BAITFISH[1]

Project ***Termination Report*** for the Period
September 1, 2006 to August 31, 2010

NCRAC FUNDING: $200,000 (September 1, 2006 to August 31, 2010)

PARTICIPANTS:

Fred P. Binkowski	University of Wisconsin-Milwaukee	Wisconsin
Gregory J. Fischer	University of Wisconsin-Stevens Point	Wisconsin
Jeffrey L. Gunderson	University of Minnesota-Duluth	Minnesota
Joseph E. Morris	Iowa State University	Iowa
Jeffrey A. Malison	University of Wisconsin-Madison	Wisconsin
Industry Advisory Council Liaison:		
Phil Goeden	Goeden Fisheries, Alexandria	Minnesota
Extension Liaison:		
Jeffrey L. Gunderson	University of Minnesota-Duluth	Minnesota
Non-Funded Collaborators:		
Barkhausen Waterfowl Reserve	Brown County	Wisconsin

REASON FOR TERMINATION
Project objectives completed.

PROJECT OBJECTIVES

(1) Determine what techniques and strategies for early season, indoor spawning of golden shiners and subsequent stocking into ponds will result in growth to 76 mm (3 in) by November 1 of that year.

(2) Develop economically viable culture techniques and strategies for growing spotfin shiners to a market size (greater than 51 mm [2 in]).

(3) Provide regular research updates related to this project to the baitfish industry through Web-based technologies, newsletters, fact sheets, workshops, and/or technical bulletins.

PRINCIPAL ACCOMPLISHMENTS

OBJECTIVE 1

Iowa State University (ISU) staff were successful at developing a strategy for early season spawning of golden shiners. Initially, fish were held indoors under "winter" conditions, i.e., 10°C (50°F) water temperature and a photoperiod of 8 h light/16 h dark and fed a 32% protein diet at 2% body weight twice weekly. Brood stock were held under these conditions for 10 weeks. Following this "winter" period, temperature and photoperiod were gradually increased over a 2-week transition period to "spring" conditions, i.e., 22°C (72°F) and a photoperiod of 16 h light/8 h dark. Once the tanks were under "spring" conditions,

[1]This is a project that had two years of funding and is chaired by Joseph E. Morris. It began September 1, 2006.

commercial spawning mats were placed into the tanks, just under the water surface. At this stage, ISU staff determined that too many eggs and fry were not surviving due to the presence of fungus on the mats; cool water temperatures combined with excess feed caused excessive fungal growth. To overcome this problem, ISU staff began utilizing a technique in which the egg-covered spawning mats were immersed for 2–2½ min in a 1.5% sodium sulfite solution bath. This caused the eggs to drop out of the mat after which they were placed in hatching jars. This method allowed for enumeration of the eggs as well as the culture of the fry in tanks without spawning mats, thus eliminating fungal growth.

In 2007 and 2008 nine larval diets were evaluated. Stocking rates ranged from 8–40 fry/L (30–151 fry/gal). Results from the 2007 and 2008 culture seasons showed the Zeigler AP100™diet yielded the best survival; mean survival ranged from 1–28%.

In a related project, the efficacy of hydrogen peroxide (H_2O_2) to control fungal (*Saprolegniasis*) infections of golden shiner eggs was evaluated in two experiments. Results garnered from this experiment indicate that golden shiner eggs should be exposed in a 15-min static bath at 800 mg/L H_2O_2 (30% active ingredient concentration of H_2O_2) in a single treatment.

Because of the low fry survival in both 2007 and 2008, ISU researchers were not able to complete the original project objectives, i.e., use of out-of-season fry in ponds. Instead the objectives of the pond portion of ISU's studies were modified in 2007 to (1) evaluate the growth of golden shiner fry in ponds using two fertilization regimes, one a mix of organic and inorganic fertilizers and the other organic fertilizer only, and (2) evaluate diet selection of fry in ponds using those two fertilization regimes. Production from this experiment in total weight ranged from 239.7–690.2 kg/ha (213.9–615.8 lb/acre) in the organic only treatment and 429.1–646.2 kg/ha (382.8–576.5 lb/acre) in the mixed fertilization treatment.

In 2008 ponds were stocked with either adults (similar stocking rate used in 2007) or with eggs obtained from out-of season spawning. The objective was to investigate if the use of eggs alone (600,000 eggs/ha; 242,820 eggs/acre) would yield fish that were of a more consistent size distribution compared to the use of brood stock. The ponds that stocked with only eggs yielded larger fish, mean 122 mm (4.8 in) than ponds stocked with adults, mean 69.2 mm (2.72 in). However, the ponds stocked with the eggs had a total mean production of 194 kg/ha (1,057 lb/acre) compared to 612 kg/ha (3,333 lb/acre). Both treatments resulted in fish larger than the targeted 76 mm (3 in) size.

OBJECTIVE 2

University of Wisconsin-Milwaukee

Wild adult brood stock were collected during the summer of 2005 from river and streams in southeastern Wisconsin. Wild fish were acclimated to 23–25°C (73–77°F) under laboratory conditions. The wild fish accepted standard commercial feeds after several days of feed training. One group of adults was maintained at seasonal (normal) temperatures and a second group was kept at a constant temperature of 23–25°C (23–25°F).

Wild brood stock that were maintained at 23-25°C (23-25°F) from August 2005 to August 2007 spawned out-of-cycle from March–May and produced progeny in the tens of thousands. The F_1 generation (older fish) produced in 2006 (domesticated brood stock) kept at a constant temperature

exhibited spawning behavior but gamete production was poor.

Wild brood stock kept at a seasonal temperature from August 2005 to August 2007 exhibited spawning behavior and produced progeny from May through September resulting in a F_1 generation of 2006. The F_1 generation exhibited spawning behavior and produced numerous 2007 F_1 generations.

Culture techniques for early life stage feeding included: green tank water (GTW), brine shrimp nauplii (BSN) and commercial larval diets. F_1 generations reached an estimated size of 51 mm (2 in) in 12–14 months. Survival was poor throughout the entire post-larvae stage.

University of Wisconsin-Stevens Point (UW-Stevens Point) Northern Aquaculture Demonstration Facility (NADF) and the University of Wisconsin-Madison (UW-Madison)

Researchers could not conduct their studies as originally planned because of issues regarding the interstate transport of fish that arose subsequent to the outbreak of viral hemorrhagic septicemia (VHS) in the Great Lakes. Because of these issues, the number of adult-sized fish that could be obtained for the 2007 and 2008 studies were limited. The limitation on brood fish, in turn, led to a reduction in number and a delay in time at which fry became available. Additionally, in 2008 the extreme flooding in the southern Wisconsin region precluded the conduct of any meaningful pond-based studies.

In the spring of 2007, NADF staff set up multiple 227 and 1,514-L (60 and 400-gal) tanks for holding, spawning, and incubation of spotfin shiners and eggs. The fish accepted a commercial trout diet and were kept in temperatures of 18–21°C (64–72°F) during spawning. Several types of spawning substrates were placed into rearing tanks during the spring of 2008. Adult fish (52.0–112.0 mm; 2.0–4.4 in) responded to a variety substrates immediately with active spawning behavior and swarming around the substrates. Eggs hatched within 5–7 days at 18–21°C (64–71°F), resulting in thousands of <5.0 mm (0.2 in) fry. Newly hatched fry were initially lethargic and non swimming but became photopositive and strong swimming within a few days. Fry were fed commercial starter diets of several types supplemented with pond water and 24-h lighting. Biomarine Artemac produced the best results with fry at NADF in 2008. Fry were observed with feed in stomachs after a few days. Survival of fry to fingerling size was <10%. Average growth rate from fingerlings examined was 0.4 mm/day (0.016 in/day) at 19–21°C (66–70°F) in the recirculating system on a commercial trout diet.

Strong swimming, photopositive fry were collected from NADF and delivered to the UW-Madison facilities at the Lake Mills State Fish Hatchery at three times during the spawning time frame. These fry were stocked into two fertilized outdoor rearing ponds at approximately 25,000 fish/ha (61,774 fish/acre). When the fish in one pond reached 15.0–25.0 mm (0.6–1.0 in) staff began regularly feeding them a formulated food, which they readily accepted. In the autumn both ponds were harvested, but only 10% of the stocked fish were recovered. The fish had a mean size of 35.0 mm (1.4 in).

In 2009, a successful attempt was made to conduct the pond-based study onsite at NADF. In May, banked brood stock at NADF and additional brood stock from Minnesota were introduced into the warm water recirculating aquaculture system

operations at NADF and spawned utilizing equipment and techniques described below from 2007-2008. Using fry garnered from the indoor spawning operations, a nursery pond were stocked in June-August 2009. Prior to being stocked, the pond was fertilized with alfalfa meal and urea. Fry survival in the outdoor pond trial appeared much better than in previous attempts indoors. In two harvest operations in September and October an estimated 20,600 fingerlings (13.0–44.0 mm [0.5–1.7 in) (95% survival was observed) were harvested and placed into a 20.0–22.0ºC (68.0–71.6°F) recirculating aquaculture system in NADF for further grow out. Fingerling spotfins were fed commercial trout starter diet (Nelson Silvercup Inc., Utah) utilizing 24-h feeders. Spotfins reached >51mm (>2 in) within 60 days in the recirculating aquaculture system. Fish were >51mm (>2 in) within 7–8 months by using a combination of indoor spawning in a recirculating aquaculture system, outdoor fry rearing, and final grow out in an indoor recirculating aquaculture system on commercial diets. The combination of recirculating aquaculture systems for brood stock holding and spawning with pond culture for fry and winter grow out back in a recirculating aquaculture system has resulted in the most promising results to date for NADF.

Methodology that proved successful in 2009 for spawning spotfins included (1) square vertical 152 × 152 × 127 mm (6 × 6 × 5 in) cedar shingles layered on a threaded rod that was hung on the side of tank with 2.0–5.0 mm (0.08–0.2 in) crevices for approximately two days to allow fish to fill with eggs(full substrates removed to separate incubation tanks); (2) recirculating aquaculture system tank temperatures >20ºC (>68°F) for spawning; (3) orientation of spawning substrates in direct current in tanks; (4) separate incubation and hatching tanks without any juvenile or adult fish; (5) 24 h lighting and water temperatures >20ºC (>68°F) for incubation/hatching tanks; (6) placing newly hatched fry into prepared outdoor rearing ponds fertilized with alfalfa meal; and (7) draining ponds in fall and bringing fingerlings into indoor recirculating aquaculture systems for final grow out on commercial feed.

In 2009, newly hatched fry were also utilized for a short term diet study at NADF using three commercial diets (Otohime B1 [Aquasonic PTY, LTD, Wauchope, NSW 2446, Australia], Inve Proton 2 [INVE Aquaculture, Inc., Salt Lake City, Utah], and Marisource Artemac [Aquafauna Bio-marine, Inc., Hawthorne, California]). In a 45-day culture period, the first diet resulted in 0% survival but the latter two diets resulted in 19 and 21% survival for Inve and Artemac, respectively.

OBJECTIVE 3

Gunderson, in his role as extension liaison for this project, has presented the results of the baitfish project at the 2007 through 2010 North Central Regional Aquaculture Center (NCRAC) Annual Program Planning Meetings. As stated in the proposal, he was to assist in the procurement of spotfin shiner brood stock. This proved to be difficult in that only one producer was able to provide 7.6-L (2.0-gal) of spotfin shiner brood stock to NADF in June 2007. Gunderson also facilitated one conference call among the researchers to discuss the status of their research efforts and delivered an underwater video camera and recorder to NADF to allow video recording of spotfin shiner spawning activities. Several hours of video have been taken.

A NCRAC Baitfish Workshop was held at the La Crosse Fish Health Center (Onalaska, Wisconsin) on September 21, 2010. Approximately 30 current and potential fish farmers from around the region attended. Twelve speakers presented results from the NCRAC Baitfish project and related topics. A survey of attendees indicated that the workshop achieved its primary objectives which were to present the results of NCRAC baitfish research, provide an overview of the baitfish industry, and to provide related information to help practicing fish farmers. Chris Weeks, the regional Aquaculture Extension Specialist, was instrumental in organizing and facilitating this workshop.

IMPACTS

OBJECTIVE 1

- The potential of using placing eggs collected from indoor culture operations did result in fish larger than the targeted 76 mm (3 in) size albeit at smaller production levels than ponds stocked with brood stock. It is possible to reach a market size in one growing season using a combination of pond fertilizers, a feeding program, and use of eggs spawned earlier in the season under indoor conditions.
- This study also showed that even though fish were fed a prepared diet, they still searched for natural prey.

OBJECTIVE 2

- Studies demonstrating combined pond and indoor recirculation aquaculture system grow out may provide baitfish producers with an opportunity to produce a new baitfish species, spotfin shiners, for the large and expanding market in the North Central Region (NCR).
- The combination of recirculating aquaculture systems for brood stock holding and spawning with pond culture for fry and winter grow out back in a recirculating aquaculture system has resulted in the most promising results to date at the UW-Stevens Point-NADF.
- However, UW-Stevens Point NADF and UW-Madison studies to date suggest that the limited capacity for producing fry from brood stock may preclude the development of this species as a viable commercial baitfish raised in ponds.
- The results from this research do provide some insight to the future direction of research, especially as it relates to nutrition as a function of growth and survival.
- The spawning and egg incubation apparatus developed during this study contributed to improved spawning behavior, egg incubation and hatching success.

OBJECTIVE 3

- This outreach effort helped coordinate the reporting of research results and make the information available to industry representatives who can base business decisions regarding the culture of spotfin shiners and early spawning of golden shiners in the NCR. The NCRAC Baitfish Workshop brought together some of the baitfish industry leaders from around the region to learn about research results and related baitfish topics. Several recommendations for future workshops were suggested on the workshop survey. Suggestions included: marketing/business management information, state/federal regulations that negatively impact baitfish production and sales, disease, water quality, and land use impacts to baitfish production.

RECOMMENDED FOLLOW-UP ACTIVITIES

At this time, the limiting factor associated with post-larvae survival is providing an appropriate nutritional diet for both golden shiners and spot fin shiners. Although there are numerous larval fish diets available to the producer, new research should focus on developing a diet specific for both shiner species.

The spotfin shiner elicited a positive response to temperature manipulation to control reproduction. In spite of this, the yield of over 2,000 mature spotfin shiners in tanks resulted in less than 5,000 fry being collected in any single week. The researchers' opinion is that this is a major problem that will impede the development of this species as a viable commercial baitfish produced in ponds.

SUPPORT

NCRAC has provided $200,000 which is the entire amount allocated for this 2-year project.

PUBLICATIONS, MANUSCRIPTS, OR PAPERS PRESENTED

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

APPENDIX

BAITFISH

Publications in Print

Meronek, T.G. 1994. Status of the bait industry in the North Central Region of the United States. Master's thesis. University of Wisconsin, Stevens Point.

Meronek, T.G., F.A. Copes, and D.W. Coble. 1995. A summary of bait regulations in the north central United States. Fisheries 20(11):16-23.

Bozwell, J.L., R.D. Clayton, and J.E. Morris. 2009. Use of hydrogen peroxide to improve golden shiner egg hatchability. North American Journal of Aquaculture 71:238-241.

Papers Presented

Copes, F.A. 1993. Aquaculture shortcourse. Sponsored by University of Wisconsin-Sea Grant and Wisconsin Department of Agriculture, Greenwood, Wisconsin, March 1993.

Copes, F.A. 1995. Baitfish aquaculture. North Central Regional Aquaculture Conference/Ninth Annual Minnesota Aquaculture Conference, Minneapolis, Minnesota, February 1995.

Meronek, T.G. 1993. Survey of the bait industry in the north central United States. Annual Meeting of the Michigan Fish Farmers Association, Cadillac, Michigan, February 1993.

Meronek, T.G. 1993. Survey of the bait industry in the north central United States. Seventh Annual Minnesota Aquaculture Conference, Alexandria, Minnesota, March 1993.

Meronek, T.G. 1993. Survey of the bait industry in the north central United States. Illinois Fish Farmers Association, Pana, Illinois, March 1993.

Meronek, T.G. 1994. Status of the bait industry in the North Central Region. Annual Meeting of the Wisconsin Chapter of the American Fisheries Society, Marinette, Wisconsin, January 1994.

Meronek, T.G. 1994. Baitfish aquaculture and production. Governor's Conference: Wisconsin Aquaculture '94. University of Wisconsin, Stevens Point, February 1994.

Morris, J.E. and T. Kent. 2008. New investigations into golden shiner culture. U.S. Trout Farmers/Midwest Aquaculture. Milwaukee, Wisconsin, September 18-20, 2008.

Kent, T., J.E. Morris, and R.D. Clayton. 2009. Feeding golden shiner fry commercial diets. World Aquaculture Society Meeting, Seattle, Washington, February 15-18, 2009.

Morris, J.E. 2010. NCRAC Baitfish workshop, La Crosse, Wisconsin, September 21, 2010.