# YELLOW PERCH[(3)]

Project Component Termination Report for the Period
September 1, 1997 to August 31, 2001

**NCRAC FUNDING LEVEL**: $185,600[(4)] (September 1, 1998 to August 31, 2001)

**PARTICIPANTS:**

| | | |
|---|---|---|
| Paul B. Brown | Purdue University | Indiana |
| Donald L. Garling | Michigan State University | Michigan |
| Robert S. Hayward | University of Missouri-Columbia | Missouri |
| Jeffery A. Malison | University of Wisconsin-Madison | Wisconsin |
| ***Industry Advisory Council Liaison:*** | | |
| Forrest Williams | Bay Port Aquaculture Systems, Inc., West Olive | Michigan |
| ***Extension Liaison:*** | | |
| Donald L. Garling | Michigan State University | Michigan |
| ***Non-Funded Collaborators:*** | | |
| Forrest Williams | Bay Port Aquaculture Systems, Inc., West Olive | Michigan |

---

## REASON FOR TERMINATION

Objective was completed.

## PROJECT OBJECTIVE

Increase growth rates of yellow perch greater than 150 mm (6 in) by evaluating diets, feeding strategies, environmental manipulation, and mono-sex/bi-sex comparisons.

## PRINCIPAL ACCOMPLISHMENTS

University of Wisconsin-Madison (UW-Madison) researchers published a manuscript describing the effects of genistein on the growth and reproductive development of yellow perch. Low levels (0.75 mg/g [parts per thousand] of diet) of genistein may have a positive effect on growth in yellow perch, but no apparent estrogenic effects on reproductive function. The effects of genistein on growth and reproductive development are highly dependent on dose.

Also at the UW-Madison, the growth of male and female yellow perch in ponds was compared using one pond in each year of the project. In both studies female yellow perch had greater weight and length gains than males when grown in ponds. Females were larger at the beginning of each trial, and the difference in size between the males and females increased significantly as the studies progressed. At the conclusion of the two pond studies, females were 35 and 47% heavier, and 10 and 12% longer, respectively, than males. The growth of both males and females in these studies was relatively poor,

most likely due to the tags used to identify individuals. Tag retention was very poor, and those individuals that did retain the tags showed a high incidence of ulcerated and necrotic tissue at the site of the tag.

Studies at the University of Missouri were designed to determine whether the tendency for dramatic growth slowing in yellow perch upon reaching 75–100 g (2.65–3.53 oz) could be negated by subjecting fish to feeding regimes that elicited compensatory growth. The expectation that compensatory growth feeding schedules might improve perch growth arises from previous North Central Regional Aquaculture Center (NCRAC)-funded studies where weight gain was doubled in hybrid sunfish (relative to controls fed ad libitum) in response to feeding schedules that elicited the compensatory growth response. This growing significantly beyond control weights through compensatory growth is now known as growth overcompensation, and was first identified through a NCRAC-funded study.

A first experiment sought to determine whether total weight gain by largely mature age-2 yellow perch could be increased over that of continuously fed controls by using compensatory growth feeding regimes. Five compensatory growth feeding regimes involving repeating cycles of no-feeding (for either 2, 7, 12, 17, or 22 days) followed by ad libitum feeding for as long as elevated feeding rates occurred, were evaluated over a 125-day experiment at 21°C (69.8°F). While episodes of compensatory growth did occur in all treatment groups when food was resupplied after the no-feeding periods, perch did not surpass control fish weights in any treatment group, unlike what occurred previously for hybrid sunfish. Point estimates of final weight did not reach that of the control group in any treatment group. A second experiment was run subsequently in an attempt to achieve greater weight gains through compensatory growth. In the second experiment, a compensatory growth feeding schedule similar to that in Experiment 1 involving 12-day periods of no feeding was used. However, 12-day periods of maintenance feeding were used rather than 12-day periods of no-feeding. Weights of perch exposed to this modified compensatory growth feeding schedule rapidly caught up to control fish (unlike in Experiment 1), but the rapid growth immediately ceased as soon as this group reached control fish weights.

Although study results indicate that compensatory growth feeding schedules cannot be used to increase growth of adult and maturing yellow perch beyond that of continuously fed controls, valuable insights relating to compensatory growth, growth overcompensation, and yellow perch aquaculture were provided by this work. Results indicated that an upper-weight limiting mechanism involving appetite suppression precluded the yellow perch undergoing rapid compensatory growth from surpassing control weights. This result was clearly different from that observed for hybrid sunfish where compensatory growth carried them well beyond control weights. Through comparisons with the hybrid sunfish studies, it is suggested that factors including fish age (or sexual maturity status), time-of-year, species-specific response, and hybrid vigor, are determinants of growth overcompensation capacity in fishes. In this study it was observed that male and female yellow perch showed their most vigorous compensatory growth responses following food deprivation periods of different durations (after 2 days

of food deprivation for males, and 12 days for females); causes for these differences are not yet apparent. Under conditions of unrestricted feeding in the control groups, growth rates and growth efficiency of female yellow perch exceeded those of males by up to two-fold. It was also indicated that substantial periods of restricted feeding can be imposed on yellow perch which, if followed by appropriate feed reprovisioning periods, will result in complete recovery of lost growth with no loss of food conversion ratio. This capacity may be of value in aquaculture in relation to feed and growth rate management. An article based on the results of this study has been published in the Journal of Fish Biology.

Research at Michigan State University was designed to compare gender-related growth rates of yellow perch greater than 150 mm (6 in) raised in single-gender or mixed-gender cohorts. Reliable external secondary sex characteristics could not be identified. Male and female stocks purchased from commercial yellow perch growers were randomly assigned (8/tank). Experiments were conducted in 110-L (29.1-gal) tanks. Water temperatures were maintained at 21°C (69.8°F) by a recirculation system. Each tank of fish was assigned to one of four feeding rates (0.5, 1.0, 2.0, and 3.0% of total tank wet body weight of fish per day) and fed a commercial diet for 16 weeks. There were three replicate tanks per feeding rate treatment. Fish were weighed every two weeks and feed levels adjusted accordingly. A mixed-gender analysis was not completed because the percentage of males in the mixed stock (66%) was not significantly different than the predominantly-male stock (71%). Gender-related metabolic differences between the all-female and predominantly-male stocks were determined using a saturation kinetics model developed by Mercer. Total proximate analysis (lipids, crude energy, crude protein, ash, and moisture) was done to determine general nutritional requirements. The all-female stock had a greater maximum growth rate (1.850 g [0.065 oz]/day/tank) than the predominately-male stock (1.112 g [0.039 oz]/day/tank). The optimal feeding level for the predominately-male stock was 0.76%/day and the maintenance level was 0.37%/day. The optimum feeding and maintenance levels for the all-female stock were similar to those determined for the predominantly-male stock at 0.78%/day and 0.37%/day, respectively. No metabolic parameters, excluding maximum growth rate, were statistically different between the two gender groups.

Work at Purdue University (Purdue) was designed to identify legal flavor additives for perch that will lead to increased consumption of feed. The original proposal indicated two genetic groups of fish would be raised at either 16, 22, or 28°C (60.8, 71.6, or 82.4°F) and offered one of three flavor additives: krill meal, squid meal, and betaine. An additional genetic group was obtained that had a proven record of rapid growth. The three genetic groups were all-female fish from Lake Mendota, mixed-sex fish from Lake Mendota, and mixed-sex fish from North Carolina. All groups of fish were obtained as juveniles and were raised to the appropriate size for experimentation.

Purdue researchers compared food consumption, weight gain, and feed conversion ratio in two different genetic groups of yellow perch fed one of three dietary flavor additives and reared at either 16, 22, or 28°C (60.8, 71.6, or 82.4°F). Consumption of feed was significantly different at the three temperatures, increasing as temperature increased.

Consumption of feed was not significantly different between all-female perch and mixed-sex perch, but weight gain and feed conversion ratio of all-female perch were significantly higher then the mixed-sex group of perch. Diets containing krill and squid meals as flavor additives were consumed significantly better than the control diet. The diet containing betaine as a flavor additive was consumed to the same degree as the control and the other two experimental diets.

Purdue researchers completed experiments to increase growth rates of yellow perch greater than 150 mm (6 in) by evaluating diets, feeding strategies, environmental manipulation, and mono-sex/bi-sex comparisons. Perch were obtained from two private producers. One group was all-female, the other mixed sex. Both groups originated from Lake Mendota, Wisconsin. Both groups of fish were obtained as juveniles, transported to Purdue, and grown for six months to the desired size. Both genetic groups were stocked into one of three experimental systems. All three systems were initially at 22°C (71.6°F). The temperature in one system was gradually lowered (1°C/day) and the temperature in another system was gradually increased (1°C/day). After achieving the desired temperatures of 16 and 28°C (60.8 and 82.4°F), respectively, all fish were acclimated for an additional two weeks. Four experimental diets, one a control and the other three with a flavor additive, were formulated based on the known nutritional requirements and recommendations for perch. All were practical diets. The three potential flavor compounds (krill meal, squid meal, and betaine) were added to the diets at 0.5% of the dry matter. All diets were offered to triplicate groups of fish in each temperature system as a satiation feeding regime. At the end of eight weeks, all fish were counted and weighed. Total consumption, weight gain, and feed conversion ratio were determined for each replicate. Feed consumption and weight gain were significantly affected by diet and temperature. Consumption increased as temperature increased from 16-28°C (60.8-82.4°F), but weight gain increased as temperature increased from 16 to 22°C (60.8 to 71.6°F), then declined at 28°C (82.4°F). All-female fish gained significantly more weight and converted feed more efficiently than the mixed-sex groups. There were no significant interactions among the variables. It seems clear that feed intake can be influenced in larger perch and additional weight gain can be realized. Several flavor additives were identified in this study that are readily available for use in diets. Diets containing flavor additives for grow out of yellow perch are recommended.

**IMPACTS**

This research has established methods for improving yellow perch growth as fish approach market size. Studies to date have shown that female perch out grow males, and accordingly the use of mono-sex female stocks may be a method for producers to increase growth rates of perch. Previous work has led to the development of methods for producing mono-sex female stocks of perch and this technology is currently being used by six regional perch producers under an Investigational New Animal Drug (INAD) exemption granted by the Food and Drug Administration. The establishment of optimum feed levels for perch will help producers minimize feed costs, which are one of the primary costs of aquaculture production. The development of methods to promote perch growth with naturally occurring dietary supplements may further improve the

profitability of the culture of food-size yellow perch. There is significant interest in moving toward regionally manufactured diets for perch, containing less fish meal and more regionally available ingredients. In this trend, diet acceptance becomes a critical issue. These data provide the framework for new dietary formulations that are accepted by perch. Together, the above strategies should provide the means for producers to reduce the cost of raising perch to market size.

### RECOMMENDED FOLLOW-UP ACTIVITIES

This project was conducted to develop ways to increase growth rates of yellow perch greater than 150 mm (6 in) by evaluating diets, feeding strategies, environmental manipulation, and mono-sex/bi-sex comparisons. Research should be conducted on additional strategies for increasing the growth of male yellow perch or the use of all-female stocks. Additional research should be conducted on additional flavor additives as well as defining the minimum level of flavor additives required in diets containing high levels of plant protein sources.

### 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 | |
| 1997-98 | $95,300 | $98,565 | $2,000 | | | $100,565 | $195,865 |
| 1998-00 | $90,300 | $94,335 | | | | $94,335 | $184,655 |
| 2000-01 | | $45,000 | | | | $45,000 | $45,000 |
| **TOTAL** | $185,600 | $237,900 | $2,000 | | | $239,900 | $425,520 |

# YELLOW PERCH

***Publications in Print***

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

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

Brown, P.B., K. Dabrowski, and D.L. Garling. 1996. Nutrition and feeding of yellow perch (*Perca flavescens*). Journal of Applied Ichthyology 12:171-174.

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.

Hayward, R.S., and N. Wang. 2001. Failure to induce over-compensation of growth in maturing yellow perch. Journal of Fish Biology 59:126-140.

Ko, K. 1996. Effect of isoflavones and estradiol-17 on growth and reproductive function in yellow perch (*Perca flavescens*). Master's thesis. University of Wisconsin-Madison.

Ko, K., J.A. Malison, and J.D. Reed. 1999. Effect of genistein on the growth and reproductive function of male and female yellow perch (*Perca flavescens*). Journal of the World Aquaculture Society 30:73-79.

Kolkovski, S., and K. Dabrowski. 1998. Off-season spawning of yellow perch. Progressive Fish-Culturist 60:133-136.

Kolkovski, S., S. Czesny, and K. Dabrowski. 2000. Use of krill hydrolysate as a feed attractant for fish larvae and juveniles. Journal of the World Aquaculture Society 31:81-88.

Kolkovski, S., C. Yackey, S. Czesny, and K. Dabrowski. 2000. The effect of microdiet supplementation of dietary digestive enzymes and a hormone on growth and enzyme activity of yellow perch juveniles. North American Journal of Aquacualture 62:130-134.

Malison, J.A. 1999. Current status of yellow perch: markets and culture. Aquaculture Magazine 25:28-41.

Malison, J.A., and M.A.R. Garcia-Abiado. 1996. Sex control and ploidy manipulations in yellow perch (*Perca flavescens*) and walleye (*Stizostedion vitreum*). Journal of Applied Ichthyology 12:189-194.

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.

Oetker, M.A. 1998. Effects of parental size and age on larval growth and development: implications for improved intensive larval yellow perch (*Perca flavescens*) culture techniques. Master's thesis. Michigan State University, East Lansing.

Twibell, R.G., and P.B. Brown. 1997. Dietary arginine requirement of juvenile yellow perch. Journal of Nutrition 127:1838-1841.

Twibell, R.G., and P.B. Brown. 2000. Dietary choline requirement of juvenile yellow perch (*Perca flavescens*). Journal of Nutrition 130:95-99.

Twibell, R.G., K.A. Wilson, and P.B. Brown. 2000. Dietary sulfur amino acid requirement of juvenile yellow perch fed the maximum cystine replacement value for methionine. Journal of Nutrition 130:612-616.

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***

Yackey, C. In preparation. Improving acceptance, efficiency, and quality of formulated feeds for juvenile yellow perch *Perca flavescens*. Ohio State University.

***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. 1997. Recent developments in perch nutrition. Martinique '97, Island and Tropical Aquaculture, Les Trois Ilets, Martinique, French West Indies, May 4-9, 1997.

Brown, P.B. 2000. Percids-The American experience. 31st Annual Meeting of the World Aquaculture Society, Nice, France, May 2-6, 2000

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.

Brown, P.B., and R.G. Twibell. 1997. Dietary arginine requirement of juvenile yellow perch. 28th Annual Meeting of the World Aquaculture Society, Seattle, Washington, February 19-23, 1997.

Brown, P.B., K. Wilson, J. Wetzel, J. Mays, F. Binkowski, and S. Yeo. 1994. Culture characteristics of juvenile yellow perch (*Perca flavescens*) from different geographical locales grown at three temperatures. 25th Annual Meeting of the World Aquaculture Society, New Orleans, Louisiana, January 12-18, 1994.

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.

Culver, D.A., and K. Dabrowski. 1998. Fertilization and stocking procedures for pond culture of percids. 29th Annual Meeting of the World Aquaculture Society, Las Vegas, Nevada, February 15-19, 1998.

Dabrowski, K. and S. Kolkovski. 1997. Larval fish rearing--diets, enzymes, endocrine systems and what else. 14th Annual Meeting of the Canadian Aquaculture Association, Quebec City, Quebec, Canada, June 10-13, 1997.

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

Garling, D.L. 2000. Current status of flow-through grow-out production systems. North Central Regional Aquaculture Center Yellow Perch Producer Forum, Hudson, Wisconsin, January 21-22, 2000.

Garling, D.L. 2000. Current status/recent advances of tank fry culture. North Central Regional Aquaculture Center Yellow Perch Producer Forum, Hudson, Wisconsin, January 21-22, 2000.

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.

Held, J.A. 1997. Yellow perch production. Minnesota Aquaculture Association and North American Fish Farmers Cooperative Aquaculture Conference and Tradeshow, Brainerd, Minnesota, March 7-8, 1997.

Held, J.A. 1997. Advances in yellow perch production. North Central Regional Aquaculture Center Symposium on Yellow Perch Production, Piketon, Ohio, June 21, 1997.

Held, J.A., and J.A. Malison. 1997. Yellow perch aquaculture. Annual Conference of the Wisconsin Agricultural Teachers Association, Madison, Wisconsin, July 9-10, 1997.

Held, J.A., J.A. Malison, and T.E. Kuczynski. 1998. Techniques for the commercial production of feed-trained yellow perch *Perca flavescens* fingerlings. 29th Annual Meeting of the World Aquaculture Society, Las Vegas, Nevada, February 15-19, 1998.

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 Tradeshow (Second North Central Regional Aquaculture Conference), 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.

Kolkovski, S., K. Dabrowski, and C. Yackey. 1997. Larval rearing of yellow perch *Perca flavescens* spawning out of the season. 2nd International Workshop on Aquaculture of Percid Fish, Island and Tropical Aquaculture, Les Trois Ilets, Martinique, French West Indies, May 3-7, 1997.

Kolkovski, S., K. Dabrowski, and C. Yackey. 1997. Weaning diets for yellow perch *Perca flavescens*—suitability of commercial, semi-commercial, and experimental dry formulations. Fish Feed and Nutrition Workshop, Frankfort, Kentucky, September 12-13, 1997.

Kolkovski, S., S. Dzesny, C. Yackey, and K. Dabrowski. 1998. The use of krill hydrolysate as feed attractant for fish juveniles. Fish Feed and Nutrition Workshop, Pine Bluff, Arkansas, September 13-15, 1998.

Malison, J.A. 1994. Pond production of yellow perch fingerlings. Wisconsin Aquaculture '94, Stevens Point, Wisconsin, February 18-19, 1994.

Malison, J.A. 1995. Production methods for yellow perch. Wisconsin Aquaculture '95, Stevens Point, Wisconsin, March 17-19, 1995.

Malison, J.A. 1997. Reproduction and sex reversal in yellow perch and walleye. Third North Central Regional Aquaculture Conference, Indianapolis, Indiana, February 6-7, 1997.

Malison, J.A. 1997. Factors promoting and constraining the commercial culture of yellow perch, *Perca flavescens*. 28th Annual Meeting of the World Aquaculture Society, Seattle, Washington, February 19-23, 1997.

Malison, J.A. 1998. Raising food-size yellow perch in ponds. Wisconsin Aquaculture '98, Eau Claire, Wisconsin, March 13-14, 1998.

Malison, J.A. 1999. Current status of yellow perch (*Perca flavescens*) markets and culture. Aquaculture America '99, Tampa, Florida, January 27-30, 1999.

Malison, J.A. 1999. Sex control and ploidy manipulations in yellow perch (*Perca flavescens*) and walleye (*Stizostedion vitreum*). Aquaculture America '99, Tampa, Florida, January 27-30, 1999.

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., and J.A. Held. 1997. Pond design and construction for aquaculture. Wisconsin Aquaculture '97, Stevens Point, Wisconsin, March 14-15, 1997.

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 × *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., D.L. Northey, J.A. Held, and T.E. Kuczynski. 1994. Habituation of yellow perch (*Perca flavescens*) fingerlings to formulated feed in ponds using lights and vibrating feeders. 25th Annual Meeting of the World Aquaculture Society, New Orleans, Louisiana, January 12-18, 1994.

Malison, J.A., J.A. Held, M.A.R. Garcia-Abiado, and L.S. Procarione. 1996. The influence of triploidy and heat and hydrostatic pressure shocks on the growth and reproductive development of perch (*Perca flavescens*) reared to adult size under selected environmental conditions. International Congress on the Biology of Fishes, San Francisco, California, July 14-18, 1996 and Midwest Endocrinology Conference, Madison, Wisconsin, June 22-23, 1996.

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. 121st Annual Meeting of the American Fisheries Society, San Antonio, Texas, September 8-12, 1991.

Malison, J.A., J. Mellenthin, L.S. Procarione, T.P. Barry, and J.A. Held. 1997. The effects of handling on the physiological stress responses of yellow perch (*Perca flavescens*) and walleye (*Stizostedion vitreum*) at different temperatures. 2nd International Workshop on Aquaculture of Percid Fish, Island and Tropical Aquaculture, Les Trois Ilets, Martinique, French West Indies, May 4-9, 1997.

Malison, J.A., J. Mellenthin, A.B. Head, L.S. Procarione, T.P. Barry, and J.A. Held. 1998. Cortisol stress responses and growth of yellow perch *Perca flavescens* reared under selected intensive culture conditions. 29th Annual Meeting of the World Aquaculture Society, Las Vegas, Nevada, February 15-19, 1998.

Oetker, M., and D.L. Garling. 1997. The effects of maternal size on growth and survivorship of larval yellow perch. 127th Annual Meeting of the American Fisheries Society, Monterey, California, August 24-28, 1997.

Riepe, J.R., J. Ferris, and D. Garling. 1995. Economic considerations in yellow perch aquaculture. Yellow Perch Aquaculture Workshop, Spring Lake, Michigan, June 15-16, 1995.

Selock, D. 1995. Floating raceways for yellow perch culture. Yellow Perch Aquaculture Workshop, Spring Lake, Michigan, June 15-16, 1995.

Starr, C. 1995. Yellow perch food fish production in flowing water systems. Yellow Perch Aquaculture Workshop, Spring Lake, Michigan, June 15-16, 1995.

Twibell, R.G., and P.B. Brown. 1999. Dietary choline requirement of juvenile yellow perch. Aquaculture America '99, Tampa, Florida, January 27-30, 1999.

Williams, F. 1995. Federal grant opportunities? Yellow Perch Aquaculture Workshop, Spring Lake, Michigan, June 15-16, 1995.

Williams, F., and C. Starr. 1991. The path to yellow perch profit through planned development. First North Central Regional Aquaculture Conference, Kalamazoo, Michigan, March 18-21, 1991.

Yackey, C., S. Kolkovski, and K. Dabrowski. 1997. Weaning diets for yellow perch (*Perca flavescens*)—suitability of commercial, semi-commercial, and experimental dry formulations. Fish Feed and Nutrition Workshop, Frankfort, Kentucky, September 21, 1997.

Yackey, C., S. Czesny, S. Kolkovski, and K. Dabrowski. 1998. Effect of digestive enzyme and hormone on growth and digestive tract enzyme activity of yellow perch *Perca flavescens*. International Congress on the Biology of Fish, Baltimore, Maryland.