Efficacy of Human Chorionic Gonadotropin for Spawning Striped Bass and White Bass

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Abstract: Human chorionic gonadotropin (HCG) is often used to induce spawning of fish. However, the U.S. Food and Drug Administration has not approved HCG for use in fish because they claim additional efficacy data are required. Efficacy of HCG for spawning striped bass (*Morone saxatilis*) and white bass (*M. chrysops*) was evaluated at 15 hatcheries in 10 states. For strip spawning of females, a single dose of HCG was effective for 90.2% of striped bass (N = 428) and 89.4% of white bass (N = 660). After strip spawning, hatching rates were 39.5% for striped bass and 26.1% for white bass. Of 90 striped bass and 70 white bass females injected with saline, none ovulated. Milt was obtained from all striped bass males (N = 325) and from 98.8% of white bass (N = 862) males injected with HCG. Of 47 striped bass and 24 white bass males injected with saline as controls for the stripping technique, only 63.8% of striped bass and 37.5% of white bass produced milt. In tank spawning of striped bass, there were 87 tanks containing 1–2 females/tank and 1–4 males/tank. The HCG-injected fish spawned in every tank, and the hatching rate was 30.1%. There were 7 tanks with saline-injected striped bass; fish in only 1 tank spawned. Results demonstrated HCG was effective for inducing spawning of striped bass and white bass.

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Stocking of striped bass has increased dramatically in large impoundments since the late 1950s when a reproducing population of land-locked striped bass in Santee-Cooper Reservoir in South Carolina was discovered (Stevens 1957). Early attempts to establish striped bass populations in freshwater im-

poundments were hampered by the lack of sufficient numbers of striped bass for stocking. Artificial propagation of striped bass usually failed because of the difficulty of collecting females with ovulated eggs (Stevens and Fuller 1962).

Production of large numbers of striped bass became possible after Stevens (1964, 1966) demonstrated an injection of human chorionic gonadotropin (HCG) induced ovulation in striped bass. During the spawning seasons from 1962 through 1964, Stevens (1964, 1966) tested 7 hormones, alone and in various combinations, for their ability to induce striped bass ovulation. These hormones were HCG, follicle stimulating hormone, pituitary luteinizing hormone, thyroid stimulating hormone, estrogen preparations, testosterone, and extract of fish pituitary. The HCG yielded the most satisfactory results because it acted rapidly with a single dose and was less expensive (Stevens and Fuller 1962). The recommended dose of HCG was 280 international units (IU)/kg of fish; levels in excess of this produced no evident advantage (Stevens 1966).

Two techniques are used to spawn striped bass in hatcheries: stripping and tank spawning. Strip spawning involves stripping eggs and milt from fish and allows hybridization of striped bass and white bass. The tank method, developed by Bishop (1974), allows the fish to spawn while undisturbed in a circular tank.

Bishop (1967) used HCG to produce hybrids between female striped bass and male white bass (palmetto bass) in 1965. These hybrids have been widely stocked in freshwater impoundments as sport fish and a predator for gizzard shad (*Dorosoma cepedianum*) (Whitehurst and Stevens 1990). More recently, sunshine bass (female white bass x male striped bass) have also been stocked (Ware 1974).

Striped bass and its hybrids are produced by federal and state hatcheries for stocking in reservoirs and estuaries in the United States. Injection of HCG is used at these hatcheries to induce ovulation and enhance milt production of striped bass and white bass (Rees and Harrell 1990). However, HCG is not approved by the U.S. Food and Drug Administration (FDA) for use in fish, and the FDA indicated additional efficacy data were required for approval of HCG (S. D. Vaughn, pers. commun.).

The objective of this study was to document the efficacy of HCG for spawning striped bass and white bass. Both spawning success and percentage of eggs that hatched were considered. Field trials were conducted at 15 hatcheries using strip-spawning and tank-spawning techniques suitable for practical production of striped bass, white bass, or hybrids of these species.

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Methods

Studies were conducted at 15 hatcheries located in 10 southeastern states (Table 1). Among these hatcheries, 2 spawned fish in tanks, 11 used the strip-spawning technique, and 2 used both tank- and strip-spawning techniques. Water temperatures during this study were 17–21 C.

The brand of HCG used was Chorulon® (Intervet Inc., Millsboro, Del.), and the saline injected into controls was the diluent for Chorulon®. Each vial of Chorulon® contained 10,000 IU lyophilized HCG and was dissolved in diluent before use.

Striped bass and white bass from rivers, reservoirs, and ponds (Table 1) were captured by electrofishing and nets. Approximately 10% of the fish were used as controls, which were randomly chosen from those fish designated as eligible for HCG injection. The intramuscular doses of HCG were 139–617 IU/kg fish for striped bass and 165–1,526 IU/kg for white bass. The large range of doses was related primarily to variation in the dose preferred at the various hatcheries. Each control fish was injected intramuscularly with a volume of sterile saline equal to the volume received by the HCG-injected fish.

For strip spawning, eggs and milt were manually stripped from fish, and then water was added and stirred for 2–3 minutes to insure adequate mixing

Table 1. Investigator and broodfish source for hatcheries in a field trial of HCG for spawning striped bass and white bass.

Hatchery	Investigator	Broodfish source
Marion, Ala.	W. C. Nichols	Smith Lake, Coosa River
Andrew Hulsey, Ark.	T. K. Penniston	Lake Ouachita, Lake Hamilton
Blackwater Center, Fla.	D. M. Yeager	Flint River, Ochlockonee River, Lake Talquin, Apalachicola River
Richloam, Fla.	C. C. Starling	Nassau River, St. Mary's River, St. John's River, Lake Talquin, Ochlockonee River, Apalachicola River
Richmond Hill, Ga.	R. A. Rees	Lake Russell, Ogeechee River, Lake Lanier
Frankfort, Ky.	M. S. Larimore	Ohio River, Cumberland River, Green River
Watha, N.C.	J. Evans	Gaston Reservoir, Dan River
Bayless, S.C.	T. A. Curtis	Santee River, Cooper River
Marine Resource, S.C.	W. E. Jenkins	Culture ponds, tanks
Eagle Bend, Tenn.	J. M. Smith	Clinch River, Holston River
A.E. Wood, Texas	H. J. Warren	Lake Livingston (Trinity River)
Dundee, Texas	H. J. Warren	Lake Livingston (Trinity River), Lake Texoma (Red River)
Possum Kingdom, Texas	H. J. Warren	Lake Livingston (Trinity River), Lake Texoma (Red River), Lake Inks (Colorado River)
Brookneal, Va.	S. Arthur	Staunton (Roanoke) River
King & Queen, Va.	F. Tanner	Pamunkey River

(Rees and Harrell 1990). The water in the pan was decanted and eggs were put in incubation chambers to hatch. The number of eggs obtained and number of eggs hatched were determined as described by Rees and Harrell (1990). Efficacy of HCG was based on ovulation (eggs flowed when the fish was stripped) for females and milt production for males. The total number of fish injected was used for calculation of percentage of fish producing gametes; fish dying after injection were included in the number injected.

For tank spawning, fish were injected with HCG or saline, placed in tanks, and observed for spawning (Smith and Whitehurst 1990). Spawning success was calculated with each tank as the experimental unit.

Results and Discussion

Strip spawning of female striped bass for production of striped bass or palmetto bass was successful for 90.2% of the 428 fish injected with a single dose of HCG (Table 2). After injection of HCG, 19 female striped bass died, and spawning success was 94.4% if these fish are not included. At 13 hatcheries using this method, success ranged from 74.1% to 100%. The number of eggs produced per kg fish ranged from 65,700 to 173,300 and the mean was 103,575.

Table 2. Strip spawning of female striped bass injected with HCG.

Hatchery	*N*	Weight[a] (kg)	Dosage (IU/kg)	Spawn (%)	Eggs/kg (× 1,000)	Hatch (%)
Marion, Ala.	34	6.7	335	82.4	68.9	38.1
	4	4.1	control	0	0	0
Andrew Hulsey, Ark.	32	5.4	276	84.4	N/A[b]	N/A[b]
	4	5.4	control	0	0	0
Blackwater Center, Fla.	6	11.1	320	83.3	87.4	33.7
Richloam, Fla.	20	5.6	375	75.0	65.7	46.5
	3	5.8	control	0	0	0
Richmond Hill, Ga.	23	8.0	331	91.3	108.0	54.2
	4	7.7	control	0	0	0
Frankfort, Ky.	5	6.8	439	80.0	107.2	25.2
	1	4.2	control	0	0	0
Watha, N.C.	36	5.0	322	94.4	173.3	25.8
	3	4.2	control	0	0	0
Bayless, S.C.	56	8.4	335	91.1	124.8	27.2
	12	8.2	control	0	0	0
Marine Resource, S.C.	27	6.5	551	74.1	115.4	13.9
Eagle Bend, Tenn.	6	3.9	353	100	145.7	61.6
A.E Wood, Texas	22	7.2	335	90.9	101.7	17.5
	3	6.7	control	0	0	0
Dundee, Texas	113	7.2	335	97.3	78.3	44.8
	47	6.5	control	0	0	0
Possum Kingdom, Texas	48	6.4	340	93.8	66.5	83.3
	9	6.5	control	0	0	0

[a]Average weight per fish. [b]Data not available.

There was a 39.5% hatching rate. The range for hatching percentage was 13.9%–83.3%. Of 90 striped bass females injected with saline, none ovulated.

A total of 325 striped bass males were injected with HCG for the strip-spawning technique (Table 3). Of these, all produced milt. There were 47 striped bass males used as controls for the strip-spawning technique and 63.8% produced milt.

In tank-spawning trials, 157 female (1–2 per tank) and 336 male striped bass (1–4 per tank) were released into 87 tanks after receiving an injection of HCG (Table 4). The hormone injection induced fish to spawn in every tank and the hatching rates averaged 30.1%. An average of 126,480 eggs and 38,070 larvae were produced per kilogram of female fish. Of 13 female and 21 male striped bass injected with saline and released into 7 tanks, spawning occurred in only 1 tank within 96 hours, and the hatching rate was 2.6%.

Among 660 female white bass injected with HCG for strip spawning, 89.4% ovulated (Table 5). After injection of HCG, 6 females died, and spawning success was 90.2% if these fish are not included. The number of eggs produced per kg fish ranged from 49,200 to 482,100 with a mean of 234,300. The range for hatching percentage was 7.5–27.7% and the average was 26.1%. None of the 73 saline-injected control females ovulated.

Male white bass were injected with a single dose of HCG to enhance sperm production. Of the 862 fish injected with HCG, 98.8% produced milt, and the range of successful strip spawning was 94.8%-100% (Table 6). Twenty-four males were used as controls; only 9 produced milt.

The latent period between injection and spawning depends on the stage of gametogenesis of individual fish and individual variation in response to HCG (Stevens 1964). Time between injection of HCG and spawning during the present study ranged from 24 to 72 hours for most fish.

Table 3. Strip spawning of male striped bass injected with HCG.

Hatchery	*N*	Weight[a] (kg)	Dosage (IU/kg)	Milt (%)
Marion, Ala.	35	5.8	161	100
Andrew Hulsey, Ark.	8	4.4	139	100
	2	4.5	control	100
Blackwater Center, Fla.	11	4.9	160	100
Richloam, Fla.	14	1.1	617	100
	16	1.2	control	62.5
Richmond Hill, Ga.	85	2.0	165	100
	12	2.0	control	0
Watha, N.C.	104	1.4	170	100
	9	1.3	control	100
A.E. Wood, Texas	24	6.0	170	100
	2	4.5	control	100
Dundee, Texas	44	6.4	176	100
	6	6.8	control	100

[a]Average weight per fish.

Table 4. Tank spawning of striped bass injected with HCG.

Hatchery	Tanks used	Females			Males			Spawn[b] (%)	Eggs/kg (× 1,000)	Hatch (%)
		N	Weight[a] (kg)	Dosage (IU/kg)	*N*	Weight (kg)	Dosage (IU/kg)			
Eagle Bend, Tenn.	7	7	10.9	320	7	8.8	200	100	180.5	81.3
	1	1	8.2	control	1	6.8	control	0	0	0
Brookneal, Va.	69	135	7.3	320	280	2.3	179	100	122.3	25.6
	6	12	7.3	control	20	2.3	control	16.7	22.0	2.6
King and Queen, Va.	11	15	8.6	238	49	2.5	187	100	N/A[c]	N/A[c]

[a]Average weight per fish. [b]Percentage of tanks with eggs. [c]Data not available.

Table 5. Strip spawning of female white bass injected with HCG.

Hatchery	*N*	Weight[a] (kg)	Dosage (IU/kg)	Spawn (%)	Eggs/kg (× 1,000)	Hatch (%)
Blackwater Center, Fla.	7	1.3	1,080	100	482.1	7.5
	2	0.4	control	0	0	0
Richloam, Fla.	41	0.8	518	85.4	285.9	25.1
	7	0.8	control	0	0	0
Richmond Hill, Ga.	444	0.6	331	95.5	266.0	27.7
	50	0.6	control	0	0	0
Frankfort, Ky.	62	0.5	1,000	45.2	147.5	25.6
	11	0.5	control	0	0	0
Watha, N.C.	17	0.8	216	76.5	88.2	9.9
	3	0.3	control	0	0	0
Marine Resource, S.C.	89	0.5	551	94.4	49.2	25.8

[a]Average weight per fish.

Table 6. Strip spawning of male white bass injected with HCG.

Hatchery	*N*	Weight[a] (kg)	Dosage (IU/kg)	Spawn (%)
Marion, Ala.	121	0.5	168	100
Andrew Hulsey, Ark.	53	0.4	368	100
Blackwater Center, Fla.	11	0.5	412	100
Richloam, Fla.	54	0.3	1,526	100
Richmond Hill, Ga.	150	0.5	165	100
	15	0.5	control	20
Frankfort, Ky.	63	0.4	222	100
	6	0.4	control	100
Watha, N.C.	29	0.5	683	100
	3	0.5	control	0
Bayless, S.C.	68	0.2	542	100
Marine Resource, S.C.	212	0.4	551	94.8
Eagle Bend, Tenn.	18	0.4	833	100
Dundee, Texas	38	0.5	201	100
Possum Kingdom, Texas	45	0.5	201	100

[a]Average weight per fish.

Statistical comparisons of spawning success at different hatcheries were not made because of differences such as broodfish origin and stage of gametogenesis when fish were collected. However, the effect of HCG on inducing ovulation was obvious in this field trial. One dose of HCG induced ovulation in almost all female striped bass and white bass, while none of the controls ovulated. Although some of the control males produced milt, HCG increased the percentage of males producing milt, and some of the investigators found HCG injection made the milt easier to extract without harming the fish and improved mixing with eggs. For males not injected with HCG, no change in milt viscosity was noticed during the 96-hour observation period.

In experiments with HCG to induce ovulation of striped bass, Stevens

(1966) and Bishop (1974) achieved excellent results (Table 7), and eggs from HCG-injected fish had a 53.3%–63.6% hatching rate. Tatum et al. (1965) had 11.1% spawning success in 1 experiment but only 3.5% of the eggs hatched. The unfavorable hatching rate was attributed to the inexperience of hatchery personnel or the quality of broodfish (Tatum et al. 1965). Another trial by Tatum et al. (1965) had a hatching rate of 55.7%. In an experiment by Smith et al. (1966), 243 female striped bass were injected with HCG. Among these, 125 fish ovulated and produced eggs with a hatching rate of 21%. Regan et al. (1968) injected 61 female striped bass with HCG to produce striped bass or palmetto bass. The spawning success was 57.4% (26 fish died before spawning), and the hatching rate was 6.8%–26.3% for striped bass and 6.5%–12.0% for palmetto bass.

All previously published trials of HCG for strip spawning *Morone* spp. involved injection of only females, compared to the current procedure at most hatcheries of injecting both males and females. In the present study, spawning success was similar to that reported by Stevens (1966) and Bishop (1974), but the average hatching rates for all hatcheries from both strip spawning and tank spawning were slightly lower. The relatively large variation in hatching rate was probably related to the diverse origin of broodfish and the stage of gametogenesis when collected.

Doses of HCG varied widely among the hatcheries participating in the present study. The relatively high doses of HCG used at some hatcheries did not appear to be detrimental to spawning success or egg hatchability. It is likely the minimum dose of HCG required depends on the readiness of fish to spawn. Additional experiments are necessary to determine if low doses (335 IU/kg for females and 170 IU/kg for males) are satisfactory in all geographical areas where *Morone* spp. are spawned.

Table 7. Comparison of studies with striped bass to determine the efficacy of HCG for strip spawning females or for tank spawning.

Spawning technique	N[a]	HCG dose (IU/kg)	Spawn (%)	Hatching (%)	Reference
Strip	69	280	95.7	63.6	Stevens (1966)[b]
Strip	78	414	89.7	59.4	Stevens (1966)[b]
Strip	25	2,000[c]	N/A[d]	55.7	Tatum et al. (1965)
Strip	99	2,000[c]	11.1	3.5	Tatum et al. (1965)
Strip	243	278–371	51.4[e]	21.0	Smith et al. (1966)
Strip	61	678	57.4[e]	9.2	Regan et al. (1968)
Tank	17	293–412	100.0	53.3	Bishop (1974)
Strip	428	276–551	90.2	39.5	Present study
Tank	87	320–328	100.0	31.4	Present study

[a]In strip spawning, N is number of fish; in tank spawning, N is number of tanks.
[b]Results were for the doses having the best spawning and hatching percentage.
[c]Dose was 2,000 IU/fish.
[d]Data not available.
[e]Spawning success was reduced because a large percentage of HCG-injected fish died prior to spawning.

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