

Predaceous insect control is partially accomplished by not filling the ponds until just prior to stocking. Further control is achieved by "oiling" the ponds within a week after stocking, and then a second application is applied 2 weeks later, or as necessary. Earlier pond filling will require the oiling schedule to be adjusted accordingly. Saran bags placed over the filling pipes will also help prevent larger organisms and fish from entering the ponds.

ACKNOWLEDGEMENT

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PROGRESS WITH *MORONE* HYBRIDS IN FRESH WATER

by

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ABSTRACT

A brief history of developments with *Morone* hybrids is given. Two of these fishes have shown potential as a supplemental sport fish for fresh water lakes and reservoirs.

The original hybrid, white bass male X striped bass female, has provided substantial fisheries in the Southeast. Compared to striped bass, greater returns to sport fishermen, faster early growth, and higher survival has been documented. The threat of backcross deformities appears minimal at this time.

The reciprocal hybrid, striped bass male X white bass female, was successfully cultured in 1973. Early findings have been encouraging, but data is incomplete for conclusive evaluation. First year growth varied between 12 and 14 inches, while average weights were higher than for striped bass of similar sizes. In general appearance, this hybrid resembles white bass.

Life history aspects and culture methods for hybrid production are discussed.

INTRODUCTION

Hybridization of fishes in the *Morone* genus began in 1965 following the breakthrough for artificial spawning striped bass, *Morone saxatilis* (Stevens, 1965). Motivation for these experiments was provided by the relatively slow development of

striped bass fisheries in many southeastern reservoirs. The quest for a large, pelagic predator to utilize the abundant gizzard shad, *Dorosoma cepedianum*, plus having the capability of natural reproduction, was the foremost objective for many of the early programs (Stevens, 1969; Bayless, 1972).

The first successful cross was accomplished by Stevens in 1965, by fertilizing striped bass eggs with sperm from white bass, *M. chrysops* (Stevens, 1965). Three separate crops of fry were produced that year. Bishop (1967), who was cooperating with Stevens at the time, experienced excellent survival with these hybrids after stocking a pothole adjacent to Cherokee Reservoir in Tennessee. From an initial release of 35,000 fry in the spring, over 5,000 juveniles measuring to 8.4 inches were recovered the following fall. Additional hybrid stockings in Cherokee Reservoir during subsequent years produced a very successful fishery.

EARLY DEVELOPMENTS

The initial success with Cherokee hybrids stimulated other experiments to follow. In 1966, North Carolina produced original hybrid fry plus the first successful cross of the male white perch, *M. americanus*, with a female striped bass. Working together, Kentucky and Virginia produced a hybrid using yellow bass, *M. interrupta*, sperm to fertilize striped bass eggs. Bayless (1967) also produced the reciprocal cross of the original hybrid using striped bass sperm to fertilize white bass eggs.

Since these early experiments, many other crosses have been attempted involving F₂'s of the original hybrid, original backcrosses, reciprocal backcrosses, etc. A detailed discussion of these efforts is provided by Bayless (1972) and will not receive further attention in this paper, other than to point out that some of the offspring showed a high incidence of deformity.

Most State and Federal hatcheries lost interest in hybrid production after 1968. Perhaps this was due to the threat of deformed backcrosses occurring in the wild or more probably from the increased availability of striped bass fingerlings. Nevertheless, South Carolina maintained their research program and Tennessee continued working with the Cherokee Reservoir population, while other researchers turned exclusively to striped bass. This was unfortunate in many respects because the original hybrid (w.b.M. X s.b.F.) was the only cross tested under field conditions. Progeny of other hybrids either perished as fry or were produced in such small numbers that little additional knowledge was gained other than taxonomic information.

In 1972, Florida began a critical review of their striped bass program. Several populations were established at that time, but the resultant sport fisheries were disappointing (Ware, 1974). After investigating the progress with hybrids in South Carolina and Tennessee a similar program was planned in Florida. Concern over backcross deformities was not a problem here, as *Morone* fishes were not endemic to Florida lakes. Texas was also interested in hybrids, and through a cooperative program 150,000 original hybrid fry were produced that spring.

After our initial success with original hybrids, efforts were made in 1973 to produce the reciprocal cross (striped bass male X white bass female). According to Bayless (1972), previous attempts to culture this fish were unsuccessful, chiefly due to its small size at hatching and lack of available food. By following his guide lines and through careful preparation of rearing ponds, several thousand fingerlings were produced that spring.

The Florida reciprocals were introduced into two small lakes and a series of controlled pond experiments. Preliminary results from these tests were impressive when compared to striped bass, especially for growth and survival. Therefore, production was increased during 1974 to 125,000 fingerlings to provide fish for a large scale stocking program.

The remainder of this paper will be devoted to updating progress with the original hybrid and presenting available information on the reciprocal hybrid. Unfortunately, data on the reciprocal is limited to its first year of life, which is insufficient for a complete evaluation.

ORIGINAL HYBRID (White Bass Male X Striped Bass Female)

Bishop (1967) provides a good account of the early success with this fish in Tennessee. Subsequent work in South Carolina supported his findings and demonstrated faster growth and better survival, when compared to striped bass (Logan, 1967; Williams, 1970). Fry stockings were also effective for establishing hybrid fisheries (Bayless, 1972). In general, several characteristics of the hybrid as a fresh water introduction have been found superior to striped bass, including hatchery production, survival, early growth, and sport fishery developments. When the two fishes are considered on the basis of investment versus return to sportsmen, it is difficult to understand how the hybrid can be ignored.

Production and Survival

Methods for the artificial propagation of hybrids were described by Stevens (1966) and Bayless (1967, 1972). Essentially, the same techniques used for striped bass are followed with these notable exceptions:

- 1) "Wet" fertilization is recommended to negate the effects of urine activation of spermatozoa. When stripping, white bass excrete urine that apparently activates spermatozoa. Since sperm life is short, sperm, eggs, and water should be mixed simultaneously to assure satisfactory fertilization.

- 2) Sperm production is usually much lower in white bass, therefore, three to five males should be used during the fertilization process.

- 3) Hatching time is a few hours longer for hybrid fry.

Survival of hybrid fry has been consistently higher than for striper fry in hatchery experiments. Logan (1967) reported a mean survival of 18.2% for hybrids compared to a mean survival of 7.5% for striped bass in fingerling rearing tests. In Florida, rearing success with striped bass fingerlings has varied between 5% and 30% over the past four years. Ponds giving 20% survival or higher, from fry to fingerling, were considered good. By contrast, hybrid survival under similar conditions ranged between 15.5% and 61.3%. The mean survival for seven ponds was 30.8% (Ware, 1974).

Bishop (1967) gives further evidence of higher survival in both pond and reservoir fry stockings. Using equal numbers of fry in a pond test hybrid survival after six months was 60%, compared to 4.5% for striped bass. Testing fry for reservoir stocking during 1965, he introduced 35,000 hybrid fry and 3,500,000 striper fry into Cherokee Lake. Fishermen catches during the next year favored the hybrid by a ratio of 80 to 1.

Growth

There is considerable evidence demonstrating better growth for hybrids during the first 18 months to 2 years of life when compared to striped bass. Bishop (1967) reported 1-year-old hybrids measuring between 9 and 14 inches (TL). By 23 months they ranged from 16.8 inches to 19.3 inches, weighing up to 4.8 pounds. Not until 27 months of age were striped bass of equal size to hybrids.

Growth data from South Carolina was similar (Williams, 1970). At 30 months of age hybrids measured between 18 inches and 21.6 inches, weighing up to 5.7 pounds. Stevens (1957) calculated the average length of 2-year-old stripers in Santee-Cooper Reservoir at 15.7 inches.

In Florida, mean lengths for striped bass at age-I and age-II were given at 11.1 inches and 18.1 inches, respectively (Ware, 1970). Hybrids grew to an average length of 14.3 inches at age-I (n=66) and 17.6 inches at age-II (n=23).

Growth potential for the hybrid has not been determined. According to findings in Tennessee, hybrids have reached a size of 6 to 7 pounds in three years, and older fish weighing up to 9 pounds were common. Larger specimens occurred infrequently and a 5-½ year old specimen weighing 14 pounds 12 ounces was the previous record. This year an 18 pound hybrid was taken from Norris Reservoir. The fish was in its 8th or 9th year of life based on stocking records (R. D. Bishop, personal communication).

Food Habits

Studies from established populations have shown clupeid fishes to be the principal forage of hybrids (Bishop, 1967; Williams, 1970). Examination of 226 hybrid stomachs from Florida's Lake Gibson population supported these findings. Small shad, mostly threadfin, *Dorosoma petenense*, comprised the bulk of the diet occurring in 69.5% of the stomachs. Other foods of minor importance included silversides (4.4%), darters (2.2%) and insect larvae (4.4%). Florida hybrids examined measured between 6 and 20 inches (F. J. Ware, unpublished data).

Bayless (1972) suggested that successful hybrid fisheries may be dependant on shad forage. This is a generally accepted criteria for successful striped bass introductions in fresh water. However, recent findings in Tennessee indicate that shad may not be an essential requirement. Juvenile hybrids stocked into an 8 acre bass-bluegill pond reached a size of 8 pounds within four years. Another hybrid population was sustained on carp and goldfish (R. D. Bishop, personal communication).

Natural Reproduction and Backcrosses

Bayless (1967) and Bishop (1967) suggested serious problems with reservoir populations if hybrid reproduction or backcrossing resulted in stunting or deformities. Laboratory experiments indicated the problem was significant.

After seven years, the Cherokee population has shown no measurable effect from this problem. Although hybrid spawning has been observed, only four specimens have been recovered that were possibly F2 hybrids (R. D. Bishop, personal communication).

Similarly, Bayless (personal communication) has repeated his F1 backcross experiments producing normal progeny. He reported that his earlier deformities with this hybrid were probably related to environmental stress, rather than genetic factors.

Sport Fisheries

In practically every instance where striped bass and hybrids have been compared for sport fishery production, the hybrid has proven superior. The original stocking in Cherokee Lake, Tennessee has already been mentioned. Subsequent fishery developments in that reservoir were supported largely by hybrids until 1973, although hybrid stocking was discontinued in 1970. Creel estimates during 1972-73, the first year of higher striper returns, reported a catch of 3,819 hybrids weighing 25,554 pounds, compared to 4,589 stripers weighing 49,743 pounds (R. D. Bishop, personal communication).

In another Tennessee reservoir, Norris Lake, a substantial fishery for hybrids resulted from two years of stocking in 1966-67, including the new record fish of 18 pounds. A recent gill net survey showed a significant hybrid population still in existence some six years later. For comparison, the capture of hybrids approximated 25% of the white bass catch and white bass were the most abundant predator within the population (R. D. Bishop, personal communication).

In South Carolina, Bayless (personal communication) has reported similar findings. Where both fish were introduced into the same lake, hybrids rather than stripers have provided a greater return to sport fishermen.

Further evidence of sport fishery benefits were documented in Florida. Creel results for the 1973-74 winter fishery (3 months) in three central Florida lakes were as follows:

<i>Lake</i>	<i>Estimated Catch</i>	<i>Stocking Records</i>
Julianna (900 acres)	29 striped bass	20/acre for 4 consecutive years
Hunter (100 acres)	60 striped bass	15/acre for 4 consecutive years
Gibson (500 acres)	329 hybrids	15/acre for 2 consecutive years

It should be pointed out that the hybrid fishery was supported by only one year-class. Recruitment of the second stocking had not reached the 15-inch minimum size limit at the time of the survey.

RECIPROCAL HYBRID (Striped Bass Male X White Bass Female)

The reciprocal was successfully cultured for the first time at Florida's Richloam Fish Hatchery in March, 1973. In appearance, this hybrid resembles the white bass more than stripers. Lateral stripes are less prominent than for striped bass and are usually continuous above and broken below the lateral line. Body depth is also greater than for stripers. Meristic characters taken from 5 juveniles were as follows:

Lateral line scale count: 50 - 54
 Scales above lateral line: 9 - 10
 Scales below lateral line: 13 - 14
 Dorsal fin: IX - 1, 11 or 12
 Anal fin: III - 11
 Pectoral fin: 14
 Pelvic fin: 0 - 5

The only distinguishing character separating reciprocals from parental or original hybrid characteristics appears to be scale rows below the lateral line; being intermediate to the other fishes.

Production and Survival

Bayless (1972) provided an excellent description of spawning techniques and development of fertilized eggs and larvae. His failure to produce fingerlings in three separate attempts was apparently related to food supply. The following procedures were used for production of reciprocal hybrids in Florida's program:

1) Methods given by Bayless (1972) for artificial spawning were followed. Human Chorionic Gonadotropin administered to white bass females at the rate of 500 I. U. to 1,000 I. U. per pound provided good results. Ovulation usually occurred between 28 and 40 hours after hormone injection.

2) Eggs were "dry" fertilized (eggs and sperm mixed prior to the addition of water) and dispersed in aquaria at a rate of 100,000 eggs to 20 gallons of water. Higher egg concentrations resulted in excessive mortality and encouraged fungus problems. The adhesive qualities of white bass eggs causes clumping and poor distribution if crowded.

3) Water outlets from aquaria were screened with brine shrimp netting or similar mesh to avoid fry losses.

4) Fry were stocked into rearing ponds at five days of age. Pond water temperatures varied between 60° F. and 75° F.

5) Rearing ponds were filled between 3 to 5 days in advance of fry stocking.

6) Organic fertilizer (hay and alfalfa pellets) was applied at the rate of 800 pounds per acre when filling ponds.

7) Fingerlings were harvested between 40 to 50 days after fry stocking.

Rearing success with reciprocal hybrids was substantially higher than for striped bass. Utilizing six ponds during 1974, survival from fry to fingerling averaged 46% (Ware 1974).

Comparative tests for survival and growth were performed in two 0.25 acre hatchery ponds. Each pond was stocked with equal numbers (30) of fingerling reciprocals and stripers of approximately equal size. Ponds were fed daily with ground shad. The experiment was terminated after 8 months with the following results:

Table 1. Survival and growth of reciprocal hybrids and stripers compared in two hatchery ponds. (8 month experiment)

	<i>Reciprocals</i>		<i>Stripers</i>	
	<i>Range</i>	<i>Mean</i>	<i>Range</i>	<i>Mean</i>
No. Stocked	30	30	30	30
No. Recovered	21-23	22	7-13	10
Percent Survival	70% - 76.6%	73.3%	23.3% - 43.3%	33.3%
Total Length (mm)	309 - 370	341.2	216 - 338	258.4
Weight (grams)	346 - 778	562.3	106 - 338	188.3

Another example of survival was demonstrated by gill net sampling a 40 acre lake stocked with 500 fingerlings. The first overnight sample taken with a 50 yard net captured 20% of the population stocked, a total number of 102 hybrids.

Growth

Reciprocals have exhibited fast growth during early life. At four months of age the dominant size-class was 6 to 7 inches (TL) and some fish measured 8 inches. As illustrated in the pond experiment, early growth was superior to striped bass.

At one year of age, reciprocals measured between 12 and 13 inches (TL) and growth appeared to be very uniform within respective populations. However, some variation was observed between populations. One group showed a mean length of 12.1 inches (n=24) at age-1. A second lake population averaged 13 inches (n=6). In the hatchery experiment, average length was 13.4 inches at 10 months of age. The largest year-old specimen measured 14.5 inches and weighed 1.7 pounds.

Due to greater body depth, reciprocals weigh heavier than striped bass for a given size-class. Comparatively, reciprocal hybrids weigh approximately one pound at 13 inches (TL). Whereas, striped bass weighing one pound will measure 14 inches or greater.

Food Habits

Food habits were determined from the examination of 225 stomachs taken from three separate populations. These data showed that reciprocal hybrids fed heavily on shad, but possibly were not as shad dependent as striped bass.

The population established in Crystal Lake fed on threadfin shad extensively, which was the dominant forage fish in the lake. Shad remains occurred in 75% of the stomachs containing food (n=58). Conversely, another population in Lake Parker fed exclusively on juvenile blue tilapia, *Tilapia aurea*, during early summer. This exotic cichlid was selected over shad, which was also present in the lake, but in lower numbers. Utilization of blue tilapia as food represented the first significant occurrence of spiny-rayed fishes in the diet of Florida hybrids or stripers in inland lakes (n=84).

A third population was established in a 3 acre pond containing a forage base of redear sunfish, gambusia, and crayfish. Growth and survival during the first year was comparable to lake populations.

Sport Fisheries

Sufficient time has not elapsed to evaluate this important aspect of the reciprocal hybrid. Although numerous catches have been reported, Florida law requires a minimum size limit of 15 inches for possession.

During hatchery pond experiments various fishing techniques were tested. Reciprocals were found to be vigorous strikers and strong fighters, worthy of gamefish classification. They were caught on many types of artificial lures including top-water plugs, minnow-type plugs, spinners, spoons, and popping bugs. Using surface lures produced the most exciting fishing. Frequently, hybrids would jump completely out of the water to take the plug. Palatability of the hybrid was rated good.

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AN EVALUATION OF STRIPED BASS INTRODUCTIONS IN THE SOUTHEASTERN UNITED STATES

by

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ABSTRACT

Striped bass have been introduced into many inland waters of the southeastern states in an effort to establish a fishery, and to provide a biological control for clupeoid fishes. The Striped Bass Committee of the Southern Division, American Fisheries Society compiled information on the success of past introductions in 1970 and again in 1973. The information collected by the Committee is used to illustrate the successes and failures of introductions of fry, fingerlings, and adult fishes. Variables, other than size of fish at the time of stocking, were tabulated and analyzed to determine their significance in the success of introductions.