YELLOW PERCH[4]

Project Termination Report for the Period
May 1, 1989 to August 31, 1993

TOTAL FUNDING LEVEL: $354,785 (May 1, 1989 to August 31, 1993)

PARTICIPANTS:

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Paul B. Brown	Purdue University	Illinois
David A. Culver	Ohio State University	Ohio
Konrad Dabrowski	Ohio State University	Ohio
Donald L. Garling	Michigan State University	Michigan
Terrence B. Kayes	University of Nebraska-Lincoln	Nebraska
Jeffrey A. Malison	University of Wisconsin-Madison	Wisconsin
Robert J. Sheehan	Southern Illinois University-Carbondale	Illinois
Extension Liaison:		
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Non-Funded Collaborators:		
Forrest Williams	Bay Port Aquaculture, Inc., West Olive	Michigan
David Northey	Coolwater Farms, Dousman	Wisconsin

REASON FOR TERMINATION

The objectives for the first three NCRAC-funded projects on Yellow Perch were completed.

PROJECT OBJECTIVES

(1) Compare the survival, growth, feed conversion, and proximate composition of offspring from selected northern, southern, and Great Plains stocks of yellow perch, at different life history stages and at different temperatures.

(2) Evaluate the survival, growth, and feed conversion of yellow perch raised at various loadings or rearing densities in selected flow-through and pond culture systems.

(3) Evaluate and improve the efficiency of various methods of inducing triploidy in yellow perch, and compare the survival and growth to market size of the triploids produced with that of normal diploids.

(4) Compare pond and intensive culture methods for the production of yellow perch fingerlings.

PRINCIPAL ACCOMPLISHMENTS

The principal goal of this work was to develop practical strategies for commercial yellow perch aquaculture under the diverse environmental conditions that exist in the NCR. Much of this goal was realized. During its 4-year history, the two projects examined: (1) the suitability of selected wild perch brood stocks obtained from different geographic locales as candidates for potential brood stock development; (2) the applicability of selected conventional production technologies to perch aquaculture; (3) the potential of using chromosomal triploidy induction to enhance growth; and (4) the relative merits of pond versus intensive culture methods for the production of perch fingerlings, and the nutrient composition of live-food organisms versus perch fry raised to different sizes (stages of development) under different culture conditions (different pond sites and laboratories, pond versus intensive culture).

With respect to Objective 1, studies at the University of Wisconsin-Milwaukee (UW-Milwaukee) found variations in percentage of survival and swim bladder inflation between perch fry from different stocks, and research at Purdue University (Purdue) identified significant differences in the growth of perch fingerlings from these same stocks at various rearing temperatures. In overview, these variations and differences appeared to be primarily reflective of the geographic locales from which the brood fish and fertilized eggs of the different stocks were selected, which is a factor that should be considered when selecting brood stock for the production of perch. Thus, producers in the northern and southern parts of the NCR should probably use brood stock from their own respective parts of the region, and not expend undue time and resources seeking "super" perch from stocks with presumed superior performance traits that have not been documented by properly controlled experimental procedures.

As part of Objective 2, Michigan State University (MSU) and University of Wisconsin-Madison (UW-Madison) researchers unequivocally demonstrated that perch can be raised to market size using conventional aquaculture production technologies in a time frame similar to that of such important commercially cultured species as channel catfish. The demonstration of this fact is perhaps one of the project's most important practical benefits, because it underscores the importance of matching species selection for aquaculture development with climatic conditions and available resources. This research effort was also important because it helps refute the notion that, except for salmon and trout, finfish aquaculture in the North, owing to the shorter growing season, cannot be competitive with aquaculture production at southern or tropical latitudes. The temperature requirements of perch for successful reproduction and optimum growth make the commercial culture of this species in the principal catfish producing states of the South highly unlikely.

Regarding Objective 2, MSU investigators, working with Bay Port Aquaculture Inc. of West Olive, Michigan, have demonstrated that perch can be raised on a commercial scale at high densities in flow-through tanks, using research-based procedures for estimating carrying capacity based on the dissolved oxygen requirements and ammonia tolerance limits of perch. Such an approach to perch aquaculture, employing intensive procedures similar to those used in commercial trout production, should be particularly applicable to situations where an inexpensive, abundant source of high-quality temperate (i.e., 18-24°C; 64.4-75.2°F) water is or can be made available for "grow out" - from natural springs, wells, and/or the utilization of dependable waste heat or clean cooling water from such providers as electric power generating stations.

Using a different approach, UW-Madison researchers, working with Coolwater Farms of Dousman, Wisconsin, have demonstrated that the commercial-scale culture of perch in ponds can be feasible, if sufficient quantities of inexpensive groundwater (which ranges between about 8 and 14°C across the NCR; 46.4 and 57.2°F) is available to moderate pond water temperature highs during the summer and ice formation during the winter. Such groundwater addition also helps maintain elevated dissolved oxygen concentrations, and facilitates ice control during the winter to provide access for management and feeding and to prevent equipment damage. The benefit of this approach is that it provides a ready means of producing commercial quantities of perch in those parts of the region where pond construction is feasible and groundwater is abundant and available at a reasonable cost.

Studies by researchers at the UW-Madison and Southern Illinois University-Carbondale (SIUC) on Objective 3 have shown that while direct triploidy induction in fertilized eggs produces perch that exhibit retarded gonadal development and somewhat higher fillet yields than is observed in normal diploid fish, direct triploidy induction does not significantly enhance growth. Investigators at the UW-Madison have developed effective procedures to induce triploidy in perch either by heat or hydrostatic pressure shocks, but have shown that such shocks exert a negative influence on growth independent of ploidy change. Accordingly, unless perch can be marketed on the basis of fillet yield or lack of reproductive competence, instead of total body weight, it is difficult to envision how direct triploidy induction can benefit commercial perch aquaculture. Researchers at the UW-Madison have also developed procedures for producing tetraploid brood perch, which presumably can be backcrossed with diploid fish to produce triploid eggs via natural fertilization, rather than by using physical or chemical shock treatments. Triploid perch produced by crossing tetraploid and diploids may grow faster than diploids, but this potential benefit has not yet been tested either experimentally or in practice.

Researchers at the UW-Madison and UW-Milwaukee, working collaboratively on Objective 4, have clearly demonstrated that with recently developed "best available" techniques, fry and early-fingerlings perch raised in ponds exhibit better survival and growth and far fewer problems with swim bladder inflation and spinal deformities than perch reared intensively in tanks since hatching. Furthermore, after habituation to formulated feed and intensive culture conditions, pond-reared perch often continue to out-grow fish reared entirely by intensive methods. Over the years, UW-Madison investigators have continued to develop improved procedures for incubating and hatching perch eggs, rearing and harvesting ever-increasing numbers of perch fingerlings from ponds (up to 1,000,000 per surface ha; 2,470,097/acre), and habituating early-fingerlings (16-18 mm total length; 0.63-0.70 in) to formulated feed and intensive culture conditions using internal tank lighting. The development of these procedures represents another one of the project's most important practical benefits, because they provide fish farmers with a ready means of producing large numbers of perch fingerlings that are habituated to formulated feed and ready for "grow out" to market size.

After three years of research on Objective 4, UW-Madison and UW-Milwaukee investigators have found that despite significant improvements in procedures and fry survival, problems with swim bladder inflation and cannibalism continue to be serious impediments to the large-scale intensive production of perch fingerlings. UW-Milwaukee researchers demonstrated that problems with early development and habituation of fry to intensive culture conditions were not as serious with perch originating from the Prquimans River in North Carolina, as with perch fry originating from other locales. Ohio State University (OSU) investigators discovered no significant differences in the amino acid compositions of young perch from Wisconsin and Ohio, suggesting similar nutritional needs across perch stocks. Researchers from OSU also found suggestive evidence, but no causal or clear-cut functional linkages, that dietary ascorbic acid deficiencies may be responsible for the high incidence of spinal deformities often observed in perch larvae reared under intensive culture conditions, and that certain long-chain fatty acids may be important in the diets of young perch.

IMPACTS

The principal impacts of the completed NCRAC yellow perch project have been the development and/or expansion of two of the NCR's leading commercial perch aquaculture operations, the actual or planned start up of several new commercial perch aquaculture ventures, the utilization of the project's newly developed knowledge and production procedures by a number of fish farmers, and the training of numerous graduate and undergraduate students at the participating institutions.

SPECIFIC EXAMPLES

The research done by MSU on the intensive flow-through culture of perch in tanks (Objective 2) played a key role in the development and expansion of Bay Port Aquaculture Inc. of West Olive, Michigan. Similarly, all of the perch net-pen and pond production research (Objective 2) and many of the perch fingerling production studies (Objective 4) reported by the UW-Madison were done at Coolwater Farms of Dousman, Wisconsin, and directly involved Coolwater Farms' personnel in these investigations. As a consequence, Coolwater Farms has greatly expanded both the scope and efficiency of its operations.

Private producers that are actually <u>known</u> to have recently started culturing perch largely as a consequence of the project, or who have made significant investments to soon start, include one in Iowa, three in Indiana, one in Michigan, two in Nebraska, two in Ohio, and two in Wisconsin. Other perch aquaculture ventures in the region may have recently started or may soon become operational, but this cannot be presently documented.

The UW-Madison has reported that several "aquaculture endeavors in Iowa, Indiana and Michigan have based their business plans on the pond culture of perch," that one in Iowa "is evaluating the use of net-pens," that "at least three commercial fish farms (one each in

Wisconsin, Michigan and Ohio) have begun to rear all-female perch," and that "at least three commercial perch aquaculture operations in the upper Midwest" have or are implementing the "egg hatching and fingerling production and training methods developed" during the project. The UW-Milwaukee has reported training fish farmers in its procedures for producing perch fingerlings intensively in tanks.

Purdue has indicated the partial training of two graduate students and three undergraduates, as part of the project; MSU reported training two graduate and several undergraduate students. In overview, all of the principal investigators and technical staff of the various laboratories and institutional programs participating in the project gained tremendous insights and new knowledge about the culture and biology of the yellow perch, and a better appreciation of the benefits of regional and inter-institutional collaboration.

RECOMMENDED FOLLOW-UP ACTIVITIES

Building on the results of these projects, NCRAC provided funding for another Yellow Perch project which began on September 1, 1993, and will run for two years. The objectives of this new project are to: (1) determine the commercial scale feasibility and improve on the best intensive tank and pond culture practices for the production of yellow perch fingerlings, and (2) determine the commercial scale feasibility of raising food-size yellow perch in flow-through raceways or tanks, open ponds, and large net-pens, comparing the best available formulated diets. A number of commercial fish farmers in the NCR have been named as major participants in this new project; many aspects of which will not be possible without their full cooperation and support.

The importance of UW-Milwaukee and OSU investigations on Objective 4 is that they demonstrate that considerable additional research will probably be required to develop the procedures and diets necessary to successfully culture perch larvae intensively in tanks on a large scale. Based on experience with other species with small larvae, a long-term investment in selective breeding or in research on perch larval diet development might make such intensive culture technically feasible. Whether or not it would be commercially competitive with the improved methods developed in recent years for culturing young perch in ponds is unclear, particularly considering that continued improvements in the latter approach are likely.

PUBLICATIONS, MANUSCRIPTS, OR PAPERS PRESENTED

See the Appendix for a cumulative output for all NCRAC-funded Yellow Perch activities.

SUPPORT

YEARS	NCRAC-USDA FUNDING	OTHER SUPPORT					TOTAL SUPPORT
		UNIVER-SITY	INDUSTRY	OTHER FEDERAL	OTHER	TOTAL	
1989-91	$162,680	$213,435				$213,435	$376,115
1990-92	$92,108	$400,543				$400,543	$492,651
1991-93	$99,997	$165,394				$165,394	$265,391
TOTAL	$354,785	$779,372				$779,372	$1,134,157

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Publications in Print

Brown, P.B., and K. Dabrowski. 1995. Zootechnical parameters, growth and cannibalism in mass propagation of yellow perch. *In* Kestamount, P., and K. Dabrowski, editors. Workshop on aquaculture of percids. Presses Universitaires de Namur, Namur, Belgium.

Brown, P.B., K. Dabrowski, and D. Garling. 1995. Nutritional requirements and commercial diets for yellow perch. *In* Kestamount, P., and K. Dabrowski, editors. Workshop on aquaculture of percids. Presses Universitaires de Namur, Namur, Belgium.

Dabrowski, K., and D.A. Culver. 1991. The physiology of larval fish: digestive tract and formulation of starter diets. Aquaculture Magazine 17:49-61.

Dabrowski, K., D.A. Culver, C.L. Brooks, A.C. Voss, H. Sprecher, F.P. Binkowski, S.E. Yeo, and A.M. Balogun. 1993. Biochemical aspects of the early life history of yellow perch (*Perca flavescens*). Pages 531-539 *in* Proceedings of the International Fish Nutrition Symposium, Biarritz, France, June 25-27, 1991.

Garling, D.L. 1991. NCRAC research programs to enhance the potential of yellow perch culture in the North Central Region. Pages 253-255 *in* Proceedings of the North Central Regional Aquaculture Conference, Kalamazoo, Michigan, March 18-21, 1991.

Glass, R.J. 1991. The optimum loading and density for yellow perch (*Perca flavescens*) raised in a single pass, flow-through system. Master’s thesis. Michigan State University, East Lansing.

Malison, J.A., and J.A. Held. 1992. Effects of fish size at harvest, initial stocking density and tank lighting conditions on the habituation of pond-reared yellow perch (*Perca flavescens*) to intensive culture conditions. Aquaculture 104:67-78.

Malison, J., and J. Held. 1995. Lights can be used to feed, harvest certain fish. Feedstuffs 67(2):10.

Malison, J.A., T.B. Kayes, J.A. Held, T.B. Barry, and C.H. Amundson. 1993. Manipulation of ploidy in yellow perch (*Perca flavescens*) by heat shock, hydrostatic pressure shock, and spermatozoa inactivation. Aquaculture 110:229-242.

Malison, J.A., L.S. Procarione, J.A. Held, T.B. Kayes, and C.H. Amundson. 1993. The influence of triploidy and heat and hydrostatic pressure shocks on the growth and reproductive development of juvenile yellow perch (*Perca flavescens*). Aquaculture 116:121-133.

Williams, F., and C. Starr. 1991. The path to yellow perch profit through planned development. Pages 49-50 *in* Proceedings of the North Central Regional Aquaculture Conference, Kalamazoo, Michigan, March 18-21, 1991.

Manuscripts

Brown, P.B., K. Dabrowski, and D.L. Garling, Jr. In press. Nutrition and feeding of yellow perch (*Perca flavescens*). Journal of Applied Ichthyology.

Malison, J.A., and M.A.R. Garcia-Abiado. In press. Sex control and ploidy manipulations in yellow perch (*Perca flavescens*) and walleye (*Stizostedion vitreum*). Journal of Applied Ichthyology.

Papers Presented

Batterson, T., R. Craig, and R. Baldwin. 1995. Advancing commercial aquaculture development in the North Central Region. Yellow Perch Aquaculture Workshop, Spring Lake, Michigan, June 15-16, 1995.

Binkowski, F. 1995. Intensive yellow perch fry rearing. Yellow Perch Aquaculture Workshop, Spring Lake, Michigan, June 15-16, 1995.

Brown, P.B. 1994. Yellow perch culture in the Midwest. Vocational Agriculture Training Workshop, Greencastle, Indiana.

Brown, P.B., and K. Dabrowski. 1995. Zootechnical parameters, growth and cannibalism in mass propagation of yellow perch. Workshop on Aquaculture of Percids, Vaasa, Finland, August 21-25, 1995.

Brown, P.B., K. Dabrowski, and D. Garling. 1995. Nutritional requirements and commercial diets for yellow perch. Workshop on Aquaculture of Percids, Vaasa, Finland, August 21-25, 1995.

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Brown, P.B., K. Wilson, J. Wetzel, J. Mays, F. Binkowski, and S. Yeo. 1994. Strain evaluations with yellow perch. Indiana Aquaculture Association Annual Meeting, Indianapolis, Indiana, February 26, 1994.

Crane, P., G. Miller, J. Seeb, and R. Sheehan. 1991. Growth performance of diploid and triploid yellow perch at the onset of sexual maturation. 53rd Midwest Fish and Wildlife Conference, Des Moines, Iowa, November 30 - December 4, 1991.

Held, J.A. 1996. Yellow perch fingerling production - Gone is the black magic. Aqua '96, the Tenth Anniversary Minnesota Aquaculture Conference and Trade Show, Alexandria, Minnesota, March 8-9, 1996.

Kayes, T. 1994. Yellow perch aquaculture. Workshop on Getting Started in Commercial Aquaculture Raising Crayfish and Yellow Perch, Jasper, Indiana, October 14-15, 1994.

Kayes, T. 1994. Investing in freshwater aquaculture: a reprise. Nebraska Aquaculture Update & Autumn Meeting, North Platte, Nebraska, November 19, 1994.

Kayes, T. 1995. Yellow perch aquaculture. Combined North Central and Ninth Annual Minnesota Aquaculture Conference and Trade Show, Minneapolis, Minnesota, February 17-18, 1995.

Kayes, T. 1995. Yellow perch culture studies at Pleasant Valley Fish Farm. Nebraska Aquaculture Update & Spring Meeting, North Platte, Nebraska, March 25, 1995.

Kayes, T. 1995. Harvesting perch and walleye fingerlings from ponds. Nebraska Aquaculture Update & Spring Meeting, North Platte, Nebraska, March 25, 1995.

Kayes, T. 1995. Spawning and incubation of yellow perch. Yellow Perch Aquaculture Workshop, Spring Lake, Michigan, June 15-16, 1995.

Kayes, T. 1995. Fingerling yellow perch production in ponds. Yellow Perch Aquaculture Workshop, Spring Lake, Michigan, June 15-16, 1995.

Kayes, T. 1995. Yellow perch food fish production in ponds and cages. Yellow Perch Aquaculture Workshop, Spring Lake, Michigan, June 15-16, 1995.

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Malison, J. A., and J. A. Held. 1995. Sex control and ploidy manipulations in yellow perch (*Perca flavescens*) and walleye (*Stizostedion vitreum*). Percid II, the Second International Percid Fish Symposium and the Workshop on Aquaculture of Percids, Vaasa, Finland, August 21-25, 1995.

Malison, J.A., and J.A. Held. 1996. Pond design, construction and management. Wisconsin Aquaculture Conference '96, Wausau, Wisconsin, February 16-17, 1996.

Malison, J.A., J.A. Held, and C.H. Amundson. 1991. Factors affecting the habituation of pond-reared yellow perch (*Perca flavescens*), walleye (*Stizostedion vitreum*), and walleye-sauger hybrids (*S. vitreum* female H *S. canadense* male) to intensive culture conditions. 22nd Annual Meeting of the World Aquaculture Society, San Juan, Puerto Rico, June 16-20, 1991.

Malison, J.A., J.A. Held, L.S. Procarione, T.B. Kayes, and C.H. Amundson. 1991. The influence on juvenile growth of heat and hydrostatic pressure shocks used to induce triploidy in yellow perch. 1991 Annual Meeting of the American Fisheries Society, San Antonio, Texas, September 8-12, 1991.

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