Suspected Natural Hybridization of Striped Bass and White Bass in Two Arkansas Reservoirs

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Abstract: In 1981, hybrid striped bass (*Morone saxatilis* x *Morone chrysops*) appeared in Lake Maumelle and Beaver Lake, Arkansas, both which had only been stocked with striped bass (*Morone saxatilis*). Therefore, it was suspected that natural hybridization might have occurred between striped bass and native populations of white bass (*Morone chrysops*). Scale sample analysis revealed that the hybrid striped bass collected from Lake Maumelle were from 1978 and 1979 year classes. Hybrids from the 1979 year class were collected from Beaver Lake. Review of historical stocking data did not reveal any potential errors in which hybrid striped bass might have been stocked in place of striped bass. Meristic counts and measurements of collected fish indicated that significant ($P < 0.05$) morphological differences existed between striped bass and hybrid striped bass (4 measurements) and also between white bass and hybrid striped bass (1 measurement). The observed meristic characteristics of the hybrid striped bass conformed to those of reciprocal hybrid striped bass (*M. chrysops* ♀ x *M. saxatilis* ♂), which would theoreti-

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cally be the fish most likely produced in the wild in Lake Maumelle and Beaver Lake.

Electrophoretic analysis revealed that all striped bass and white bass in the sample were pure species representatives. Further examination revealed that all hybrid striped bass collected had genotypes consistent with F_1 hybrids. This determination eliminated certain possible hatchery errors which could have occurred. No determination could be made electrophoretically as to whether the hybrid striped bass were original or reciprocal hybrids. Historical rainfall data indicated that the 1978 year class of hybrid striped bass occurred during a year of "normal" spring precipitation. However, both 1979 year classes occurred during a year of extremely high rainfall in the Lake Maumelle and Beaver Lake watersheds.

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Striped bass (*Morone saxatilis*) have been stocked in inland waters throughout the southeastern states since the late 1950s in an effort to create a desirable sport fishery (Bailey 1974). However, these fisheries did not succeed until Stevens (1965) devised a method for the artificial spawning of striped bass. Hybridization of fishes in the *Morone* genus began in 1965 following this breakthrough (Ware 1974). The original objectives of the hybridization program were to produce a fish with the desirable characteristics of the parent species, i.e., retain the size, longevity, food habits, fighting ability, and food quality from the striped bass, while acquiring environmental adaptability from the white bass (*Morone chrysops*) (Bonn et al. 1976). Subsequently, original hybrid striped bass (*M. saxatilis* ♀ x *M. chrysops* ♂) were produced and stocked in various waters throughout the southeastern states.

While striped bass have been stocked in waters containing established populations of white bass, natural hybridization between these 2 species has not been documented (Setzler et al. 1980). It was believed that limited natural hybridization occurred in Cherokee Reservoir and Norris Reservoir in Tennessee during the late 1970s (Dave Bishop and Kirby Cottrell, pers. commun., Tenn. Wildl. Resour. Agency, Nashville) and in Clayton Lake in Virginia (David Whitehurst, pers. commun., Va. Comm. Game and Inland Fish., Richmond), although data to substantiate this does not exist. This study documents 2 instances of possible natural hybridization between striped bass and white bass in Arkansas.

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Case History

In March 1981, 2 large hybrid striped bass (approximately 2 kg in size) were caught in Lake Maumelle, Arkansas, by a sport fisherman. Although not a spectacular feat in itself, the event was perplexing, since the Arkansas Game and Fish Commission had never stocked hybrid striped bass in Lake Maumelle. As the design of the dam forming the lake prevents the ingress of fishes from the Arkansas River, it was assumed that a minor hatchery mix-up had occurred and that a few hybrid striped bass had accidently been stocked with hatchery reared striped bass. However, during the procurement of brood fish for Arkansas' 1981 striped bass spawning program, it became apparent that no minor hatchery mistake could have accounted for the large number of hybrid striped bass netted in Lake Maumelle.

During fall 1981, large numbers of hybrid striped bass also appeared in Beaver Lake which, like Lake Maumelle, had only been stocked with striped bass. Besides having established striped bass populations, Lake Maumelle and Beaver Lake both had large native white bass populations. Consequently, it was hypothesized that natural *Morone* sp. hybridization might have occurred in both lakes.

Methods

Historical records of striped bass and hybrid striped bass production, harvest and stocking from the Joe Hogan State Fish Hatchery (Lonoke, Ark.) were reviewed for possible errors. Shoreline seining and cove rotenone sample data from 1976 to 1982 for Lake Maumelle and Beaver Lake were also reviewed for any evidence of young-of-the-year (yoy) hybrid striped bass. Shoreline seining and rotenone sampling were conducted each year during July and August, respectively, as part of routine district fisheries activities. Five seine hauls approximately 15.0 m in length utilizing a 6.1-m seine and 1 cove rotenone sample of approximately 0.5 ha constituted an annual sample for Lake Maumelle, while 5 seine hauls and 3 cove rotenone samples (5 to 6 ha total) made up an annual sample in Beaver Lake.

Striped bass, hybrid striped bass, and white bass were collected from Lake Maumelle during March and April, 1981 and 1982, and Beaver Lake during November, 1982, to obtain life history data. For comparative purposes, life history data were also obtained for fish from DeGray Lake, where hatchery reared hybrid striped bass had been stocked. Fish were collected by fisheries biologists from the Arkansas Game and Fish Commission and U.S. Fish and Wildlife Service using 91.4-m multifilament gill nets with 7.6-cm^2 or larger bar mesh. Fish were sexed, weighed to the nearest gram, and measured to the nearest millimeter for total length. Scale samples were taken from each fish and aged according to Carlander (1969). Various meristic characters were also determined for the DeGray Lake and Lake Maumelle fish using methodology by Lagler et al. (1962) and Eddy (1974).

Randomly selected specimens of white bass, striped bass and suspected F_1 hybrids were frozen and shipped on dry ice to the Illinois Natural History Survey (Champaign, Ill.) for electrophoretic analysis. Initially, samples of muscle, eye, liver, gill, and stomach tissues were excised from individual white bass and striped bass, homogenized in 2 volumes of 100-mm Tris-HCL, pH 7.0 buffer, centrifuged for 20 minutes at 20,000 x g at 4° C; and the resulting supernatants were used for electrophoretic analysis. Tissue extracts were electrophoresed using vertical starch gel procedures following the methods described by Philipp et al. (1979). The resulting gels were sliced longitudinally and histochemically stained for 16 enzyme systems encoded at 29 loci (Table 1). These analyses were used to determine for each enzyme system the number of loci expressd, the tissue specific pattern of their expression, and those loci at which the 2 species have fixed allelic differences. All of the tentatively identified hybrids were electrophoretically analyzed to determine their genotypes at those enzyme loci for which the 2 species exhibited fixed allelic differences.

To determine the role, if any, that increased rainfall and subsequent higher feeder stream inflow may have had on the suspected hybridization, his-

Table 1. Enzyme systems/genetic loci investigated (Philipp et al. 1979).

Enzyme	Loci	Tissue analyzed	Electrophoretic conditions
1. Alcohol dehydrogenase	Adh-A	Liver	TC
2. Sorbitol dehydrogenase	Sdh-A	Liver	HC
3. α-Glycerolphosphate dehydrogenase	Gpdh-A	Muscle	TC
4. Lactate dehydrogenase	Ldh-A	Muscle	TC
	Ldh-B	Muscle	TC
	Ldh-C	Eye	TC
5. Malate dehydrogenase	Mdh-A	Muscle	TC
	Mdh-B	Muscle	TC
	Mdh-M	Muscle	TC
6. Isocitrate dehydrogenase	Idh-A	Muscle	TC
	Idh-B	Liver	TC
7. 6-Phosphogluconate dehydrogenase	6-Pgdh-A	Liver	TC
8. Superoxide dismutase	Sod-A	Liver	EBT
9. Aspartate aminotransferase	Aat-A	Muscle	TC
	Aat-B	Liver	TC
	Aat-M	Liver	TC
10. Aldolase	Ald-A	Muscle	HC
	Ald-B	Liver	HC
11. Phosphoglucomutase	Pgm-A	Muscle	EBT
12. Creatine kinase	Ck-A	Muscle	EBT
	Ck-B	Eye	EBT
	Ck-C	Stomach	EBT
13. Adenylate kinase	Ak-A	Muscle	HC
	Ak-B	Eye	HC
14. Glucosephosphate isomerase	Gpi-A	Liver	EBT
	Gpi-B	Muscle	EBT
15. Esterase	Est-A	Liver	EBT
	Est-B	Liver	EBT
16. Calcium binding protein	Cbp-A	Muscle	EBT

torical rainfall values were obtained for Lake Maumelle and Beaver Lake from the Little Rock Public Water Works Commission and the U.S. Army Corps of Engineers, respectively.

Results and Discussion

Scale sample analysis indicated that the hybrid striped bass collected from Lake Maumelle were from 1978 and 1979 year classes, while only fish from the 1979 year class were collected from Beaver Lake.

The lengths and weights of hybrid striped bass collected from Lake Maumelle (Table 2) differed little from those of hybrid striped bass collected from Beaver Lake (Table 3). Because of the relatively small sample sizes, no higher statistics were applied to this data.

Comparisons of maximum age and weight data from the Lake Maumelle and Beaver Lake populations with published values indicated growth was similar to the higher values reported (Table 4). McCabe (1981) reported the mean total lengths (TL) and condition factors (KTL) of 3-year-old hybrid striped bass from 4 Texas lakes. The values ranged from 472 to 554 mm

Table 2. Comparison of Lake Maumelle hybrid striped bass mean lengths (Ln), mean weights (Wt), and number captured (*N*) by scale analysis age and year of capture.

	Age:	2		3		4	
Year collected	Data type	Ln (mm)	Wt (kg)	Ln (mm)	Wt (kg)	Ln (mm)	Wt (kg)
1981	Mean	399	1.03	526	2.57		
	Range	394–400	1–1.13	495–559	2.04–3.04		
	N:	4		24		0	
1982	Mean			530	2.40	580	290
	Range			483–571	1.45–3.27	521–610	2.27–3.40
	N:	0		21		14	

Table 3. Comparison of Beaver Lake hybrid striped bass mean lengths (Ln), mean weights (Wt), and number captured (*N*) by scale analysis age and year of capture.

	Age:	2+	2+	3+	3+
Year collected	Data type	Ln (mm)	Wt (kg)	Ln (mm)	Wt (kg)
1981	Mean	493	1.72		
	Range	333–528	0.45–2.45		
	N:	26		0	
1982	Mean			544	2.34
	Range			495–580	2.04–2.61
	N:	0		7	

Table 4. Comparison of maximum reported weights (kg) of hybrid striped bass.

Weight (kg)	Location	Source
2.0	Lake Bastrop (Tex.)	Crandall (1978)
2.4	Cherokee Lake (Tenn.)	Bishop (1967)
2.7	Clark Hill Reservoir (S.C.)	Williams (1970)
2.7–3.2	Various TN Reservoirs	Ware (1974)
3.3	Lake Maumelle (Ark.)	This study
2.5	Beaver Lake (Ark.)	This study

TL and ranged from 1.417 to 1.486 (KTL). The TL for fish from Lake Maumelle and Beaver Lake were 528 mm and 493 mm, respectively. The condition factors (KTL) for the fish from these lakes were 1.693 and 1.435, respectively. Since the Lake Maumelle fish were collected during spring pre-spawning runs when weights were at maximums, and since the Beaver Lake fish were collected during the fall near the end of the growing season, no significance was attributed to the higher condition factor (KTL) of the Lake Maumelle fish.

From 1978 to 1979, Lake Maumelle received 96,686 striped bass fingerlings and Beaver Lake received 300,938 striped bass fingerlings. The possibility of hatchery errors occurring during these stockings seemed plausible, but a review of hatchery production data for 1978 to 1979 did not reveal any potential errors. A mix-up during initial fry stockings was a possibility, but again no indication of such an error exists. During 1978 and 1979, many of the striped bass ponds at the Joe Hogan State Fish Hatchery were stocked in unison with fry received from the South Carolina Department of Wildlife and Marine Resources.

In nature, it would be theoretically possible to obtain either the original or reciprocal hybrid. Only the original hybrid striped bass has been produced and stocked in Arkansas to date. During the spawning run, white bass of both sexes and striped bass males normally arrive simultaneously at the spawning shoals of Lake Maumelle and Beaver Lake. However, the white bass usually have departed prior to the arrival of striped bass females. Therefore, if natural hybridization had occurred, the reciprocal hybrid (white bass ♀ x striped bass ♂) appears to be the most likely cross to have been produced. The adhesive qualities of reciprocal hybrid eggs (Ware 1974) would also have allowed for survival under conditions unsuitable for the survival of original hybrid eggs.

Meristic counts and measurements obtained from Lake Maumelle striped bass, hybrid striped bass, and white bass indicated that mean values were significantly different ($P < 0.05$) for striped bass and hybrid striped bass in the number of scale rows above the lateral line and in the 3 body measurement ratios (Table 5). Mean values for hybrid striped bass and white bass were significantly different ($P < 0.05$) in the head length divided by second anal spine ratio.

Table 5. Ranges and means of meristic characters for *Morone* sp. in Lake Maumelle, Arkansas.

Species	Sample size	Scale rows above lateral line	Scale rows below lateral line	Lateral line scale count	Front dorsal fin count	Back dorsal fin count	Anal fin count
Striped bass	20	8–11 (10)[a]	12–15 (14)	54–61 (58)	VIII–IX; 0 (IX–0)	I; 11–14 (1; 13)	III; 9–12 (III; II)
Hybrid striped bass	28	8–10 (9)	12–14 (13)	52–59 (56)	VIII–IX; 0 (IX–0)	I; 13–14 (1; 13)	III; 9–13 (III; II)
White bass	5	9	13	56–57 (56)	IX–0	I; 13–14 (1; 14)	III; 11–12 (III; II)

Species	Sample size	Pectoral fin count	Pelvic fin count	Head length divided by 2nd anal spine	2nd anal spine divided by 3rd anal spine	Fork length divided by body depth
Striped bass	20	13–16 (15)	1–5	6.25–10.99 (8.2)	0.50–0.80 (6.0)	2.92–4.30 (3.6)
Hybrid striped bass	28	14–16 (15)	1–5	3.85–6.30 (4.98)	0.60–0.95 (0.81)	2.87–3.30 (3.09)
White bass	5	15	1–5	3.77–4.30 (3.93)	0.75–0.90 (0.83)	2.89–4.05 (3.36)

[a] Figures in parenthesis are means.

Table 6. Ranges and means of meristic characters for original and reciprocal striped bass x white bass hybrids.

Species and citation	Sample size	Scale rows above lateral line	Scale rows below lateral line	Lateral line scale count	Front dorsal fin count	Back dorsal fin count	Anal fin count
Hybrid striped bass Present study Lake Maumelle	28	8–10 (9)[a]	12–14 (13)	52–59 (56)	VIII–IX; 0 (IX–0)	1; 13–14 (1; 13)	III; 9–13 (III; II)
Original hybrid striped bass Present study DeGray Lake	6	10	11–13 (12)	53–57 (56)	VIII–IX (IX)	I; 11–12 (I; 11)	III; 10–11 (III–11)

Species and citation	Sample size	Pectoral fin count	Pelvic fin count	Head length divided by 2nd anal spine	2nd anal spine divided by 3rd anal spine	Fork length divided by body depth
Hybrid striped bass Present study Lake Maumelle	28	14–16 (15)	1–5	3.85–6.30 (4.98)	0.60–0.95 (0.81)	2.87–3.30 (3.09)
Original hybrid striped bass Present study DeGray Lake	6	1	1–5	4.70–6.38 (5.60)	0.67–0.85 (0.77)	3.26–3.74 (3.48)

[a] Figures in parenthesis are means.

Table 6. Continued

Species and citation	Sample size	Scale rows above lateral line	Scale rows below lateral line	Lateral line scale count	Front dorsal fin count	Back dorsal fin count	Anal fin count
Original hybrid striped bass	?	10–12 (10)[a]	15–17 (16)	54–58 (56)		1; 12–14	?; 12–13
Bayless, 1972							
Reciprocal hybrid striped bass	5	9–10	13–14	50–54	IX–0	I; 11 or 12	III; 11
Ware, 1974							

Species and citation	Sample size	Pectoral fin count	Pelvic fin count	Head length divided by 2nd anal spine	2nd anal spine divided by 3rd anal spine	Fork length divided by body depth
Original hybrid striped bass				3.4–4.03 (4.01)	0.89–0.96 (0.92)	2.6–3.4 (2.7)
Bayless, 1972						
Reciprocal hybrid striped bass		14	1–5			
Ware, 1974						

[a] Figures in parenthesis are means.

Ranges and means of meristic characters for original or reciprocal hybrid striped bass from the present study and from the literature (Bayless 1972, Ware 1974) are listed in Table 6. Ware (1974) stated that the only distinguishing character which separated reciprocals from parental or original hybrid characteristics appeared to be scale rows below the lateral line. While the range and mean values for scale rows below the lateral line of Lake Maumelle hybrid striped bass (Table 6) appeared to conform to these respective values for reciprocal hybrid striped bass (Ware 1974), it was also evident (Tables 5, 6) that the same conformity appeared between Lake Maumelle striped bass, Lake Maumelle white bass, or DeGray Lake original hybrid striped bass and the reciprocal hybrid striped bass (Ware 1974). Although perplexing, these conformities and some meristic differences between various hybrid striped bass populations (Table 6) might be explained by the indiscriminate use of various striped bass stocks (i.e. Gulf Coast vs. Atlantic Coast stock) in striped bass production facilities. Also, the observed meristic variation could be resultant to the use of larger fish in this study, versus the use of fingerling fish by Ware (1974). Comparisons of mean values for hybrid striped bass from Lake Maumelle and DeGray Lake (original hybrid) were significantly different ($P < 0.05$) only for the fork length divided by body depth ratio (Table 6).

Allele frequencies at 29 loci for the groups of striped bass, white bass and hybrid striped bass are shown in Table 7. Electrophoretic analysis of the striped bass and white bass revealed that all individuals were pure species representatives, and that the 2 species were fixed for electrophoretically distinguished alleles at 5 loci (Sod-A, Est-A, Est-B, Gpi-B, and Cbp-A).

In addition, electrophoretic analysis of 1978 year class hybrid striped bass from Lake Maumelle and 1979 year class hybrid striped bass from Lake Maumelle and Beaver Lake revealed that the genotypes of all specimens were consistent F_1 hybrids. The F_1 determination eliminated certain potential hatchery errors, such as the possibility that a hybrid striped bass male was inadvertently used as a striped bass male during the fertilization of striped bass eggs. The electrophoretic results also indicated that, at least to date, there has been no detectable back crossing occurring in the wild. Electrophoretic analysis could not, however, determine whether the F_1 hybrids were original hybrids or reciprocal hybrids.

Rainfall values for March, April, and May from 1976 to 1981 for the Lake Maumelle area (Fig. 1) and the Beaver Lake area (Fig. 2) were plotted to determine if above average rainfall and resultant high feeder stream inflows into Maumelle Lake and Beaver Lake might have been related to the appearance of hybrid striped bass in these lakes.

The 1978 year class of hybrid striped bass in Lake Maumelle occurred during a year of "normal" rainfall values. However, in 1979 when hybrid striped bass occurred in both Lake Maumelle and Beaver Lake, rainfall values for both areas were extremely high. This could be an indication that increased

Table 7. Allele frequencies of striped bass, white bass, and F_1 hybrids at the 29 loci analyzed.

Locus Allele Striped bass ($N = 14$) F_1 hybrid ($N = 13$) White bass ($N = 16$)

Locus	Allele	Striped bass ($N = 14$)	F_1 hybrid ($N = 13$)	White bass ($N = 16$)
1. Adh-A	A^1	1.000	1.000	1.000
2. Sdh-A	A^1	1.000	1.000	1.000
3. Gpdh-A	A^1	1.000	1.000	1.000
4. Ldh-A	A^1	1.000	1.000	1.000
5. Ldh-B	B^1	1.000	1.000	1.000
6. Ldh-C	C^1	1.000	1.000	1.000
7. Mdh-A	A^1	1.000	1.000	1.000
8. Mdh-B	B^1	1.000	1.000	1.000
9. Mdh-M	M^1	1.000	1.000	1.000
10. Idh	A^1	1.000	1.000	1.000
11. Idh-B	B^1	1.000	1.000	1.000
12. 6-Pgdh-A	A^1	1.000	1.000	1.000
13. Sod-A	A^1	1.000	0.500	0.000
	A^2	0.000	0.500	1.000
14. Aat-A	A^1	1.000	1.000	1.000
15. Aat-B	B^1	1.000	1.000	1.000
16. Aat-M	M^1	1.000	1.000	1.000
17. Ald-A	A^1	1.000	1.000	1.000
18. Ald-B	B^1	1.000	1.000	1.000
19. Pgm-A	A^1	1.000	1.000	1.000
20. Ck-A	A^1	1.000	1.000	1.000
21. Ck-B	B^1	1.000	1.000	1.000
22. Ck-C	C^1	1.000	1.000	1.000
23. Ak-A	A^1	1.000	1.000	1.000
24. Ak-B	B^1	1.000	1.000	1.000
25. Gpi-A	A^1	1.000	1.000	1.000
26. Gpi-B	B^1	0.000	0.500	1.000
	B^2	1.000	0.500	0.000
27. Est-A	A^1	0.000	0.500	1.000
	A^2	1.000	0.500	0.000
28. Est-B	B^1	0.000	0.500	1.000
	B^2	1.000	0.500	0.000
29. Cbp-A	A^1	0.000	0.500	1.000
	A^2	1.000	0.500	0.000

rainfall and subsequent higher inflow may have had some effect on the suspect hybridization.

A review of shoreline seining and rotenone sampling data from 1976 to 1982 for Lake Maumelle and Beaver Lake did not reveal any recorded yoy ($\leqslant$152 mm) striped bass hybrids. However, yoy ($\leqslant$152 mm) white bass were recorded during rotenone samples in Lake Maumelle during 1979 and 1981 and in Beaver Lake from 1976 through 1981 (Table 8). However, as identification of small hybrid striped bass is difficult under field conditions and since small fish tend to decompose rapidly during warm weather cove rotenone samples, misidentification of hybrid striped bass yoy could feasibly have oc-

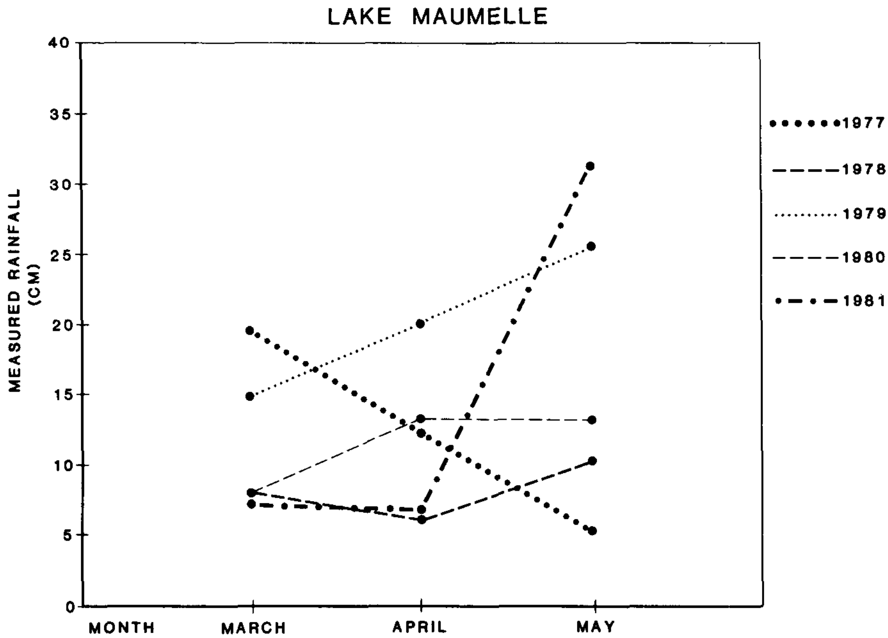

Figure 1. Measured rainfall for Lake Maumelle, Arkansas (1976–1981).

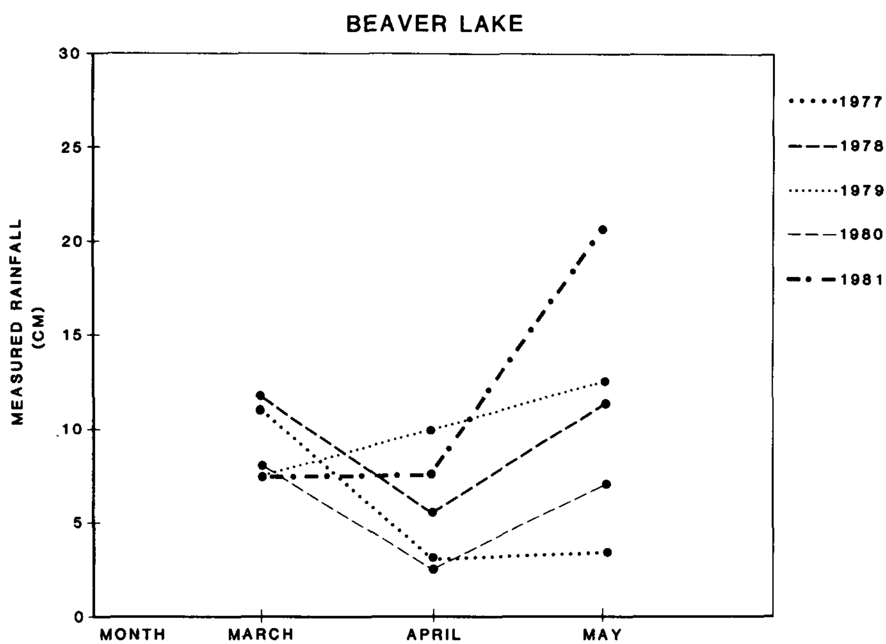

Figure 2. Measured rainfall for Beaver Lake, Arkansas (1976–1981).

Table 8. Young-of-year *Morone* spp. collected in Lake Maumelle and Beaver Lake (1976–1982).

	Lake Maumelle	Beaver Lake	
Year	White bass	Striped bass	White bass
1976			13
1977			28
1978			324
1979	7		124
1980			2
1981	29		142
1982		7	

curred. Also, as evidenced by the relatively small numbers of fish collected, shoreline seining and cove rotenone sampling are often ineffective sample techniques for pelagic fish, such as those of the *Morone* genus.

Summary

Although this study did not document the suspected natural hybridization of striped bass and white bass in Lake Maumelle and Beaver Lake, it did corroborate the unexplained presence of large numbers of hybrid striped bass in the 2 lakes. In the authors' opinion, the review of various types of historical data and the electrophoretic analysis refuted, to a certain degree, the argument that a hatchery error was responsible for the appearance of the hybrid striped bass.

Should natural hybridization between members of the *Morone* genus be in fact occurring, it apparently has not been widespread to date. However, should these occurrences become more frequent, several undesirable management implications could be realized.

Successful attempts to artificially reproduce F_1 hybrid striped bass (Bishop 1967), coupled with the fish's high degree of fecundity (Williams 1971), point out the possibility that backcrossing potentially could occur in the wild. Should this become reality, instances of parental gene pool contamination, as well as the appearance of large numbers of deformed backcross progeny could be envisioned (Bishop 1967, Ware 1971).

Other potential management problems created by natural hybridization might be the direct competition between hybrids and parental species. As overlaps have been noted in food habits of members of the *Morone* genus (Stevens 1958, Bishop 1967, Olmstead 1971, Ware 1974), suppression of both striped bass and white bass populations might be a distinct possibility.

Future efforts directed toward documenting suspected natural hybridization of striped bass and white bass would need to include intensive sampling efforts, including:

1. Identification and collection of both striped bass and white bass adult fish from the same spawning school.

2. The use of fine mesh drift nets in upstream areas to collect any eggs, if the original cross (striped bass ♀ x white bass ♂) should occur, resulting in the production of buoyant non-adhesive eggs. Eggs should then be reared at the hatchery to a size which would be easy to identify.

3. Intensive use of shoreline seining and electrofishing during late spring and early summer periods to collect yoy hybrid striped bass.

4. And finally, trawling to collect larval hybrid striped bass would also be useful to document natural hybridization.

Literature Cited

Bailey, W. M. 1974. An evaluation of striped bass introductions in the southeastern United States. Proc. Annu. Conf. Southeast. Assoc. Game and Fish Comm. 28:54–68.

Bayless, J. E. 1972. Artificial propagation and hybridization of striped bass, *Morone saxatilis* (Walbaum). Spec. Publ. S.C. Wildl. and Mar. Resour. Dep. 135pp.

Bishop, R. D.. 1967. Evaluation of the striped bass (*Roccus saxatilis*) and white bass (*R. chrysops*) hybrids after two years. Proc. Annu. Conf. Southeast. Assoc. Fish and Wildl. Agencies. 21:245–254.

Bonn, E. W., W. M. Bailey, J. D. Bayless, K. E. Erickson, and R. E. Stevens (eds.). 1976. Guidelines for striped bass culture. Am. Fish. Soc., Striped Bass Committee of the South. Div. Bethesda, Md. 103pp.

Carlander, K. D. 1969. Handbook of freshwater fishery biology, Vol. I, The Iowa State University Press, Ames.

Crandall, P. S. 1978. Evaluation of striped bass x white bass hybrids in a heated Texas reservoir. Proc. Annu. Conf. Southeast. Assoc. Fish and Wildl. Agencies. 32:588–598.

Eddy, S. 1974. The freshwater fishes. W. C. Brown Co., Publishers. Dubuque, Iowa. 208pp.

Lagler, K. F., J. E. Bardach, and R. R. Miller. 1962. Ichthyology. John Wiley and Sons, Inc. New York. 536pp.

McCabe, R. L. 1981. Striped bass program review. Internal Rep., Texas Parks and Wildl. Dep., Austin.

Olmstead, C. L. 1971. The feeding biology of white bass, *Roccus chrysops* (Rafinesque) in Beaver Reservoir, Arkansas. Final rep. to Ark. Game and Fish Comm., Little Rock. 118pp.

Philipp, D. P., W. F. Childers, and G. S. Whitt. 1979. Evaluation of differential patterns of gene expression; a comparison of the temporal and spatial patterns of isozyme locus expression in two closely related fish species (northern largemouth bass, *Micropterus salmoides,* and smallmouth bass (*Miscopterus dolomieui*). J. Exp. Zool. 210:473–488.

Setzler, E. M., W. R. Boynton, K. V. Wood, H. H. Zion, L. Lubbers, N. K. Mountford, P. Frere, L. Tucker, and J. A. Mihursky. 1980. Synopsis of biological data on striped bass, *Morone saxatilis* (Walbaum). U.S. Dep. Comm., NOAA Tech. Rep., NMFS Cir. 433. Rockville, Md.

Stevens, R. E. 1958. The striped bass of the Santee Cooper Reservoir. Proc. Annu. Conf. Southeast. Assoc. Game and Fish Comm. 11:536–541.

———. 1965. A report on the operation of the Moncks Corner striped bass hatchery. S.C. Wildl. Res. Dep., Bonneau.

Ware, F. J. 1971. Some early life history of Florida's inland striped bass (*Morone saxatilis*). Proc. Annu. Conf. Southeast. Assoc. Game and Fish Comm. 24: 439–447.

———. 1974. Progress with *Morone* hybrids in fresh water. Proc. Annu. Conf. Southeast. Assoc. Game and Fish Comm. 28:48–54.

Williams, H. M. 1971. Preliminary studies of certain aspects of the life history of the hybrid (striped bass x white bass) striped bass in two South Carolina reservoirs. Proc. Annu. Conf. Southeast. Assoc. Game and Fish Comm. 24: 424–431.

———. 1971. Preliminary fecundity studies of the hybrid (striped bass x white bass) in two South Carolina Reservoirs. Proc. Annu. Conf. Southeast. Assoc. Game and Fish Comm. 25:536–591.