HYBRID STRIPED BASS[5]

Project Component Termination Report for the Period

September 1, 1995 to December 31, 1997

NCRAC FUNDING LEVEL: $135,000 (September 1, 1995 to December 31, 1997)

PARTICIPANTS:

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REASON FOR TERMINATION

The objectives for this work on Hybrid Striped Bass were completed.

PROJECT OBJECTIVES

(1) Examine fry (phase I) to fingerling (phase II) production of three strains of white bass and three strains of hybrid striped bass (sunshine bass) in ponds with and without lights and vibrating feeders.

(2) Conduct field testing of fingerling (phase II) to advanced fingerling (phase III) production of three strains of hybrid striped bass (sunshine bass) in various culture systems.

PRINCIPAL ACCOMPLISHMENTS

OBJECTIVE 1

Adult white bass were acquired from three regions representing the extremes of the native range for white bass: Arkansas, South Dakota, and Lake Erie. Brood fish were held at Southern Illinois University-Carbondale (SIUC) and both white bass and hybrid striped (sunshine) bass fry were produced using these brood stock. At 4 days of age, the larvae were enumerated and subsequently stocked into fertilized 0.04 ha (0.10 acres) ponds 500,000/ha (202,350/acre). Training the fish to accept commercial diets began 21 days poststocking. At 36-41 days of age

phase I fingerlings were harvested; survival rates varied from pond to pond, but was generally poor (0-21% survival). Fish survival rates were markedly higher for hybrid striped bass ponds compared to white bass ponds, averaging 13% and 3%, respectively.

The phase I fingerlings were restocked for phase II production at SIUC. Due to a lack of fish, all three white bass stocks were eliminated from this segment of the experiment. Both Arkansas and South Dakota hybrid striped bass stocks were restocked in triplicate, while Lake Erie hybrid striped bass were only restocked in duplicate. The stocking rate used for phase II production was 25,000 fish/ha (10,118/acre). Fish were feed twice daily to satiation. At the end of the growing season, phase II fingerlings were harvested; survival rates ranged from 49-86%. Survival rates for both Arkansas and Lake Erie hybrid striped bass were about 72%, while the survival rate for South Dakota hybrid striped bass was only 57%. The average weight of individual fish also varied from stock to stock. The highest average weight was 90.2 g (3.2 oz) for Lake Erie hybrid striped bass, while South Dakota and Arkansas hybrid striped bass had average weights of 69.0 g (2.4 oz) and 58.4 g (2.1 oz), respectively.

In an attempt to feed-train hybrid striped bass fingerlings in ponds, 100,000 hybrid striped bass fry were stocked into a 0.4-ha (1.0-acre) pond at the University of Wisconsin-Madison's (UW-Madison's) facilities at the Lake Mills State Fish Hatchery, Lake Mills, Wisconsin in the spring/summer of 1997. The pond was equipped with a series of underwater lights and automatic feeders. The failure to observe any fish in the vicinity of the lights and feeders suggests that hybrid striped bass fingerlings are, or quickly become, photo-negative or photo-neutral; hence, the use of lights and automatic feeders to feed-train fingerlings in ponds does not appear to be an effective strategy for these fish.

Whole body proximate analysis was performed on phase II hybrid striped bass and white bass. Percent moisture for all strains of white bass (70.4%) was significantly higher than all hybrid striped bass strains (67.7%). Conversely, percent fat was significantly higher in hybrid striped bass (10.6%) than in white bass (9.0%). There was no difference in fat content, however, between Arkansas hybrids and South Dakota white bass. The only difference in percent protein was found between South Dakota white bass (15.5%) and South Dakota hybrid striped bass (14.2%). Percent protein for all other crosses were intermediate and not significantly different from either South Dakota taxon. White bass had significantly higher percent ash values than hybrid striped bass (4.1 and 3.6%, respectively). All hybrid strains and white bass strains were in separate groupings, but an intermediate grouping included Lake Erie white bass, South Dakota hybrids, and Arkansas hybrids. These results suggest that difference in body composition may exist between white bass and hybrid striped bass, but differences between strains are unlikely.

OBJECTIVE 2

Ponds

SIUC researchers investigated the use of ponds in producing phase III hybrid striped bass. Following phase II harvest, all three strains of hybrid striped bass were redistributed into newly filled ponds at 5,000 fish/ha (2,024 fish/acre). Fish were fed to satiation with a commercial trout feed (40% protein). Feeding rate was increased to twice per day during the warmer months, not exceeding the recommended 56 kg/ha (50 lb/acre). During the hot summer months of the study, one replicate of each strain was lost from dissolved oxygen depletion.

Phase III fish were harvested in fall 1997 at the end of the second growing season. Percent survival averaged 90.4% in all ponds harvested. Lake Erie hybrids averaged 0.65 kg (1.43 lb), Arkansas hybrids averaged 0.64 kg (1.41 lb), and South Dakota hybrids averaged 0.57 kg (1.26 lb); mean weights were not significantly different. Production values averaged 2,853, 2,801, and 2,628 kg/ha (2,545, 2,499, and 2,345 lb/acre), respectively, for the above strains with no

significant differences detected. Feed conversions were excellent (1.71, 1.49, and 1.67 for Lake Erie, Arkansas and South Dakota hybrids, respectively) and not significantly different. Fish grown in the small research ponds had production values similar to those obtained by the industry in large ponds when continual aeration is not provided.

Percent dress out for South Dakota hybrids (37.8%) and Lake Erie hybrids (37.3%) was significantly higher than that of Arkansas hybrids (34.6%). Sex ratios for all three strains were nearly 50:50. Gonadal Somatic Index of Lake Erie hybrids (1.4) was significantly higher than that of South Dakota (1.1) and Arkansas hybrids (1.0). No significant differences were detected between strains for Liver Somatic Index or Visceral Somatic Index.

Throughout all phases of pond production, Lake Erie hybrids performed as well or better than the other two strains of hybrid striped bass. The Lake Erie component of hybrid striped bass appears to be the strain of choice for North Central Regional aquaculture, but crosses with other strains of striped bass may yield different results. Perhaps the most promising results from phase III production is that commercially acceptable values for average weight, production, and feed conversion were achieved in an experimental setting in this region.

Tanks (Recirculation)

Two groups of hybrid striped bass fingerlings (Arkansas and South Dakota hybrids) were transported from SIUC to South Dakota State University (SDSU) to conduct strain comparison and density experiments. The culture system for both experiments consisted of 110-L (29.1-gal) glass aquaria connected as a closed freshwater recirculating system. Randomly selected fish from each strain group were stocked in individual aquaria to provide four replicates. The density experiment consisted of four replicates each of 5 (45/m^3; 1.3/ft^3), 15 (136/m^3; 3.9/ft^3) or 30 (273/m^3; 7.7/ft^3) South Dakota hybrids per 110-L (29.1-gal) aquaria. Performance characteristics (e.g., growth, conversion, condition, and survival) were monitored in both experiments. Strain comparisons were conducted at the low density.

Hand-feeding frequency was three times per day until the seventh week when belt feeders were incorporated, then feeding occurred continuously over the 12-h day period. Feed used was a commercial hybrid striped bass diet (38% protein, 5% lipid; Southern States, Farmville, North Carolina). Feed conversion was observed to decrease across all treatments when fish were switched to continuous belt feeding, as compared to three hand-feeding periods separated by 4-h intervals during the early portion of the study. Feed conversion differed little among treatments until week 11 of the study. During weeks 11 through 14 the high density treatment showed significantly poorer feed conversion than low and medium treatments. Strain comparisons did not reveal any conversion differences.

Growth pattern differences among treatments began to emerge during the second week of the study. Hybrid striped bass held at the medium density produced the largest proportional weight gain by the end of the study. Body condition at the conclusion of the experiment did not differ among treatments. No differences were detected between the two strains for growth and condition. Calculations from this study indicate that 200-mm (7.9-inch) hybrid striped bass can be safely reared at 8.8 kg/m^3 (0.6 lb/ft^3) up to 14.85 kg/m^3 (0.9 lb/ft^3) in recirculating systems.

Because uniform size is an important processing and marketing aspect, SDSU researchers examined the variability in individual weights over time to determine whether feeding hierarchies might have been established within tanks. There were distinct differences that corresponded with densities; however, the medium culture density provided fairly uniform fish size.

With the exception of ammonia, all monitored water chemistry was acceptable for the culture of hybrid striped bass. Ammonia concentrations in the high density treatment were sporadically well

above baseline levels; those measurements were associated with feeding and observed to decrease shortly thereafter. Unionized ammonia concentrations in the high density treatment were not determined to be potentially toxic, rarely exceeding 0.011 mg/L (ppm) as NH_3-N.

The highest mortality (22%) occurred in the medium density treatment followed by the high (9%) and low (0%) density treatments. However, the mortality that occurred in the medium density treatment was a single event and a direct result of a plugged water jet.

Cages and Tanks

Studies at Purdue University were designed to examine maximum density of hybrid striped bass raised in cages and tanks. Two separate field studies were completed with two private producers in Indiana. In the first study, hybrid striped bass were grown through a production season and fed a standard diet. Initial densities ranged from 2.5-5.0 kg/m^3 (0.16-0.31 lb/ft^3) and final densities ranged from 6-31 kg/m^3 (0.17-1.95 lb/ft^3). There were no significant differences within or between sites. In the second field study, initial densities ranged from 4-18 kg/m^3 (0.25-1.13 lb/ft^3) and final densities ranged from 26-45 kg/m^3 (1.64-1.28 lb/ft^3). There were no significant difference within sites, but significant differences between sites were identified. Eviscerated dress out percentages were not significantly different in either study and ranged from 86-90%.

In the first tank culture study, densities ranged from 0.8-2.7 kg/m^3 (0.05-0.17 lb/ft^3) and final densities ranged from 8-28 kg/m^3 (0.23-1.6 lb/ft^3). Fish were fed a standard diet to satiation once each day and feed conversion ratios (FCR) ranged from 1.18-1.06. No significant differences were detected in weight gain, FCR, eviscerated dress out percentage, condition factor, or blood glucose or cortisol concentrations. In the second tank culture study, initial densities of 2.5-15 kg/m^3 (0.16-0.94 lb/ft^3) were used. At the end of the 86-day trial, weight gain and feed efficiency were not affected by the treatments in any of the stocking densities. There was no evidence of chronic stress in the fish. It appears that phase II hybrid striped bass can be stocked up to 15 kg/m^3 (0.94 lb/ ft^3) in recirculation systems; this finding is also reflective in SDSU studies.

IMPACTS

The Lake Erie strain of white bass was identified as being the most suitable for the NCR of the strains evaluated.

It has been demonstrated that hybrid striped bass grow as well or better in earthen ponds in the southern portion of the NCR as anywhere else in the United States.

Many of the hybrid striped bass fingerling producers in the United States are adopting the white bass out-of-season spawning protocols developed through NCRAC funding.

Stocking densities at levels best for fish production of hybrid striped bass cultured in ponds, tanks and cages have been identified

RECOMMENDED FOLLOW-UP ACTIVITIES

The combination of the findings of this study, identification of the best hybrid strain, along with the sperm storage protocols now being tested under industry settings, should allow for the culture of hybrid striped bass in the NCR. Continued demonstration of the technologies developed need to be undertaken with industry partners. In addition, economic analyses of hybrid striped culture at the densities identified in this study need to be undertaken.

PUBLICATIONS, MANUSCRIPTS, OR PAPERS PRESENTED

See the Appendix for a cumulative output for all NCRAC-funded Hybrid Striped Bass activities.

SUPPORT

YEARS	NCRAC-USDA FUNDING	OTHER SUPPORT					TOTAL SUPPORT
		UNIVER-SITY	INDUSTRY	OTHER FEDERAL	OTHER	TOTAL	
1995-97	$135,000	$118,286	$55,019		$50,000	$223,305	$358,305
TOTAL	$135,000	$118,286	$55,019		$50,000	$223,305	$358,305

APPENDIX

HYBRID STRIPED BASS

Publications in Print

Anonymous. 1995. Proceedings of the NCRAC Hybrid Striped Bass Workshop. NCRAC Publications Office, Iowa State University, Ames.

Brown, P.B., R. Twibell, Y. Jonker, and K.A. Wilson. 1997. Evaluation of three soybean products in diets fed to juvenile hybrid striped bass *Morone saxatilis* × *M. chrysops*. Journal of the World Aquaculture Society 28:215-223.

Kelly, A.M., and C.C. Kohler. 1996. Sunshine bass performance in ponds, cages, and indoor tanks. Progressive Fish-Culturist 58:55-58.

Kohler, C.C. 1997. White bass production and broodstock development. Pages 169-185 *in* R.M. Harrell, editor. Striped bass and other *Morone* culture. Elsevier Press, Amsterdam.

Kohler, C.C., R.J. Sheehan, C. Habicht, J.A. Malison, and T.B. Kayes. 1994. Habituation to captivity and controlled spawning of white bass. Transactions of the American Fisheries Society 123:964-974.

Settor, K. 1998. Evaluation of different densities for hybrid striped bass (*Morone saxatilis* × *M. chrysops*) in cages and small-scale recirculation system. Master's thesis. Purdue University, West Lafayette, Indiana.

Woods, L.C., C.C. Kohler, R.J. Sheehan, and C.V. Sullivan. 1995. Volitional tank spawning of female striped bass with male white bass produces hybrid offspring. Transactions of the American Fisheries Society 124:628-632.

Manuscripts

Brown, G.G., R.J. Sheehan, C.C. Kohler, C. Habicht, L. Koutnik, L. Ellis, and L.D. Brown. In preparation. Short-term and long-term storage of striped bass *Morone saxatilis* semen. Journal of the World Aquaculture Society.

Kelley, A.M., and C.C. Kohler. In preparation. Relationship between cold tolerance and fatty acid composition in striped bass, white bass, and their hybrids. North American Journal of Aquaculture.

Kohler, C.C. In review. Striped bass and hybrid striped bass aquaculture. *In* R.R. Stickney, editor. Encyclopedia of aquaculture, Wiley Science, New York.

Morris, J.E., and C.C. Kohler. In review. Pond culture of hybrid striped bass fingerlings in the Midwest. NCRAC Fact Sheet Series #107, NCRAC Publications Office, Iowa State University, Ames.

Suresh, A.V., J.B. Rudacille, M.L. Allyn, V. Sheehan, R.J. Sheehan, and C.C. Kohler. In review. Induction of ovulation in white bass (*Morone chrysops*) using hCG and LHRHa. Aquaculture.

Papers Presented

Brown, P.B., R. Twibell, Y. Hodgin, and K. Wilson. 1995. Soybeans in diets fed to hybrid striped bass. 24th Annual Fish Feed and Nutrition Workshop, Columbus, Ohio, October 19-21, 1995.

Brown, P.B., Y. Hodgin, R. Twibell, and K.A. Wilson. 1996. Use of three soybean products in diets fed to hybrid striped bass. 27th Annual Meeting of the World Aquaculture Society, Bangkok, Thailand, January 29-February 2, 1996.

Brown, G.G., L.D. Brown, K. Dunbar, C. Habicht, R.J. Sheehan, C.C. Kohler, and L. Koutnik. 1991. Evaluation of white bass semen with 31P-NMR for the improvement of transportation, storage, and fertility methods. 53rd Midwest Fish and Wildlife Conference, Des Moines, Iowa, November 30-December 4, 1991.

Brown, G.G., R.J. Sheehan, C.C. Kohler, C. Habicht, L. Koutnik, L. Ellis, and L.D. Brown. 1995. Use of cryopreservatives. North Central Regional Aquaculture Center Hybrid Striped Bass Workshop, Champaign, Illinois, November 2-4, 1995.

Brown, G.G., R.J. Sheehan, C.C. Kohler, C. Habicht, L. Koutnik, L. Ellis, and L.D. Brown. 1998. Short-term storage of striped bass *Morone saxatilis* semen. Aquaculture '98, Las Vegas, Nevada, February 15-19, 1998.

Habicht, C., R.J. Sheehan, C.C. Kohler, G.G. Brown, and L. Koutnik. 1991. Routine collection, storage, and shipping of white bass sperm. 29th Annual Meeting Illinois Chapter of the American Fisheries Society, Champaign, Illinois, March 5-7, 1991.

Kohler, C.C. 1993. The farm fish of the future: hybrid stripers. Aqua '93: 7th Annual Minnesota Aquaculture Conference, Alexandria, Minnesota, March 5-6, 1993. (Invited paper)

Kohler, C.C. 1994. Hybrid striped bass aquaculture. Yellow Perch and Hybrid Striped Bass Production: From Fry to Frying Pan, Piketon, Ohio, July 3, 1994. (Invited speaker)

Kohler, C.C. 1995. Broodstock management of white bass. North Central Regional Aquaculture Center Hybrid Striped Bass Workshop, Champaign, Illinois, November 2-4, 1995.

Kohler, C.C. 1996. Induced out-of-season spawning of fishes. Missouri Aquaculture Industry Association Annual Meeting, Jefferson City, Missouri, February 3-4, 1996 .

Kohler, C.C. 1996. Advancing hybrid striped bass culture in the North Central Region and elsewhere. U.S. Chapter of the World Aquaculture Society, Arlington, Texas, February 14-17, 1996.

Kohler, C.C. 1997. Induced spawning of fishes. Third North Central Regional Aquaculture Conference, Indianapolis, Indiana, February 6-7, 1997.

Kohler, C.C. 1998. Hybrid striped bass culture in the Midwest. Joint Missouri-Kansas Aquaculture Conference, Springfield, Missouri, March 4-6, 1998.

Kohler, C.C., and R.J. Sheehan. 1991. Hybrid striped bass culture in the North Central Region. First North Central Regional Aquaculture Conference, Kalamazoo, Michigan, March 18-21, 1991.

Kohler, C.C., R.J. Sheehan, M.L. Allyn, J.B. Rudacille, and A. Suresh. 1996. Controlled spawning of white bass. U.S. Chapter of the World Aquaculture Society, Arlington, Texas, February 14-17, 1996.

Kohler, C.C., R.J. Sheehan, C. Habicht, J.A. Malison, and T.B. Kayes. 1992. Acclimization to captivity and out-of-season spawning of white bass. 23nd Annual Meeting of the World Aquaculture Society, Orlando, Florida, May 21-25, 1992.

Kohler, C.C., R.J. Sheehan, J.J. Myers, J.B. Rudacille, M.L. Allyn, and A.V. Suresh. 1998. Performance comparison of geographically distinct strains of white bass to produce sunshine bass. Striper 2000, College Park, Maryland, June 6-7, 1998.

Kohler, C.C., R.J. Sheehan, C. Habicht, V. Sanchez, J. Finck, J.A. Malison, and T.B. Kayes. 1991. Domestication and out-of-season spawning of white bass. 53rd Midwest Fish and Wildlife Conference, Des Moines, Iowa, November 30-December 4, 1991.

Kohler, C.C., R.J. Sheehan, C. Habicht, V. Sanchez, J.A. Malison, and T.B. Kayes. 1992. Collection, acclimation to captivity, and out-of-season spawning of white bass. 122nd Annual Meeting of the American Fisheries Society, Rapid City, South Dakota, September 14-17, 1992.

Kohler. C.C., R.J. Sheehan, C. Habicht, V. Sanchez, J.A. Malison, and T.B. Kayes. 1993. Development of white bass brood stock and spawning protocol. U.S. Chapter of the World Aquaculture Society, Hilton Head Island, South Carolina, January 27-30, 1993. (Invited paper)

Kohler, C.C., R.J. Sheehan, and T.B. Kayes. 1989. Advancing hybrid striped bass culture in the Midwestern United States. 51st Midwest Fish and Wildlife Conference, Springfield, Illinois, December 5-6, 1989.

Kohler, C.C., R.J. Sheehan, V. Sanchez, and A. Suresh. 1994. Evaluation of various dosages of hCG to induce final oocyte maturation and ovulation in white bass. 25th Annual Meeting of the World Aquaculture Society, New Orleans, Louisiana, January 12-18, 1994.

Kohler, C.C., R.J. Sheehan, A. Suresh, L. Allyn, and J. Rudacliffe. 1996. Effect of hCG dosage on hatching success in white bass. International Congress on the Biology of Fishes, San Francisco, California, July 15-18, 1996.

Kohler, S.T. 1995. Cost of production. North Central Regional Aquaculture Center Hybrid Striped Bass Workshop, Champaign, Illinois, November 2-4, 1995.

Koutnik, L.A., R.J. Sheehan, C.C. Kohler, C. Habicht, and G.G. Brown. 1992. Motility and fertility of extended and cryopreserved *Morone* sperm: when is cryopreservation the best option? Annual Meeting, Illinois/Wisconsin Chapters of the American Fisheries Society, Waukegan, Illinois, February 10-13, 1992. (Awarded Best Student Paper)

Myers, J.J., C.C. Kohler, R.J. Sheehan, M.L. Allyn, J.B. Rudacille, and A.V. Suresh. 1998. Geographic strain comparison of hybrid striped bass (*Morone chrysops* × *M. saxatilis*) to a market size in earthen ponds. Illinois Renewable Natural Resources Conference, Springfield, Illinois, March 4-6, 1998.

Morris, J. 1995. Pond preparation for larval fish. North Central Regional Aquaculture Center Hybrid Striped Bass Workshop, Champaign, Illinois, November 2-4, 1995.

Rudacille, J.B., and C.C. Kohler. 1996. Relative performance of white bass, sunshine bass, and palmetto bass fed a commercial diet. U.S. Chapter of the World Aquaculture Society, Arlington, Texas, February 14-17, 1996. (Awarded Best Student Presentation)

Rudacille, J.B., and C.C. Kohler. 1997. Performance of Phase III palmetto bass, sunshine bass and white in a recirculating water system. 28th Annual Meeting of the World Aquaculture Society, Seattle, Washington, February 19-23, 1997.

Rudacille, J.B., and C.C. Kohler. 1997. Relative performance of Phase III sunshine bass, palmetto bass, and white bass in an indoor recirculating system. 35th Annual Meeting of the Illinois Chapter of the American Fisheries Society, Collinsville, Illinois, March 4-6, 1997. (Awarded Lewis L. Osborne Best Student Paper)

Sheehan, R.J. 1995. Use of sperm extenders. North Central Regional Aquaculture Center Hybrid Striped Bass Workshop, Champaign, Illinois, November 2-4, 1995.

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