Hatchery Performance and Reuse of Domesticated White Bass Broodstock

Theodore I. J. Smith, *Marine Resources Research Institute, South Carolina Department of Natural Resources, P.O. Box 12559, Charleston, SC 29422-2559*

Wallace E. Jenkins, *Marine Resources Research Institute, South Carolina Department of Natural Resources, P.O. Box 12559, Charleston, SC 29422-2559*

Louis D. Heyward, *Marine Resources Research Institute, South Carolina Department of Natural Resources, P.O. Box 12559, Charleston, SC 29422-2559*

Abstract: White bass (*Morone chrysops*) were reared to maturity and spawned in 2 consecutive years to evaluate their hatchery performance and potential for reuse. Egg production and hatching could not be statistically compared between 2- and 3-year-old fish due to estimation of size data and pooling of hatch data in 1994. Three-year-old virgin females had a mean production of 81,413 larvae/kg body weight and an egg hatching level of 62.9%. No statistical differences ($P \leq 0.05$) in latency, egg and fry production, or hatching were detected between 3-year-old virgin and previously strip-spawned fish. Hatchery performance data for domesticated white bass were similar or greater than the information available on similar-size wild white bass. Our results suggest that domesticated white bass may be a suitable substitute for wild fish currently used in hatchery operations.

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The white bass is an important recreational and commercial species. In addition, the hybrids produced from crossing white bass with striped bass (*M. saxatilis*) are stocked in public waters throughout the United States (Whitehurst and Stevens 1990) and are also the focus of an aquaculture industry (Hodson and Smith 1988). Farming hybrid striped bass is a relatively new industry with production of food fish in the United States estimated to be 3.9 million kg in 1995 (J. Carlberg, unpubl. rep., World Aquacult. Soc., San Diego, Calif. 1995). The industry is developing throughout the nation (Rhodes and Sheehan 1991, Smith and Jenkins 1996) as the hybrids are hardy, eurythermal, and display heterosis (Kerby 1986). In mid-Atlantic and southern states, hybrids are typically reared in outdoor ponds where food-size fish (0.5–1.0 kg) can be produced in about 20–22 months under ambient temperatures (Smith et al. 1992). Intensive tank systems have been developed to maintain optimum temperatures and produce marketable fish in 9–14 months. Currently, such systems located in California, Mississippi, and Massachusetts provide the major portion of the food fish marketed in the United States.

Due to development of controlled production systems, there is now year-round demand for hybrid striped bass fingerlings to restock harvested tanks. In recent years, researchers have characterized the reproductive system of striped bass (Berlinsky and Specker 1991, Woods and Sullivan 1993) and white bass (Kohler et al. 1994, Berlinsky et al. 1995) and new spawning techniques have been developed (Hodson and Sullivan 1993, Woods and Sullivan 1993). In addition, photothermal control of the spawning cycle has been demonstrated for hybrids and both wild parents (Smith and Jenkins 1984, 1986; Henderson-Arzapalo and Colura 1987; Blythe et al. 1994; Kohler et al. 1994). There has also been substantial success in developing domesticated striped bass (Smith and Jenkins 1986, Woods and Sullivan 1993, Hodson and Sullivan 1993) and white bass (Smith et al. 1996) broodstocks.

Production of sexually mature domesticated white bass of both sexes and striped bass males requires 2 years, while female striped bass require a minimum of 3–4 years to reach reproductive age (Smith and Jenkins 1986, Smith et al. 1996). Thus, from an aquaculture perspective, domesticated broodstocks are costly to produce and maintain and their hatchery suitability needs to be demonstrated.

This manuscript documents the hatchery performance and repeated spawning of domesticated white bass broodstock. Hatchery data are provided on the spawning of 2- and 3-year-old virgin fish as well as 3-year-old white bass which had been previously treated with hormones and strip spawned.

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Methods

Three female and 6 male wild white bass were conditioned in an outdoor tank (Smith and Jenkins 1985*a*,*b*) and spawned on 11 April 1992. The 3-day-old fry were stocked in a pond at the Waddell Mariculture Center in Bluffton, South Carolina, and reared to fingerling size using methods similar to those described for striped bass (Bonn et al. 1976). After 9 weeks, small juveniles, mean weight 5.9 g, were harvested from the pond and transferred to 1.9-m diameter (1.8-m³) indoor tanks at the Marine Resources Research Institute, Charleston, where they were trained to accept a pelleted feed (trout diet, 38% protein, Zeigler Brothers, Inc., Gardners, PA). After 2 weeks, these fish (mean weight 11.6 g) were moved to an outdoor, 42.3-m³ tank where they were reared to adult size (Smith et al. 1996). These tank-cultured white bass were mature in March 1993 at 2 years of age. These white bass were used when 2 and 3 years old in various hatchery trials in 1994 and 1995.

Fish were selected for spawning based on their stage of maturity. A 2.3-mm o.d. plastic catheter was used to remove a sample of eggs from the genital pore. Females containing eggs $\geq$550 microns in diameter and $>$15-hour stage (Bonn et al. 1976) were considered suitable. Males which expressed milt when their abdomen was gently compressed were considered mature. All fish were injected intramuscularly with human chorionic gonadotropin (HCG) (Chorulon®, Intervet Inc., Millsboro, DE) at a rate of 550 IU/kg body weight. After hormonal treatment, males and females were placed in separate 1.9- $\times$ 0.8-m black fiberglass tanks which received flow-through well water (0 ppt salinity). Females were regularly inspected to determine time of ovulation after injection (= latency period) and then strip spawned. Normally, 2–3 males were stripped to provide milt for fertilizing each group of eggs using the wet fertilization method (Rees and Harrell 1990). After strip spawning, volume of eggs was determined in a beaker. Number of eggs was estimated based on previous sample counts (N = 5) of number of white bass eggs contained in 1-ml samples. Egg adhesion was prevented by vigorously aerating the eggs in a 7-minute bath of tannic acid at a concentration of 150 mg/liter (Rottmann et al. 1988). Eggs from each female were incubated in separate MacDonald jars. Due to hatchery limitations in 1994, hatches of fry from several females were concurrently collected in 113-liter aquaria. Thus, only mean hatch and fry production data were available for the white bass spawned in 1994. In 1995, fry from each female were collected in separate 38-liter aquaria. Numbers of live fry were estimated volumetrically 24 hours after hatching. Estimates were based on mean counts of fry in 4 75-ml composite water samples. Eight random vertical water samples were taken with a plastic 18-mm o.d. tube and combined to establish the composite 75-ml samples.

Fish were weighed to the nearest 45 g during the first trial in 1994 and during both trials in 1995. However, for the second trial in 1994, fish weight was estimated to be 454 g based on the previous sample of fish. This was done to reduce stress as these fish had been handled 3 weeks previously. During this hatchery trial, all white bass received the same amount of HCG (250 IU/fish). After hatchery use, all fish received a dorsally implanted passive integrated transponder (PIT) tag (Biosonics, Inc., Seattle, WA). This electronic tag allowed identification of individual fish during subsequent hatchery use.

Several data sets were collected on performance of the domesticated white bass. In 1994, 2-year-old virgin fish were spawned on 7 March and 28 March. In 1995, 2 spawning trials were conducted using the 3-year-old fish. In the first spawning trial, virgin fish (control) were spawned 14 March concurrently with fish that were spawned the previous year to compare performance. On 21 March 1995 another spawning trial was conducted using virgin × virgin fish (control), and previously-spawned × virgin fish to collect additional hatchery performance data. Unfortunately, due to a limited number of available females for this trial, only 2 previously-spawned female × virgin male spawns could be produced. In these 1995 trials, a virgin female was defined as a female which had not been hormonally injected and striped spawned the previous year at 2 years of age. However, these females were mature at 2 years of age and therefore their eggs had been reabsorbed, aborted and/or tank spawned.

Water quality at initiation, during and at completion of each hatchery trial was monitored. Measured parameters included water temperature, dissolved oxygen, pH, ammonia, nitrite, nitrate, carbon dioxide, alkalinity and iron.

Hatchery data (size of females, eggs/kg, fry/kg, and hatch rate) were analyzed using Student's *t*-test or analysis of variance (ANOVA) at $P \leq 0.05$ after confirmation of homogeneity of variances and normality. Hatch data (percentages) were normalized using arcsin transformation prior to statistical analyses. Latency data were compared using the Kruskal-Wallis one-way ANOVA on ranks ($P \leq 0.05$). All statistical analyses were performed by computer using SigmaSTAT (1992). In 1994, statistical analyses were limited due to the estimation of size data and/or pooling of hatch data.

Results

In general, the various water quality parameters appeared similar and no mortalities associated with water quality were observed. However, during the first hatchery trial in 1994, carbon dioxide levels became elevated (61 mg/liter) and may have impacted hatching success. Mean (range) values recorded during the 4 hatchery trials were: temperature (C) — 19.1 (18.3–19.6); dissolved oxygen (mg/liter) — 7.6 (6.2–8.8); pH — 7.7 (7.4–8.0); ammonia (mg/liter) — 0.4 (0.0–1.2); nitrite (mg/liter) — 0.2 (0.1–0.5); nitrate (mg/liter) — 4.5 (2.3–6.7); carbon dioxide (mg/liter) — 14.8 (8.4–25.0); alkalinity (mg/liter) — 99 (81–133); and iron (mg/liter) — 0.3 (0.0–0.8).

Two-Year-Old Virgin Fish

Latency period was statistically different between the 2 trials (Table 1). Based on estimated and pooled data, mean egg production was 98,273/kg. During the second trial, mean hatch rate was 23.0.%.

Three-Year-Old Virgin and Previously-Spawned Fish

In 1995, the first spawning trial provided data on the performance of virgin and previously-strip spawned white bass that were 3 years old (Table 2). Individual size of females ranged from 0.27 to 0.73 kg with mean size of the previously-spawned females significantly larger than the virgin females (0.47 kg vs. 0.39

Table 1. Mean hatchery data (SD) for 2-year-old domesticated white bass. Column values with different letters are statistically different ($P < 0.05$).

Treatment date	Females *N*	Females Wt. (kg)	Latency (hours)	Eggs/kg	Fry/kg[a]	Hatch[a] (%)
7 Mar 1994	9	0.38	35.3 (1.7)A	80,522 (39,426)	11,434	14.2[b]
28 Mar 1994	10	0.45[c]	33.1 (1.2)B	114,249 (30,538)	26,277	23.0

[a]Values are based on pooled hatches. [b]High CO_2 levels may have affected hatching. [c]Weight of females estimated.

kg). No differences were detected between latency period, number of eggs, fry produced, or hatching success (Table 2).

In the second trial, when gametes from virgin and previously strip-spawned white bass were cross fertilized and compared to a virgin × virgin cross (control), no differences were detected between mean size of the females, latency period, egg and fry production, or hatching success (Table 3).

Discussion

Strip-spawning of white bass is an art which can result in variable results. Indeed, the latency period in *Morone* spp. varies according to individual maturation stage and response to the hormone (Stevens 1967). If eggs are taken too early, low numbers of eggs are obtained and fertility is low. If the fish is stripped too late, many eggs will be obtained but they will be overripe. Thus, hatchery data often has high variances (e.g., see SD's in Tables 1–3).

Our results indicate that 3-year-old virgin and previously-spawned white bass perform similarly. Thus, proper handling techniques during hatchery operations and suitable husbandry techniques during recovery and maturation can provide fish for spawning in successive years. Use of HCG does not appear to cause any lasting impact on repeated spawnings.

Egg production of the domesticated white bass was greater than that reported from similar-size wild white bass spawned at the Frankfort Hatchery, Kentucky (84,300 eggs/kg for 0.5-kg females) (Grizzle et al. 1995), but similar to the 0.3–0.6-kg wild fish spawned in Illinois (Kohler et al. 1994). Estimated hatch from the domesticated 2-year-old white bass was generally similar to that reported by Kohler et al. (1994) for 3 different groups of photothermally controlled wild fish (mean 14.5%, 24.6%, and 29.5%). However, hatching success of our 3-year-old fish was superior (mean hatch 54.6%) to these wild fish.

Supply of wild white bass and the quality of their gametes are controlled by nature. As a result, in some years hatchery operations may be interrupted or halted due to lack of suitable broodstock. Our findings indicate that hatchery performance of domesticated white bass was similar or better than that of wild white bass of a similar size. Thus, cultured white bass can be used to supplement or replace the need for annual collections of wild fish to sustain hatchery opera-

Table 2. Mean hatchery data (SD) for virgin (V) and previously-spawned (PS) 3-year-old domesticated white bass. Column values with different letters are statistically different ($P < 0.05$).

	Females					
Treatment	*N*	Wt. (kg)	Latency (hours)	Eggs/kg	Fry/kg	Hatch (%)
V	11	0.39 (0.09)A	37.1 (2.7)A	135,372 (27,238)A	93,813 (33,018)A	69.3 (20.5)A
PS	12	0.47 (0.09)B	35.3 (2.2)A	113,876 (36,848)A	62,643 (44,641)A	51.5 (20.4)A

Table 3. Mean hatchery data (SD) for 3-year-old virgin (V) and virgin × previously-spawned (PS) domesticated white bass. Column values with different letters are statistically different ($P < 0.05$).

	Females					
Treatment	*N*	Wt. (kg)	Latency (hours)	Eggs/kg	Fry/kg	Hatch (%)
V♀ × V♂	5	0.32 (0.05)A	36.6 (0.9)A	111,158 (14,700)A	54,134 (43,494)A	48.7 (33.9)A
V♀ × PS♂	5	0.34 (0.05)A	36.8 (1.5)A	129,849 (35,618)A	62,398 (49,435)A	42.9 (30.5)A
PS♀ × V♂	2	0.34 (0.04)A	36.0 (7.1)A	123,711 (66,828)A	47,653 (24,016)A	39.0 (1.6)A

tions. Availability of domesticated white bass should allow fishery mangers and aquaculturists more flexibility in scheduling hatchery operations and also improve the predictability in their hatchery production. Further, when placed in photothermal control systems synchronized with striped bass, near continuous production of hybrid bass fry can be accomplished to supply the growing aquaculture industry.

White bass are hardy and can readily be produced in captivity (Smith et al. 1996). In addition, they can be reared in brackish water (Heyward et al. 1995) which offers flexibility in parasite control and site selection of production facilities.

Our results support the use of cultured white bass for public and private hatchery operations producing hybrid striped bass. Further, availability of cultured white bass allows expanded research activities including genetic manipulation and selection studies as well as comparison of performance of different strains.

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