WALLEYE[(6)]

Project Termination Report for the Period
September 1, 1999 to June 30, 2002

NCRAC FUNDING LEVEL: $127,000 (September 1, 1999 to June 30, 2002)

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REASON FOR TERMINATION

The project objectives were completed.

PROJECT OBJECTIVES

(1a) Carry out commercial-scale field trials for rearing hybrid walleye fingerlings to food size (25.4 cm; 10.0 in minimum) in tanks.

(1b) Carry out commercial-scale field trials for rearing hybrid walleye fingerlings to food size (25.4 cm; 10.0 in minimum) in ponds (at least three ponds at each site) at sites in the upper and lower portions of the North Central Region (NCR).

(2) Conduct producer training workshops on propagation of hybrid walleye.

PRINCIPAL ACCOMPLISHMENTS

OBJECTIVE 1A

During spring 2000, Ohio State University (OSU) researchers raised both out-of-season and regular season spawned hybrid walleye in an 800-L (211-gal) cylindrical-tank rearing system. For these studies, the Spirit Lake (Iowa) strain of walleye and Mississippi River strain of sauger were used as brood fish because previous studies showed this particular cross to be faster growing than others. The water flow was set at 4.0-5.0 Lpm (1.1-1.3 gpm) and there were two surface spray points supplying an additional 0.75 Lpm (0.20 gpm) each. The central stand pipe in each tank was covered with 500-µm mesh screen. Daily measurements of turbidity, temperature, and dissolved oxygen were recorded. Turbidity in the tanks was maintained at a level of 10-20 nephelometric turbidity units by a constant supply of clay solution to the system through inlet pipes using a peristaltic pump (Masterflex, model 7021-24, Cole Parmer Instruments, Vernon Hills, Illinois). Water temperature was maintained at approximately 19-20°C (66.2-68.0°F) in both experiments. Dissolved oxygen levels varied between 6.5 and 8.0 mg/L (ppm). Light intensity and photoperiod were kept at 150 lx and 12-h light/12-h dark, respectively.

Samples of 10-20 viable larvae or juveniles from each tank were collected every three to four days. Presence of food in the gut and swim bladder inflation was recorded. These same larvae were measured for caudal length and wet weight. Survival of hybrid walleye after both experiments was determined by counting all the viable fish remaining.

Survival, final length, and weight for out-of-season and regular-season hybrid walleye reared at OSU were as follows: (1) out-of- season—13.1 ± 2.4% survival, 24.6 ± 2.4 mm (0.97 ± 0.09 in) final length, 0.15 ± 0.05 g (0.005 ± 0.002 oz) final weight; (2) regular season—19.0 ± 1.7% survival, 30.6 ± 4.2 mm (1.20 ± 0.17 in) final length.

In the second year of the study, OSU researchers were not able to produce sufficient numbers of 5.0-7.5 cm (2.0-3.0 in) feed-trained hybrid walleye juveniles for all of the tank and pond rearing experiments as originally proposed. Therefore, wild parental stocks from Ohio had to be used.

On April 4, 2001, OSU researchers with the help of Ohio Department of Natural Resources personnel, collected walleye eggs from ovulating females caught by trap nets from the Maumee River, Ohio. Undiluted hybrid walleye sperm was transported on ice. The eggs were fertilized with sperm on the river bank for 3 min and washed three times with 400 mg/L (ppm) tannic acid solution for 2 min each washing. The fertilized eggs were then washed with river water to allow water hardening. The fertilized eggs were transported to the OSU Aquaculture Laboratory in Columbus in oxygenated plastic bags. The time between fertilization and incubation of eggs in McDonald jars was about 4 h. Temperature of incubation was 14 ± 1°C (57.2 ± 1.8°F). Eggs were treated daily with 100 ppm formaldehyde starting four days after fertilization until one day before hatching to prevent fungal infection.

Hybrid walleye embryos hatched on April 17 and 18, 2001. Hatching rate was 70.4%. The newly-hatched embryos were stocked in 400-L (106-gal) circular tanks provided with flow-through water and allowed to absorb the yolk sac for three to four days. On April 21, 2001, newly-hatched embryos were placed in six oxygenated plastic bags (about 17,000 embryos per bag) and transported to OSU's Piketon Research and Extension Center (PREC). Fish from each of the six plastic bags were stocked into the same rearing system used in spring 2000. Temperature ranged from 16.7-19.8°C (62.1-67.6°F) and dissolved oxygen ranged from 7.7-8.2 ppm.

Fish were fed with dry diets of Biokyowa™ B-400 and B-700. Fish (<11 mm [0.4 in] total length) were fed with 100% Biokyowa™ B-400 from April 24 to May 8. The high survival observed in tanks 1-5 during this period (78-100%) suggested the high palatability of this diet and suitability of the pellet size for hybrid walleye. On May 8, survival ranged from 78-81% in tanks 1-5, although a lower survival of 7.8% was recorded in tank 6. From May 9 to May 15, fish (11-13 mm [0.43-0.51 in] total length) were fed with 50% Biokyowa™ B-400 and 50% B-700. Survival in tanks 1-6 declined sharply (0.1-7.8%) on May 15. A lot of uneaten food was observed at the bottom of the tank and fungus accumulated in the sidewalls of some tanks. Survival of fish in tanks 1-5 was similar during May 15-22 (3.7-7.8%).

In tank 6 a bimodal distribution of fish sizes was observed: 12 and 26 mm (0.47 and 1.02 in) total length; hence, cannibalism had occurred. On May 15, the experiment in tank 6 was terminated because of the very few fish that remained (N = 17).

On June 14, 2001, 300 feed-trained hybrid walleye (23.2 ± 3.4 mm [0.91 ± 0.13 in] total length; 0.13 ± 0.04 g [0.005 ± 0.001 oz]) were transported in oxygenated plastic bags to Freshwater Farms of Ohio, Inc. (FFO) for further rearing. However, these fish died soon after transport due to pump failure in the small rearing system at FFO.

Stocking of the tanks at FFO was dependent on the number of fingerlings produced by OSU. It was anticipated that a total of 18,000 fingerlings would be available and an estimated 21,500 fish were provided to this phase of the project. These fish were not the 50 mm (2.0 in) fingerlings that were anticipated for the demonstration of the commercial grow-out facility, but were 25 ± 2 and 31 ± 4 mm (0.98 ± 0.08 and 1.22 ± 0.16 in) in length, for early and regular season spawnings, respectively. Large mortalities occurred with these fish after transport and temporary facilities were provided in which they could better adapt to new facilities (tank and feed). They were placed in a 4.9 m (16 ft) wooden trough in which the tank system water was passed through and in which a small 1.2 m (4 ft) section was made with small mesh dividers for the fish to occupy. In-tank lighting and an automatic feeder was installed in the center of this section to increase the likelihood of feeding and to decrease the level of stress by creating high schooling density. A semi-moist salmon diet as feed (Rangen™, Buhl, Idaho) was successfully accepted by most of these fish.

The first batch of hybrid walleye juveniles was from out-of-season spawning and approximately 9,500 arrived at FFO on April 28, 2000. After 40 days the survivors numbered 3,350 and these were then transferred to the large tank system. As of the end of August, approximately 2,500 hybrid walleyes remained and averaged 13.4 cm (5.28 in), ranging from 12.1-15.2 cm (4.76-5.98 in). Average weight was 60 fish/kg (27 fish/lb) for a total of 48 kg (106 lb) in a 3,596-L (950-gal) tank. This rate of growth is as good or better than hybrid walleye raised in summertime under extensive pond culture conditions, and much better than that seen in other indoor laboratory studies in tank culture.

The second batch of hybrid walleye juveniles from OSU was from normal-season spawning and approximately 12,000 arrived on June 16. The juveniles were again stocked into a wooden trough that allowed system water to pass through. After 11 days, there were approximately 2,500 survivors. After 30 days, the 2,000 remaining fish were 6.35-10.2 cm (2.5-4.0 in). Unfortunately, just days before the planned transfer of fish from the trough to the large tank, a power outage occurred. While the rest of the system continued to operate after the backup system resumed flow in the main system, the brief shutdown produced an airlock in the water supply pipe to the temporary trough arrangement. This was not discovered until virtually all the fish were lost in the stagnant water of the trough.

FFO continued the rearing of hybrid walleye in the WaterSmith recirculation system for 521 days until October 1, 2001. The following data represents date of sampling, estimated number, and size at sampling: (1) April 28, 2000 (day 0), $N = 9{,}500$, 1.25 cm (0.49 in); (2) October 31, 2000 (day 186), $N = 1{,}600$, 80% at 15-20 cm (5.9-7.8 in), 19/kg (8.6/lb) and 20% at 10-15 cm (3.9-5.9 in), 55/kg (24.9/lb); (3) January 10, 2001 (day 257), $N = 1{,}579$, 80% at 19.7-22.3 cm (7.6-8.8 in), 13/kg (5.9/lb) and 20% at 16.5-18.4 cm (6.5-7.4 in), 31/kg (14.1/lb); (4) March 12, 2001 (day 318), lost 812 fish due to mechanical failure over four days; (5) March 16, 2001 (day 322), $N = 746$, 80% at 22.9-27.9 cm (9.0-11.0 in), 9/kg (4.1/lb) and 20% at 15.2-20.3 cm (6.0-8.0 in), 18/kg (8.2/lb); (6) September 15, 2001 (day 505), $N = 719$, 75% at 27.9-35.6 cm (11.4-14.0 in), 3/kg (1.4/lb) and 25% at 22.9-27.9 cm (9.0-11.0 in), 9/kg (4.1/lb); (7) October 1, 2001 (day 521); $N = 711$.

The recirculating WaterSmith tank system has proven to be quite successful in rearing fingerling hybrid walleye to market size. There has been no problem with outbreaks of columnaris (*Flexibacter columnaris*) and bacterial gill disease (*Flavobacterium branchiophila*), and the fish in these round tanks appear to avoid the problems of physical injury. The use of in-tank lighting on a 24-h constant cycle has helped minimize the amount of stress in the hybrid walleye as noted in their aggressive feeding behavior. The collection and disposal of solid waste has proven to be easy in the conical-bottom tanks, and the activities of the fish have not interfered with the removal. The simple pea gravel system as biofilter has removed the ammonia produced by fish, and the temperature of the water in the system has been maintained through most of the year.

FFO personnel observed that the first month of feeding when the hybrid walleye were still quite small (<3 cm [1.2 in] in length) was very labor intensive using hand-feeding 4-6 times a day. An automatic feeder operating 24 h/day was also used. A combination of two starter diets produced by Rangen, Inc. was utilized. A 50/50 mix of #00 trout starter and 1/32 in semi-moist salmon starter diets was used in the first month. In the second and third month, feed sizes were gradually increased until a 50/50 mix of Rangen 1/16 and 1/8 semi-moist diets was fed. It was during this time that the hybrid walleye were transferred into the large tanks of the WaterSmith recirculation systems, and most of the feeding was done by the automatic clock-sweep feeders. By the end of six months after arrival at FFO, the feed was switched to Rangen's 3/16 in sinking "Trout Production Diet." The delivered price for this diet in the NCR is usually $0.70/kg ($0.32/lb).

Initially, a feeding rate of 0.9 kg (2 lb) per tank per day was dispensed from an automatic clock-sweep feeder over the central standpipe that housed the in-tank lighting system.

The amount of feed consumed by the fish that were weighed on August 31, 2001 at the end of the experiment was calculated to be 214.9 kg (473.8 lb). (This figure is corrected for fish lost on March 11, 2001 when approximately 50% were killed due to a mechanical failure. Installation of a water level alarm in the sump pump barrel would have prevented this loss of fish.) Therefore, the estimated feed/gain ratio for the surviving hybrid walleye (148.3 kg [327 lb]) was 1.45:1. This includes the feed consumed by other mortalities during the phase II grow out, because all other deaths were only 6.5% of the starting population, and were distributed evenly throughout the time of the experiment.

At FFO, ammonia levels were usually quite low, and were never above 1.1 ppm. Nitrite levels were measured during the summer of 2001 when ammonia levels were at their peak, but remained low (0.01-0.03 ppm), even after ammonia levels returned to normal at 0.4 ppm. Fish densities at the end of the experiment were 0.4 kg of fish/L of tank water or 0.33 lb/gal. Dissolved oxygen and carbon dioxide levels were always at normal levels. Three times during the course of the experiment the stainless steel aquaculture heaters failed and had to be replaced. These expensive ($250-$350) commercial units were sizes suggested by the manufacturer, and regular cleaning of the heater elements was necessary. Because of the failures, optimal temperatures around 23°C (73.4°F) were not always maintained, and this probably slowed the growth of the hybrid walleye when water temperatures were below 20°C (68.0°F).

Two of the major problems with previous hybrid walleye culture efforts have been the stress factors due to light and sound disturbances, and the resulting incidence of diseases such as columnaris and secondary fungal infections. No incidence of disease was evident throughout this project. The use of larger round tanks, in-tank low-level light systems, partial tank covering with no overhead lighting, and 24 h constant-on light cycles all seemed to reduce apparent behavioral stress in the hybrid walleye. In addition, prophylactic levels of salinity were usually maintained between 0.15-0.25% and this may have been important in preventing the columnaris outbreaks that are common in percids. Future controlled studies will be necessary to confirm this effect.

Another common problem with hybrid walleye culture has been cannibalism. Until most fish were over 10 cm (3.9 in) in length, a good deal of effort was involved in removal of larger cannibals during phase I culture in the make-shift troughs. In the phase II culture when the fish were in the large round tanks, the incidence of cannibalism was relatively minor. The use of automatic feeders that dropped pellets over a 24 h period may have helped reduce this problem.

Aeration of WaterSmith systems is provided by low-pressure, high-volume regenerative blowers, and these also provide air to operate air-lift pumps that move water from the ring filter sections to the pea gravel biofilter. One 1-hp blower is able to support the air needs of eight tanks in four modules. Each two-tank module also requires a submersible pump that lifts the water from the bottom of the gravel biofilter to the top of the fish tanks where it is directed at an angle to induce a circular flow pattern. A continuous-duty submersible pump manufactured by Little Giant, Co. was utilized (rated at 1/3 hp with a maximum zero-head lift at 2,500 gal/h [gph]). Measurements of energy consumption were taken and found to have an operating energy use of 10.25 amps at 115 VAC. With an expected power factor of 70%, this translates into 825 watts of power usage. Therefore, continuous operation of this pump at 19.8 KW/day would cost $1.64/day (assuming $0.08 per KWH). Later tests with other pumps found that a ½ hp pump manufactured by Tsurumi would be more economical, and would pump 3,500 gph using only 6.2 amps at 115 VAC, or $0.98 worth of electricity per day.

Daily labor requirements for the modules consists of cleaning overflow screens, checking water flows, loading the automatic feeders (with some supplemental hand-feeding), and flushing the solids from the collection basins at the bottoms of the conical tanks. These tasks typically require less than 2 min/day/module. The ring filters are cleaned twice a year, and this takes about 2 h of time. Normal monthly maintenance also includes removal of mineral deposits from the water heater elements, testing of alarm and backup systems, and checking fish for signs of disease or body condition factors (2-3 h/module/month). Water quality parameters may be measured weekly, biweekly, or as needed when fish behavior becomes suspicious (usually a change in feeding or swimming behavior). Based on 15 years of previous experience with the pea gravel biofilters, these require surface raking or tilling every 1-2 months, and gravel replacement every 8-10 years.

In total, the amount of time required for normal feeding, monitoring, and maintenance labor would be 40 h/yr for each WaterSmith 2-tank module. The length of time that was required to raise fingerlings to market size was about one year. If average farm labor and overhead are calculated at $8.00/h, then the total labor cost for 40 h/yr/module would be $320.

The estimated total operational costs per 454 kg (1,000 lb) fish (including labor costs) was estimated at $2.87/kg ($1.30/lb) fish or $2.23/kg ($1.01/lb) fish (excluding labor costs). These estimates do not include the cost of the WaterSmith systems and the cost of fingerlings.

OBJECTIVE 1B

<u>University of Wisconsin-Madison</u>

Commercial-scale pond studies conducted by the University of Wisconsin-Madison (UW-Madison) at the Lake Mills State Fish Hatchery near Madison, Wisconsin represented a site in the upper, or northern, portion of the NCR. In 2000, hybrid walleye fingerlings (using the same parental stocks as those used by OSU; Spirit Lake, Iowa female walleyes and Mississippi River male saugers) were raised to the appropriate size needed (20-80 g; 0.7-2.8 oz) for subsequent pond grow-out studies. In May 2001, these fingerlings were stocked into four ponds, each at 898 fish/ha (2,220 fish/acre). The fish in two ponds were fed a floating diet, and the fish in the other two ponds were fed a sinking diet. All fish were fed once per day at dusk. The grow-out study lasted 156 days.

Fish growth rates were excellent over the course of the study, averaging 0.79 g/day (0.0279 oz/day) and 0.60 mm/day (0.0236 in/day). No growth differences were found between the two diets (0.80 versus 0.78 g/day [0.0282 versus 0.0275 oz/day] and 0.62 versus 0.57 mm/day [0.0244 versus 0.0224 in/day] for fish fed sinking and floating food, respectively). A strong feeding response was observed in all ponds during the late spring and early summer. An unusually warm summer, however, resulted in high pond temperatures (>28°C; 82.4°F) during July, and was likely responsible for a sharp decrease in feeding activity that was observed during this time. A strong feeding response was again observed when water temperatures declined (<25°C; 77.0°F) in August.

After harvest, the fish were identified for sex and processed as scaled skin-on fillets. Important production and carcass characteristics were as follows, for males and females, respectively: (1) total length— 25.6 ± 0.6 versus 26.3 ± 0.5 cm (10.1 ± 0.2 versus 10.4 ± 0.2 in); (2) weight—160.0 ± 11.8 versus 170.0 ± 9.3 g (5.6 ± 0.4 versus 6.0 ± 0.3 oz); (3) fillet weight—74.9 ± 5.7 versus 78.2 ± 4.4 g (2.6 ± 0.2 versus 2.8 ± 0.16 oz); (4) fillet yield (%)—46.7 ± 0.6 versus 45.9 ± 0.5; and (5) gonadosomatic index* (%)—1.1 ± 0.1 versus 0.5 ± 0.2 (* significantly different at $P > 0.05$).

As the above data shows, sexually-related dimorphic growth was not apparent in this study. This result was not surprising, since other studies in our laboratory have shown that female walleye do not begin to outgrow males until the fish reach approximately 230 g (8 oz) total weight and 30 cm (12 in) total length.

Fish survival in two of the ponds was very poor (<25%). This poor survival was due to severe predation by blue herons, which were frequently observed catching fish during feeding times. The Lake Mills State Fish Hatchery is located in the center of a small city and municipal regulations prohibit the use of firearms, noisemakers, or traps to control predation. Subsequent to this study, it was found that bird netting can be used to effectively eliminate the activity of the important predators at the Lake Mills ponds.

At the conclusion of these studies, groups of hybrid walleye fillets were sent to investigators at Michigan State University and North Dakota State University for sensory evaluations and marketing studies on hybrid walleye.

University of Missouri

The major goal of the University of Missouri's (UM) portion of the study was to develop information on growth and survival rates of hybrid walleye reared to 25.4-30.5 cm (10.0-12.0 in) in commercial production ponds in the lower, or southern, portion of the NCR. Findings were to be compared, ultimately, to those from a parallel pond study conducted near Madison, Wisconsin, to portray differences in survival and times to market size due mainly to differences in thermal regimes.

Bioenergetics Modeling

A walleye bioenergetics model was used at UM to gain insight into effects of the different thermal regimes in Madison, Wisconsin ponds and ponds located in southern Missouri on both consumption and growth rates of hybrid walleye. Modeling results indicated that juvenile hybrid walleye should grow substantially faster under the warmer thermal regimes in southern Missouri ponds and that fish appetites (cumulative consumption) will average 1.4× greater than in the Madison, Wisconsin ponds. However, the modeling also indicated that adult hybrid walleye would consume more food and grow faster in the northern location because of fewer days with pond temperatures in excess of 26°C (78.8°F). The model also predicts adult walleye to grow poorly and to ultimately lose weight at temperatures above 26°C (78.8°F). Overall, bioenergetics modeling suggested that ponds in the southern Midwest may be more favorable for growing hybrid walleye to low-end market size (25.4-30.5 cm; 10.0-12.0 in) but that thermal conditions are more favorable in the north for rearing hybrid walleye to larger sizes. This relates to the tendency among fish to grow best in early life stages at temperatures higher than those that are most favorable for adult fish growth.

Commercial Pond Study

Hybrid walleye (3.8 cm [1.5 in] mean length) received from OSU on May 5, 2000 survived poorly in net pens anchored nearshore in production ponds at Flowers Aquaculture in Dexter, Missouri. Examination of fish guts indicated that the fish had gone off feed. None of these fish were released into ponds due to the low survival rates. Delivery of a second batch of hybrid walleye was expected from OSU in 2000, however, these fish were not provided due to rearing problems at OSU. Consequently, 9,000 pure walleye were secured from the Spirit Lake State Fish Hatchery in Iowa, with the assistance of Mr. Alan Moore (Iowa Department of Natural Resources), Ms. Donna Mumm (the hatchery manager), and others. These fish (mean length of 7.4 cm [2.9 in]) were stocked into net pens in ponds at Flowers Aquaculture, fed a commercial diet by hand, and monitored carefully for approximately two weeks. Survival rates in net pens were high (mortality <10%) and fish were released into three ponds (N = 3,000 fish/pond) on July 29, 2000. Fish were sampled from the ponds by seining on three different dates over a 14 month period, with final harvest on October 3, 2001 when the ponds were drained. Fish had been fed once daily through June 27, 2001, and then twice daily thereafter. Size grading to reduce cannibalism was limited to removing individuals collected during routine sampling that were substantially larger than the mean size. Because walleye survival through February 2001 was low in two ponds, the pond owner combined fish from these two ponds into the third pond (in which walleye survival had been substantially better) in February 2001. Consequently, averaged growth results from all three ponds is reported.

Walleye mean lengths and weights across all ponds reached 23.6 cm (9.3 in) and 118 g (4.2 oz) in 14 months, just under the minimum food-market size of 25.4 cm (10.0 in). Examination of final length showed that the fish size range was quite broad. However, the upper 50th percentile of fish had surpassed the low-end market size of 25.4 cm (10.0

in), and upper-quartile fish reached sizes ranging from 28-43 cm (11.0-16.9 in), beyond the lower market limit. Hence, a potential was indicated for a substantial portion of walleye stocked at approximately 7.6 cm (3.0 in) to reach low-end food-market size in a little more than one year in southern Missouri ponds. Comparative data for 14-month growth of pure walleye in northern ponds were not available. However, rough projections of the time required to rear fingerling walleye to 40.6 cm (16.0 in) based on extrapolation of the data from southern Missouri ponds indicated it would take 23.9 months, whereas a study of northern Midwest ponds indicated it would take roughly 27.3 months to reach 40.6 cm (16.0 in). Taken in combination, southern Missouri pond results and bioenergetics modeling provide some evidence that walleye or hybrid walleye can be grown to low-end food market sizes (25.4-30.5 cm [10.0-12.0 in], petite walleye) more rapidly in the southern portion of the Midwest than in more northerly portions.

Cannibalism was considered the primary cause of mortality of walleye in the southern Missouri ponds. Total mortality across all ponds appeared persistent throughout the 14-month study period. Periodic, absolute mortality rates were estimated as: July-October 2000 (69%), October 2000-February 2001 (50%), and February-October 2001 (69%), with an overall mortality rate of 95%. It is believed that four factors led to the high mortality rates in the southern Missouri ponds: (1) that it was necessary to stock walleye rather than hybrid walleye, the latter being known to show lower rates of cannibalism, (2) that the warmer southern Missouri water temperatures, though apparently favorable for juvenile growth, likely also elevated walleye appetites (by 1.4×), and increased the potential for cannibalism, (3) that a once-daily feeding frequency with sinking feed, applied throughout most of the study may not have sufficiently satiated the walleye, and (4) that combining of fish whose mean lengths and length ranges differed by more than 2.54 cm (1.0 in) and 12.7 cm (5.0 in), respectively, likely promoted cannibalism. Parallel comparisons of mortality rates in two of the study ponds, one with substantially more walleye size disparity than the other (total ranges of walleye length being 17.8 cm [7.0 in] versus only 5.3 cm [2.1 in] in the other), showed rather modest differences in mortality rates (60% versus 40%, respectively) during the period October 16- February 23. These results suggest that while grading for increased size uniformity may hold some benefits in terms of improving survival, substantial mortality still occurred in the pond with relatively uniform fish sizes. Efforts beyond promoting size uniformity will be necessary to achieve high survival.

Finally, an analysis of profit margins with respect to rearing walleye or hybrid walleye to a range of food-market sizes (25.4 cm [10.0 in], 35.6 cm [14.0 in], and 40.6 cm [16.0 in]) with fish survival rates ranging from 25-100% was performed. Cost factors included fingerling walleye ($0.50/fish) and feed; selling price was considered $4.87/kg ($2.21/lb) live weight; the analysis was based on starting with 9,000 fingerlings. The most striking results of this rough analysis was that profit margins appeared extremely narrow for 25.4-cm (10.0-in) fish relative to those for rearing 35.6-cm (14.0-in) and 40.6-cm (16.0-in) fish. At 100% survival, profits for rearing those three size fish were indicated as $467, $8,745, and $16,195, respectively. Results suggest that for rearing 25.4-cm (10.0-in) fish, if markets for fish of this size truly exist, a very high volume would be needed in combination with high survival rates for reasonable profits to be made. Given the increase in profit margin potential indicated for rearing fish to larger sizes, it appears that targeting for 30.5-cm (12.0-in) fish for the petite walleye market may be most reasonable.

In summary, this study provided evidence that there may be benefits to rearing hybrid walleye in ponds in the southern Midwest ponds for petite walleye food markets due to a more rapid growth potential associated with warmer thermal regimes. However, higher appetites associated with warmer temperatures may also promote cannibalism. Future work should focus on rearing hybrid walleye rather than pure walleye in southern Midwest ponds. The use of removable physical structures for the purpose of predation interference could be considered if additional means for reducing cannibalism are warranted. Rearing walleye to 30.5 cm (12.0 in) versus 25.4 cm (10.0 in) for petite walleye markets appears more reasonable due to much increased profit margins for the former.

Kinnunen of Michigan State University (MSU) organized the first Hybrid Walleye Culture Workshop in February 2002 in conjunction with the Michigan Aquaculture Association Annual Meeting in Cadillac, Michigan. Researchers from OSU, UW-Madison, and UM involved with this project made presentations on the growth and sex control of hybrid walleye; status report on hybrid walleye rearing, polyploidy, and sex determination; growth rates of walleye in southern Missouri ponds; marketability of hybrid walleye; and preliminary results of industry and consumer surveys. After the presentations the researchers participated in a hybrid walleye panel discussion and answered questions from aquaculture producers. At this workshop, participants had the opportunity to taste test hybrid walleye fillets and they rated the final product as highly acceptable. The workshop ended with a focused discussion on producer perspectives on the feasibility and opportunities for producing and marketing hybrid walleye.

Kinnunen, working with Bob Pierce of UM, has organized a second Hybrid Walleye Culture Workshop that will be held in Cape Girardeau, Missouri on March 5, 2003. The second workshop will be conducted similarly to the first.

IMPACTS

The field trials described under Objectives 1a and 1b have generated some baseline information on production parameters (including, but not limited to, fish growth rate, survival, and feed conversion) that can be expected for commercially raising hybrid walleye to food size in recirculation tanks and in ponds in the upper and lower portions of the NCR. In addition, the trials generated detailed information that can be used to plan studies on economic models outlining the production costs of producing food-size walleye hybrids with these different systems.

New and existing fish farmers in the NCR have already started to express interest in the implications of an economical approach to indoor recirculating systems for the raising of high-value fish like hybrid walleye. Based on commercial experience to date with rainbow trout, farms in Michigan, Minnesota, and Ohio are considering the use of the WaterSmith designs. It is an important part of the beneficial impact of this technology transfer that indoor systems like these help solve many problems associated with outdoor culture of fish. The main benefits are: (1) year-round production cycles instead of winter down time, (2) improved waste handling and management, (3) exclusion of wild bird and animal predation, (4) containment of aquaculture species to prevent wildlife impacts, (5) prevention of off-flavors derived from algal blooms as seen with pond cultured fish, (6) improved control over fish diseases and parasites compared to outdoor culture, (7) reduced cost and labor at harvest, (8) expansion of aquaculture production into areas where water quantity or quality may be limiting, (9) development of aquaculture facilities closer to markets and population centers, and (10) decreased space and land requirements for indoor intensive fish farming compared to extensive pond culture (<2% of area needed for ponds).

There is substantial interest in the potential to rear walleye in Missouri for food markets. Results from this study should begin to define this potential including possible pitfalls.

Results of the UW-Madison study demonstrate that hybrid walleye can be grown in ponds in the upper part of the NCR to a marketable size by the end of the second growing season. The UW-Madison researchers documented expected production parameters and key information on the economic inputs and outputs for this species and system type. The results of these studies have provided important information regarding grow out of hybrid walleye to market size in ponds.

Those who took part in the Michigan workshop all rated hybrid walleye as an extremely high quality product.

RECOMMENDED FOLLOW-UP ACTIVITIES

In a study performed outside of this project, researchers at OSU demonstrated that triploid saugeye produced by pressure shocking has potentially better growth than diploids. This research should be continued with respect to intensive rearing systems.

Economists should use the information generated by these studies to develop economic models for defining the production costs of hybrid walleye raised using the various system types evaluated in this project. Key bottlenecks that limit the profitability of raising hybrid walleye to food size should be identified, and subsequent research should be directed at removing these constraints.

PUBLICATIONS, MANUSCRIPTS, OR PAPERS PRESENTED

See the appendix for a cumulative output for all NCRAC-funded Walleye activities.

SUPPORT

YEAR	NCRAC-USDA FUNDING	OTHER SUPPORT					TOTAL SUPPORT
		UNIVER-SITY	INDUSTRY	OTHER FEDERAL	OTHER	TOTAL	

1999-00	$63,750	$45,027	$750[a]			$45,777	$109,527
2000-01	$57,350	$71,780	$1,500			$73,280	$130,630
2001-02	$5,900	$25,475				$25,475	$31,375
TOTAL	$127,000	$142,282	$2,250			$144,532	$271,532

[a]Freshwater Farms of Ohio, Inc., Urbana, Ohio

WALLEYE

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