A	3.65 ± 0.22 A	0.75	66.0 ± 1.9 B
		Brackish Water		
9,880	80.4 ± 5.1 A	2.12 ± 0.20 A	0.60	136.0 ± 5.9 A
9,880	102.0 ± 2.8 B	1.89 ± 0.08 A	1.40	167.0 ± 11.3 A

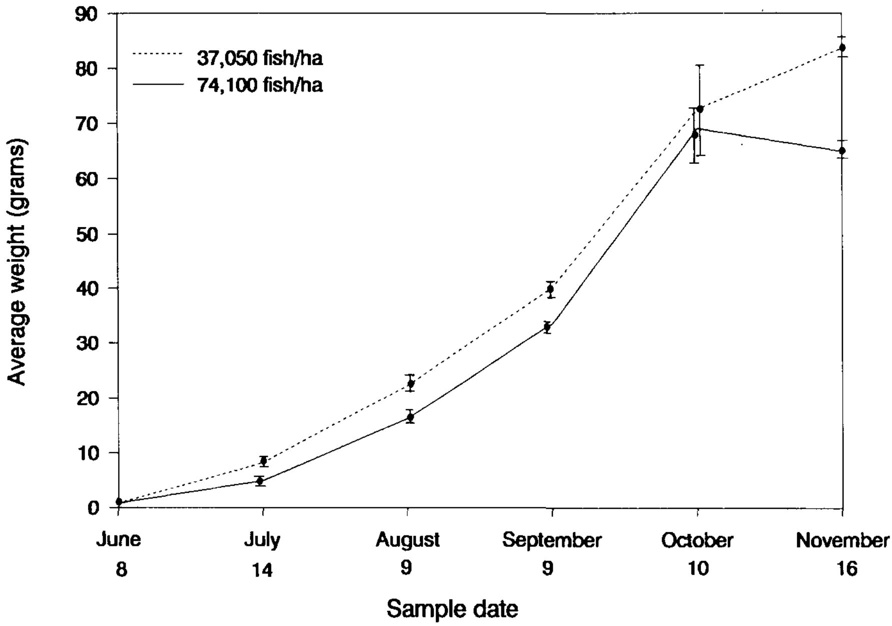

Figure 2. Average weight (g ± SE) of Phase II hybrid striped bass reared in fresh water at 2 densities during June–November 1988.

Average weight at harvest and survival at the lowest density (9,880/ha) were similar to those reported in other studies, considering the length of the culture period (Table 4). However, survival at high densities (freshwater) was lower. Even though we thought mortalities were caused by our monthly sampling, sampling was not discontinued because data to derive a growth curve were needed. It should be noted that South Carolina hybrid striped bass research was conducted in brackish water (at 4 ppt, Jenkins et al. 1988), whereas North Carolina research was conducted in hard fresh water (Kerby et al. 1983).

Based upon previous experience with high hybrid striped bass mortalities, we suspected that fish at the MSUAU suffered from osmoregulatory stress after handling in water with a total alkalinity of about 100 mg/liter as $CaCO_3$. Though this alkalinity does not seem low, about 85% of the alkalinity anions are associated with sodium rather than with the more desirable calcium ion. Hodson and Hayes (1989) suggested that high levels of calcium may be important for good culture conditions. Additional observations suggest that hybrid striped bass generally grow faster in brackish water (Brewer and Rees 1990). Despite having been stocked at a smaller size, fish reared in brackish water at the CAU grew to the same or to a larger size than those reared in fresh water (MSUAU, unpubl. data) at the same density (Fig. 3). Calcium concentrations at the CAU and the MSUAU were >200 and <20 mg/liter, respec-

Table 4. A comparison of final weight and survival in relation to stocking density, duration of culture period, and initial weight from recent Phase II hybrid striped bass studies.

Stocking density (N/ha)	Period (month)	Initial $\bar{x}$ weight (g)	Final $\bar{x}$ weight (g)	Survival (%)	Author(s)
16,500	6	5.20	167.9	84.7	Kerby et al. (1987)
5,000	10	1.40	116.2	88.1	Jenkins et al. (1988)
10,000–37,500	9–10	1.40–1.7	179.0	90.8	
37,050	5	0.75	83.6	59.8	Robinette and Young (this study)
74,100	5	0.75	65.0	57.1	
9,880	5	0.60	136.0	80.4	
9,880	5	1.40	167.0	102.0	

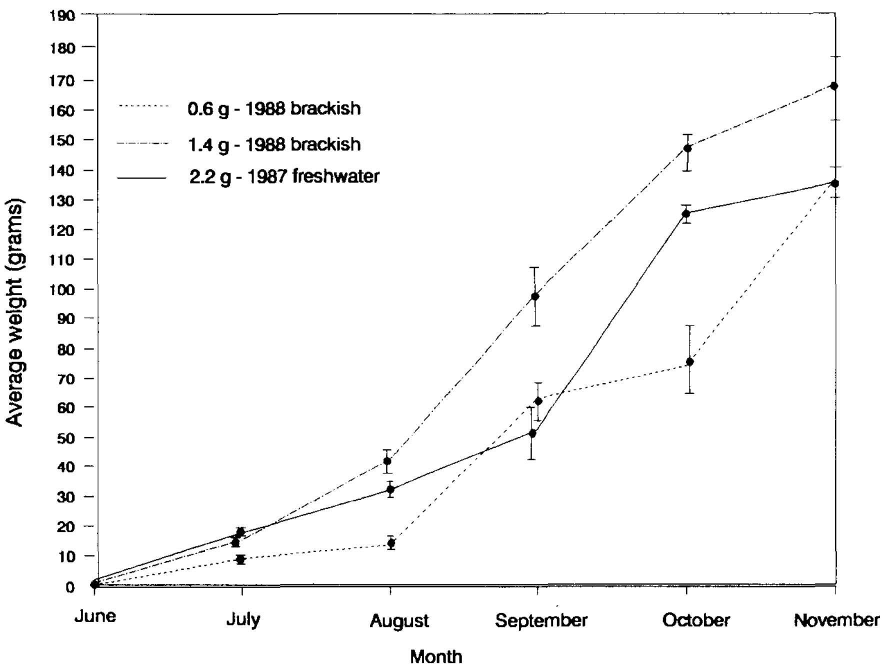

Figure 3. Growth of 3 sizes of Phase II hybrid striped bass stocked at 9,880/ha in brackish (CAU, Gulfport, Miss.) and fresh (MSUAU, Starkville, Miss.) water.

tively. At the CAU, temperature averaged 2–3 C higher in June–September and 5–6 C higher in October–November. The CAU culture period was 15 days longer.

This study indicates that the production of Phase I and II original cross hybrid striped bass in Mississippi may be feasible, particularly in brackish waters. However, more research is required to elucidate the relationship between desirable characteristics of fresh water and brackish water hybrid striped bass production.

Literature Cited

Brewer, D. L. and R. A. Rees. 1990. Pond culture of phase I striped bass fingerlings. Pages 99–120 *in* R. M. Harrell et al., eds. Culture and propagation of striped bass and its hybrids. Am. Fish. Soc., Bethesda, Md.

Fitzmayer, K. M., J. I. Broach, and R. D. Estes. 1986. Effects of supplemental feeding on growth, production, and feeding habits of striped bass in ponds. Prog. Fish-Cult. 48:18–24.

Geiger, J. G. 1983. Zooplankton production and manipulation in striped bass rearing ponds. Aquaculture 35: 331–351.

———, C. J. Turner, K. Fitzmayer, and W. C. Nichols 1985. Feeding habits of larval and fingerling striped bass and zooplankton dynamics in fertilized rearing ponds. Prog. Fish-Cult. 47: 213–223.

Hodson, R. G. and H. Hayes. 1989. Hybrid striped bass pond production of foodfish. SRAC publication No. 303. So. Reg. Aquacul. Ctr. Stoneville, Miss. 2pp.

Jenkins, W. E., T. I. J. Smith, A. D. Stockes, and R. A. Smiley. 1988. Effect of stocking density on production of advanced juvenile hybrid striped bass. Proc. Annu. Conf. Southeast. Assoc. Fish and Wildl. Agencies 42:56–65.

Kerby, J. H., L. C. Woods, III, and M. T. Huish. 1983. Pond culture of striped bass × white bass hybrids. J. World Maricult. Soc. 14:613–623.

———, J. D. Bayless, and R. M. Harrell. 1985. Growth, survival and harvest of striped bass produced with cryopreserved spermatazoa. Trans. Am. Fish. Soc. 114:761–765.

———, J. M. Hinshaw, and M. T. Huish. 1987. Increased growth and production of striped bass × white bass hybrids in earthen ponds. J. World Aquacult. Soc. 18:35–43.

Mississippi Cooperative Extension Service. 1989. For fish farmers. Ref. 89–1. Miss. State Univ. 10pp.

Rees, R. A. and S. F. Cook. 1983. Evaluation of optimum stocking rate of striped bass × white bass fry in hatchery rearing ponds. Proc. Annu. Conf. Southeast. Assoc. Fish and Wildl. Agencies 37:257–266.

SAS Institute Inc. 1988. SAS/STAT User's Guide, Release 6.03 Edition. SAS Inst. Cary, N.C. 1,028pp.

Smith, T. I. J. and W. E. Jenkins. 1985. Aquaculture research with striped bass and its hybrids in South Carolina. Proc. Annu. Conf. Southeast. Assoc. Fish and Wildl. Agencies 39:217–227.

———, ———, and J. F. Snevel. 1985. Production characteristics of striped bass (*Morone saxatilis*) and F1, F2 hybrids (*M. saxatilis* and *M. chrysops*) reared in intensive tank systems. J. World Maricul. Soc. 16:57–70.

———, ———, A. D. Stokes, and R. A. Smiley. 1989. Semi-intensive pond production of market-size striped bass (*Morone saxatilis*) × white bass (*M. chrysops*) hybrids. World Aquacult. 20: 81–83.