NORTH CENTRAL REGIONAL AQUACULTURE CENTER BAITFISH PROJECT

Chairperson: Joseph E. Morris, Iowa State University

Industry Advisory Council Liaison: Phil Goeden, Alexandria, Minnesota

Extension Liaison: Jeffrey L. Gunderson, University of Minnesota-Duluth

Funding Request: $200,000

Duration: 2 Years (September 1, 2006 - August 31, 2008)

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.

Proposed Budgets:

Institution	Principal Investigator(s)	Objec-tive(s)	Year 1	Year 2	Total
Iowa State University	Joseph E. Morris	1	$24,407	$26,489	$50,896
University of Wisconsin-Stevens Point Northern Aquaculture Demonstration Facility	Gregory J. Fischer	2	$27,000	$20,500	$47,500
University of Wisconsin-Madison	Jeffrey A. Malison	2	$23,750	$23,750	$47,500
University of Wisconsin-Milwaukee	Fred P. Binkowski	2	$31,840	$12,264	$44,104
University of Minnesota-Duluth	Jeffrey L. Gunderson	3	$5,000	$5,000	$10,000
		Totals	**$111,997**	**$88,003**	**$200,000**

Non-funded Collaborators:

Facility	Collaborator
Barkhausen Waterfowl Reserve	Brown County, Wisconsin

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JUSTIFICATION

In the North Central Region (NCR), baitfish production is an important component of the aquaculture industry. In contrast to other segments of the aquaculture industry, the baitfish industry is extremely diverse in market demand, type of production, and species sold (Gunderson and Tucker 2000). The amount of baitfish produced varies greatly from state to state within the NCR. The need for increased baitfish aquaculture was recently identified as important due to increasing restrictions imposed on the wild harvest of baitfish and unmet baitfish market demand.

Restrictions on Wild Harvest

Wild baitfish producers increasingly experience problems accessing traditional harvest areas because of user conflicts and private land ownership. The spread of exotic species and subsequent regulations limiting baitfish harvest in infested areas, designed to prevent further spread of the invading species, have further reduced wild baitfish production. As exotic species continue to spread, the restrictions on harvesting baitfish from the wild will likely increase.

Draining and tiling of agricultural land is a serious threat to baitfish production. Many tiling projects have been constructed to drain or reduce the size of important baitfish production lakes and ponds to increase agricultural production. The creation of drainage connections to other surface waters allows baitfish to be lost in overflow and allows competing species to enter the lakes from downstream sources. Once bullheads (*Ameiurus* spp.), sunfish (*Lepomis* spp.), carp (*Cyprinus carpio*), and other species enter these lakes, baitfish production declines dramatically. Walleye fingerling producers also compete for the shallow winterkill lakes that are significant baitfish producers; no baitfish are produced when these lakes are used for walleye fingerling production. Another concern expressed by baitfish producers is that agricultural pesticide and herbicide runoff causes declines in wild baitfish populations.

In addition, some management agencies have applied or are considering harvest restrictions on important baitfish production areas. These additional restrictions are in response to increasing concerns regarding the environmental impacts of stocking or harvesting baitfish on duck and gamefish populations.

Market Demand

The demand for baitfish in the NCR far exceeds the supply from within the region. To meet the demand, cultured fatheads (*Pimephales promelas),* including the rosy red variation; golden shiners (*Notemigonus crysoleucas*); and goldfish *(Carassius auratus)* from Arkansas are imported into the NCR. Still, significant shortages of a variety of species (including the three primary NCR aquacultured species—fatheads, white suckers [*Catostomus commersoni*], and golden shiners) are frequently reported by bait dealers (Meronek et al. 1997). Baitfish reported in short supply during various times of the year were large fathead minnows, lake shiners (primarily emerald [*Notropis atherinoides*], and spottail [*Notropis hudsonius*] shiners), white suckers, golden shiners, chubs (hornyhead [*Nocomis biguttatus*] and creek [*Semotilus atromaculatus*]), dace (finescale [*Phoxinus neogaeus*] and pearl [*Margariscus margarita*]), and goldfish (*Carassius auratus*).

The following information regarding baitfish shortages comes from a survey of six NCR states (Illinois, Michigan, Minnesota, Ohio, South Dakota, and Wisconsin) conducted by Meronek (1994) and also reported by Meronek et al. (1997). The peak of golden shiner shortages occurs in August. Of the six states surveyed, Minnesota reported the largest shortage, probably due to baitfish import restrictions. Shortages through most of the year in Michigan, Minnesota, and Wisconsin probably result from the popularity of golden shiners. Shortages of golden shiners in summer also reflect transportation problems; many wholesale dealers stop hauling golden shiners from Arkansas because of high mortality rates associated with handling golden shiners during periods of warmwater (>24°C; 75°F).

Seasonal shortages of emerald shiners occur frequently in late spring and autumn along Lake Erie. This is caused sometimes by population size fluctuations and other times by erratic distribution of emerald shiners. The shortages cause periodic demands for imported golden shiners, and less frequently, for imported fathead minnows for fishing on Lake Erie (F. Snyder, Ohio Sea Grant, Port Clinton, personal communication).

Aquaculture Opportunities in the NCR

The baitfish species for which producers across the NCR most consistently requested aquaculture research was on the golden shiner. Even though many cultured golden shiners are brought into the region from Arkansas, the shortages that still exist warrant examining ways to increase golden shiner production in the region. The main obstacles to local production seem to be that the growing season is not long enough or that golden shiner fry are not available early enough in the year to reach market size in one growing season in outdoor ponds.

Mittelmark et al. (1993) investigated the potential profitability of golden shiner culture in Minnesota. They were able to grow fish to a marketable size (86.0 mm; 3.4 in) by November of the first year, but yields were low; only 143 kg/ha (128 lb/acre) were harvested. An economic analysis by Mittelmark et al. (1993) found that the break-even price for raising golden shiners in 10, 0.2-ha (0.5-acre) ponds was $2.65/kg ($1.20/lb). Pounds et al. (1991) found that the break-even price for raising golden shiners in Arkansas ranged from $5.14–$6.39/kg ($2.33–$2.90/lb) in ponds that ranged from 2–8 ha (5–20 acre) and total farm sizes that ranged from 65–259 ha (160–640 acre) of ponds.

Some species that are not readily found in the wild baitfish market could offer aquaculture and marketing opportunities. One species is the spotfin shiner (*Cyprinella spiloptera*). Its culture potential has been identified most recently by the North Central Regional Aquaculture Center Industry Advisory Council and previously by Scott and Crossman (1973), Gale and Gale (1977), and Snyder (1993). Snyder (1993) reports that the spotfin shiner's shape, coloration, and hardiness could make them preferable to fathead minnows and golden shiners in some NCR baitfish markets. Spotfin shiners are fractional spawners (periodically maturing eggs) that deposit eggs in crevices (Gale and Gale 1977). This spawning characteristic was used to collect fertilized eggs in multiple plate spawning devices from wild spotfin shiners. The spawning devices were then transferred to a pond for hatching and grow out (Snyder 1993) similar to the egg transfer method used for golden shiner and goldfish culture. Spotfin shiners attained a maximum length of 81.0 mm (3.2 in) in a 110-day growing season (Snyder 1993). Spotfin shiners 76 mm (3 in) and larger may be able to address market shortfalls currently experienced because of low availability of spottail, emerald, and golden shiners.

Market Price

Prices of baitfish vary by species, time of year, state, and production method (wild harvest versus culture). Of the three main species cultured in the NCR, golden shiners generally command the highest price, followed by white suckers and fathead minnows. The wholesale price for golden shiners in Minnesota in 1992 was reported at $7.05/kg ($3.20/lb) (Minnesota Aquaculture Report 1993). The 1999 pond-side price of farm-raised Arkansas golden shiners was $7.16/kg ($3.25/lb), but the wholesale price reported in Kansas City and southwest Ohio was $15.43/kg ($7.00/lb) (J. Keller, Keller's Bait and Fish Farm, Buckner, Missouri and M. Fessel, Wholesale Bait Co., Inc., Hamilton, Ohio, personal communication). Because spotfin shiners are not a significant part of the baitfish market in the NCR, there is little information regarding prices paid for spotfin shiners. However, it is expected that they may sell for prices similar to that of golden shiners and sell wholesale (to retail outlets) for $11–$15/kg ($5–$7/lb).

RELATED CURRENT AND PREVIOUS WORK

Golden shiners are both wild harvested and cultured in the NCR (Gunderson and Tucker 2000). Culture of golden shiners in the southern part of the NCR is limited but is similar to culture methods used by southern producers. Typically, the egg transfer method is used, but free spawning and fry transfer methods may be employed (Giudice et al. 1983). In the egg-transfer method spawning mats are placed in brood ponds where fish lay eggs on them. The mats containing fertilized eggs are then transferred to nursery ponds where the eggs hatch and young are fed formulated feed. Stone et al. (1998) estimated that less than 40% of eggs laid on these mats hatch.

The growing season is shorter in the NCR (120–150 days) than in Arkansas (180 days), consequently the size attained by golden shiners over a single growing season is less. In southern states, golden shiners will become sexually mature at 1 year at a length of approximately 64.0 cm (2.5 in) (Huner and Dupree 1984). In contrast, a Michigan study indicated that these fish will not reach 76 mm (3 in) in length until their second summer (Cooper 1936). Growth of golden shiners to market size in the northern part of the NCR nearly always takes more than one growing season.

When cultured in the northern part of the NCR, golden shiner brood stock are placed in ponds by the first of May. They are stocked at rates of 81–1,214 adults/ha (200–3,000 adults/acre) (Dobie 1948; Dobie et al. 1956; Forney 1957) or as high as 1,619–3,238 adults/ha (4,000–8,000 adults/acre) for intensive culture where fry removal is planned (Dobie et al. 1956). Spawning usually begins in May when water temperatures reach 20–21°C (68–70°F) and continues into August. After the eggs hatch, the fry feed on naturally occurring zooplankton. Formulated feeds are typically not provided to golden shiners in the northern NCR, although some producers have experimented with feeding and fertilizing ponds. Management consists primarily of making sure that no competing fish enter the pond and selectively harvesting the golden shiners as they reach market size.

In response to the previously described hatching rates using spawning mats, Stone et al. (1998) notes that tank spawning and hatching is now being practiced by large baitfish producers. Along with improved egg hatch and less labor associated with field operations, a major advantage has been to spawn these fish either early or late in the season. Golden shiners are brought indoors early in the spring and are slowly warmed up to 22–25°C (71–77°F). Fish are then placed into spawning tanks that have two sections; a shallow section for spawning mats and a deeper area whereby fish can hole up until moving onto the spawning mats. Overhead tank lighting should provide 15–16 hours of light.

The spotfin shiner may be more hardy and warmwater tolerant than other shiners, and accordingly, may be an ideal market fit for shiners in the spring and early summer. Because spotfin shiners are not currently cultured anywhere, it is important to examine what an economically viable culture system might entail and then develop research and extension strategies that best address the most critical questions. The following describes a potential culture system based on what is known from previous work with spotfin shiners and from the literature. Following that is the description of a research and extension approach.

Spotfin shiners are fractional, crevice spawners. They spawn over an extended period (from May to August) and lay eggs in crevices like the bark of trees or cracks in rocks (Becker 1983; Gale and Gale 1977). Spotfin shiners will spawn on artificial substrate if the correct crevice size is provided and there is a slight current (Snyder 1993). This provides an opportunity to collect eggs and hatch out the fry so that known numbers of fry can be stocked.

Once eggs are deposited on artificial spawning substrates, they can be hatched in tanks, ponds, or washed off spawning substrates using a sodium sulfite solution and hatched in jars. Fry can then be stocked into ponds. Because spotfins continue laying eggs, fry can be stocked into ponds throughout the season.

It is expected that because spotfin shiners spawn later in the season and throughout the summer, the majority will not likely reach market size by the end of their first growing season in ponds in the NCR. Although Snyder (1993) grew them to over 76 mm (3 in) in one season, he was unable to determine if they were at commercial scale densities. One approach will be to bring spotfin shiners into indoor recirculating aquaculture systems for grow out as growth stops in the late summer or early fall in outdoor ponds.

This approach could be viable for a number of reasons. First, spotfin shiners are expected to be valuable enough ($11–15/kg; $5–$7/lb) to make recirculating aquaculture practical. Second, because they can be grown to market size quickly and spawn multiple times a season, more than one cycle can be produced in a recirculating aquaculture system per year. Therefore, a moderately sized recirculating system may be able to produce the equivalent number of fish that would be produced by using multiple culture ponds. The combination of ponds to grow them for stocking into a recirculating aquaculture system also allows for the production of large numbers of fish in a limited area because they would only be grown to a size practical for stocking into a recirculating aquaculture system and not to market size.

To determine the viability of a combined pond/indoor approach, the following will need to be assessed during indoor recirculating aquaculture system culture: growth, survival, density, and temperature effects, feeds and feeding strategies, and fish health management. It will likely be important to develop an effective prophylactic treatment for parasites and other pathogens prior to putting spotfin shiners into the recirculating aquaculture system. To be sustainable, spotfin shiners may need to be held in ponds over the winter and brought indoors as fish reach market size in the recirculating aquaculture system and are sold. This would ensure that the recirculating aquaculture system operates near capacity for much of the year.

Developing techniques to control spotfin reproduction are a key to establishing them as a mass propagated baitfish. Although their growing season might be extended to enhance growth into the fall, there will still be a need to either collect them from the wild or to propagate large numbers of seed stock for the initial outdoor phase. It is difficult and time consuming to sort large numbers of spotfin from other minnows that occur in mixed wild collections. Although egg collection devices have been used on a limited basis to provide young fish by egg transfer, it has not been practiced on a commercial scale. Also, in-pond reproduction of spotfin captive brood stocks has yet to be established on a commercial scale. Control of spotfin reproduction could solve this problem and open up the possibility of earlier than normal season production of seed stock. This would lengthen the growing season by inducing early season spawning in addition to trying to achieve extended fall growth.

Although previous work has defined the spotfin's reproductive behavior and their breeding habitat requirements, it falls short of accomplishing a reliable means of achieving mass spawning of this species or of developing mass propagation of this species for seed stock for conventional pond grow out or for possible indoor rearing by a recirculating aquaculture system. Limited previous work by Pflieger (1965) also suggests that these fish can be manipulated indoors to spawn far in advance of their normal season, and perhaps multiple times during the year.

Previous work on spotfin shiners (Hankinson 1930; Stone 1940; Trautman 1957; Pfleiger 1965; Gale and Gale 1976, 1977) has established that, like other members of the genus *Cyprinella*, they are fractional spawners that deposit eggs in crevices. Field and laboratory investigations of spotfin spawning suggest that for mature fish the requirements of visual and tactile cues regarding the presence of adequate spawning crevices and moderate current are important factors for inducing spawning activity. Gale and Gale (1976, 1977) examined the importance of visual cues and current in the choice of artificial substrate crevices by spotfin shiners both in the wild and in laboratory situations. Darker (blue and black) artificial acrylic substrates were preferred over lighter ones, and clear substrates were ineffective. Pfleiger (1965) found that spawning sites were frequently near riffles and that invariably there was at least a slight current. Their studies showed the orientation of the crevice to the current, and the ability of the fish to hold its position in relation to the current, were important for successful spawning. At their sites (Gale and Gale 1976, 1977), currents ranged from 0.23–0.57 m/sec (0.75–1.9 ft/sec), but currents over 0.4 m/sec (1.3 ft/sec) caused fish to prefer the sheltered trailing side of the substrates (Gale and Gale 1977).

Stone (1940) reported that spotfins could be propagated in ponds with sufficient brush and logs placed in them, but Snyder (1993) was unable to verify this, suggesting that the absence of stream-like currents or the presence of too much turbidity due to clay soil may have prevented spawning. The crevice-spawning characteristic of spotfin shiners has prompted researchers to develop devices to collect fertilized eggs from them in the wild during their normal spawning period. Snyder (1993) used multiple plate devices to collect eggs from spotfin spawning in the wild and transferred them to a pond for hatching and grow out. His process was similar to the egg transfer method used for golden shiner and goldfish culture. However, Snyder (F. Snyder, Ohio Sea Grant, Port Clinton, personal communication) did not achieve actual spawning of spotfin in ponds. These pond-reared spotfin shiners attained a maximum length of 81.0 mm (3.2 in) in a 110-day growing season (Snyder 1993). This suggests that it may be possible in some portions of the NCR to grow spotfins to marketable size in ponds if in-pond spawning could be achieved. It may be that this could be accomplished if the requirement for moderate current can be overcome as well as provisions made for adequate numbers of crevice-spawning sites.

Previous workers conducting examinations of ovaries have noticed different sized eggs in the ovary. In addition, Gale and Gale (1977) have demonstrated conclusively that in a single season, a single female may have as many as 12 spawning sessions spaced from 1–7 days, but typically 5 days apart. Consequently, the total amount of eggs released by a single female in a season can be several times her body weight. This is one of the potential advantages this species may have as a bait aquaculture species. Fortunately, this species exhibits sexually dimorphic breeding characteristics at maturity that indicate readiness to spawn. Males have breeding tuberculation and distinctive breeding coloration, and breeding females have distended bellies. Because of the fractional spawning nature of this species, conventional gross methods of assessing spawning (e.g., gonadal somatic indices) will be of little utility to the practical culturist.

Members of the genus *Cyprinella* are known to exhibit elaborate spawning behavior including the establishment of territories by breeding males, dominance displays and aggressive territory defense, and sound emission (Winn and Stout 1960; Stout 1975) during territorial and courtship activity. Males establish territories (approximately 0.5 m [1.6 ft] in diameter) centered on one or two good spawning crevices (Gale and Gale 1977). This territorial behavior may be a potential constraint to achieving mass production and high-density spawning activity of spotfin shiners. Individual males do spawn with multiple females, and Gale and Gale (1977) recommended that ratios of one male for 10–20 females would be useful for bait culture purposes. They also observed a female choosing a crevice and enticing a male to use it outside of his defended territory, suggesting that territoriality might be overridden.

Previous work also suggests that the timing of spawning can be manipulated in an indoor controlled-rearing setting. After holding brood fish in 38–189-L (10–50-gal) aquaria over winter, Pflieger (1965) was able to induce early spawning of spotfins in March, well in advance of their normal spawning period. He successfully used a piece of bark attached to an inverted flowerpot as a spawning site. Although Pflieger (1965) initially provided 16 hours of supplemental illumination from January through May to induce early spawning, in a subsequent trial he found this to be unnecessary and achieved spawning in March. He attributed the earlier attainment of sexual maturation and spawning of the over-wintered fish to the constant temperatures (21.1–23.9°C or 70.0–75.0°F) and the continuation of feeding under laboratory rearing conditions.

The development of indoor advanced spawning and early life history propagation of baitfish prior to pond grow out is likely to provide a better solution for most portions of the NCR with shorter, less reliable growing seasons. The primary objective of this study is to develop the husbandry techniques for successful early season spawning and the commercial production of golden and spotfin shiners in conjunction with recirculating and pond aquaculture systems.

ANTICIPATED BENEFITS

This is extremely relevant to the industry because the use of natural ponds and lakes for baitfish production is becoming increasingly difficult due to pressures from shoreland development and environmental groups. Exotic species and pathogens are also restricting waters where baitfish can be wild harvested. As a result, market demands for baitfish and the need for new culture techniques and new baitfish species is increasing. This research explores a potentially economically viable solution applicable to the whole NCR.

From the proposed investigations, culture techniques for spotfin shiners will be developed for the NCR that will aid in overcoming specialized spawning requirements and regional thermal constraints. The development of techniques for producing fry earlier in the growing season so that they can be stocked into ponds concurrent with the onset of natural spawning cycles, will allow for grow out to market size within one growing season. In addition, the application of indoor culture to complete the grow out of spotfin shiners to market size might provide a significant advantage for meeting baitfish market demands and provide additional economically viable aquaculture opportunities. This could also result in a two-crop production of spotfin shiners.

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.

PROCEDURES

Golden Shiners (Objective 1)

<u>Tank Studies</u>

In October 2006, Iowa State University (ISU) researchers will purchase age-0 and age-1 golden shiners from a private fish culturist. Fish will be transported to the ISU campus and placed into six 1,000-L (264-gal) fiberglass tanks, which will be used as spawning tanks. Each spawning tank will have two sections of varying depths similar to Stone et al. (1998). Fish will be stocked at 500 fish/tank. Assuming 50% females, 750 eggs/female, and 25% survival, each tank should potentially produce approximately 50,000 viable fry.

Initially, fish will be placed under winter conditions, i.e., 10°C (50°F) water temperature and a photoperiod of 8 h light/16 h dark, over a period of two weeks. Fish will be feed twice weekly, 2% body weight, 32% protein diet. Brood stock will be held under these conditions for six weeks. Following this winter period, temperature and photoperiod will then be gradually increased to spring conditions, i.e., 22°C (72°F) and a photoperiod of 16 h light/8 h dark; a two-week transition period will again be used. These spring environmental conditions are similar to those used by Rowan and Stone (1996). ISU researchers have had earlier success in spawning sunfish out-of-season (Mischke and Morris 1997).

Ten fish will be removed from each tank when they are first stocked. On a two-week basis, ten fish will be collected randomly from each culture tank. Fish will be euthanized using 80 mg/L (ppm) of Finquel® and then weighed and measured. Gonads will be removed and gonadal somatic index calculated.

Once the tanks are under spring conditions, commercial spawning mats will be placed into the spawning tanks, just under the water surface. The spawning mats will be placed in the shallow area while the deeper area will be used by the brood stock prior to spawning on the mats (Stone et al. 1998). As indicated by Rowan and Stone (1996), unused spawning mats will be replaced weekly.

Spawning mats containing spawns will be removed from the spawning tanks and placed into 150-L (39-gal) hatching/rearing tanks, six tanks total. The number of eggs will be estimated using information from Stone and Ludwig (1993), by removing plugs from each mat and estimating the numbers of eggs.

Hatched fry will be stocked into twelve 100-L (26-gal) rearing tanks at 50 fry/L (193 fry/gal). A completely randomized experimental design will be used with two treatments; six replicates per treatment. Treatment #1 will consist of feeding fry Gemma 0.3. Fry in the second treatment will be fed Nutra HP 0.3. Fry will be cultured in these tanks until being stocked into the research ponds, scheduled for mid-April 2007. Fry will be fed every 15 minutes, 22 hours per day; the remaining 2 hours will be used for the daily cleaning and maintenance of the tanks.

In addition to investigating the effect of diet, stocking densities will also be assessed. Fry will be stocked at one of two densities in six 277-L (73-gal) rearing tanks. In one treatment, fry will be stocked at 50/L (193/gal) while fry in the second treatment will be stocked at 100/L (385/gal). A completely randomized design will be used to assign treatments to the tanks. Although Rowan and Stone (1995) had best success using BioKyowa for golden shiner fry, this feed is no longer marketed in the United States.

Gemma 0.3 will be used for this study because walleye culturists have had reasonable success using this feed for walleye fry. Fry will be fed every 15 minutes, 22 hours per day; the remaining 2 hours will be used for the daily cleaning and maintenance of the tanks. Alternative open-formula may be used if suitable size composition exists.

At the completion of both indoor studies, fry survival and growth will be assessed prior to the fry being stocked into the research ponds.

Pond Studies

Six 0.08-ha (0.20-acre) earthen research ponds will be used for this portion of the project. The completely randomized design will consist of two treatments. In the first treatment, fry from the tank study will be stocked at 250,000 fry/ha (100,000/acre). The second treatment will consist of stocking age-1 golden shiner brood stock at 22.5 kg/ha (20 lb/acre). All ponds will be stocked by mid-April 2007. Commercial spawning mats will be placed along the edge of ponds being stocked with brood stock.

All ponds will be fertilized using alfalfa meal as organic fertilizer. The initial application will be 112 kg/ha (100 lb/acre) with bi-weekly applications of 56 kg/ha (50 lb/acre). Initial total phosphorus will be adjusted to 0.10 mg/L (ppm) and subsequent nutrient levels adjusted to 7:1 (NO_3-N:TP) (Rogge et al. 2003). Pond fertilization regimes will be followed as long as water quality is maintained.

A tube sampler will be used to sample the water column. A YSI Model 60 pH meter (Yellow Springs, Ohio) will be used to record pH. During the first 30-day culture period, weekly water chemistry will include ammonia-nitrogen (NH_3-N), nitrite-ammonia (NO_2-N), NO_3-N, and total phosphorus. Morning (0600) and afternoon (1500) temperature and dissolved oxygen levels at the bottom, middle, and top of the ponds will be taken weekly with a YSI Model 55 Oxygen Meter (Yellow Springs, Ohio). Thereafter, water chemistry will be collected bi-weekly.

Also, during the initial 30-day culture period, chlorophyll a and phaeophytin levels will be analyzed using the procedures described by APHA et al. (1998). Zooplankton samples will be taken weekly with oblique tows of an 80-μ Wisconsin net (Wildco Company, Saginaw, Wisconsin) and preserved with a chilled formalin/sucrose solution (APHA et al. 1998). Specimens will be counted and identified on site using Pennak (1989). Corresponding production data on fish biomass, density, quality and quantity of feed used, growth and food conversion, e.g., specific growth rate and food conversion rate, and chemical treatments will be recorded. In addition, water quality (ammonia, pH, and morning dissolved oxygen) will be measured weekly.

Ponds containing the fry from the tank studies will be fed using fry meal, Nelson's trout diet, from time of stocking until the time when fish are better able to consume lower protein diets, e.g., 32% protein. Feeding rates will be 5% of the total fish biomass.

Ponds that contain golden shiner brood stock will be initially fed a 32% protein diet, primarily for the brood stock. Once spawning activities have taken place, fry meal will be used to feed the newly hatched fry; feeding rates of fry will be 5% of the estimated total fish biomass.

Fish sampling will initially consist of using fry trap samplers described by Summerfelt et al. (1996). Following fry stocking, traps will be placed in ponds weekly. Fish will be sacrificed and preserved in buffered formalin for future stomach content analyses. Once the fry get larger, they will be sampled using a 3-mm (0.12-in) seine. All ponds will be harvested November 2007. During harvest, approximately 30 fish will be taken from each pond for gut analysis. Stomach contents will be identified to the lowest practical taxon and counted.

Spotfin Shiners (Objective 2)

The following research approach was developed to take advantage of the facilities, capabilities, and knowledge of the collaborators and to address the most critical questions for developing a viable culture operation as just described. Researchers will take a two-pronged approach to extending the growing season to enhance spotfin growth. University of Wisconsin-Stevens Point (UW-Stevens Point)/University of Wisconsin-Madison (UW-Madison) researchers will extend growth of pond-held shiners into the fall and adapt them to spawn in indoor recirculating aquaculture systems to produce eggs that will be subsequently reared through early life stages in fertilized rearing ponds. University of Wisconsin-Milwaukee (UW-Milwaukee) researchers will produce captive indoor held brood stock to spawn early out-of-cycle. Tank-based feeding techniques will be used to rear stocks indoors for both early season stocking in ponds (to extend the growing season), or for entire life cycle propagation indoors with tanks and recirculating aquaculture systems. UW-Milwaukee will develop specialized indoor spawning tanks that can potentially be used to achieve in-pond spotfin spawning.

<u>UW-Stevens Point/UW-Madison</u>

Brood Stock

With the assistance of Jeff Gunderson, spotfin shiner brood stock will be secured from the baitfish industry in Minnesota and/or Wisconsin prior to the start of this project. Spotfin shiners will be brought into the UW-Stevens Point Northern Aquaculture Demonstration Facility (UW-Stevens Point NADF) in spring 2006 (before funding) for experimental testing of spawning and hatching protocols. Brood stock will be secured and stored in a pond at the UW-Madison's facility at the Lake Mills State Fish Hatchery (LMSFH) to ensure that brood stock will be available in spring 2007. In spring 2007, spotfin shiner brood stock will be brought into the UW-Stevens Point NADF from newly captured wild stocks or from stock overwintered at LMSFH.

Spawning

Spawning trials will be conducted at the UW-Stevens Point NADF; artificial spawning devices will be constructed similar to those described by Snyder (1993). Researchers have learned from previous work that 6.4-mm (0.25-in) crevices contained significantly more eggs than 13.0-mm (0.50-in) crevices. Spawning substrates will be placed in moving water (in previous work spawning occurred at flow rates of 0.1 m/sec [0.32 ft/sec]). Temperature will be held at 21–24°C (70–75°F). A male to female ratio of 1:10 will be used initially. Enough spawning devices and brood stock will be introduced into the spawning system to produce enough fry for the LMSFH pond trials (32,000 in Year 1) in a short spawning period even though spawning will be continued throughout the season. Paul Tucker, who has previously worked with spotfin shiner spawning and hatching, will assist UW-Stevens Point NADF staff in this effort. Hatchery success will be evaluated by determining number of eggs produced per surface area of spawning substrate, eggs produced per female, egg survival, and length of spawning when held indoors.

Hatching

As spawning substrates are filled with eggs, they will be removed from the spawning system. Eggs will be hatched in a manner similar to that used for hatching yellow perch eggs by suspending the substrates in a tank with moving water. Eggs will also be washed from the spawning substrates with sodium sulfite and hatched in a bell jar incubation system. Hatching success for each method will be determined. Number of eggs and fry per quart will be determined by enumeration.

Pond Production

In Year 1 fry will be transported from the UW-Stevens Point NADF to the LMSFH and stocked into six 0.04-ha (0.1-acre) ponds, one stocking per year all at the same time (beginning of season). Researchers will evaluate three treatments using two ponds per treatment: (1) low stocking density (74,130/ha [30,000/acre]), no supplemental feeding, regular fertilization; (2) low stocking density (74,130/ha [30,000/acre]), with supplemental feeding, regular fertilization; and (3) high stocking density (247,710/ha [100,000/acre]), with supplemental feeding, regular fertilization. The pond fertilization protocols that will be followed are those that have been used successfully for other fish species at the LMSFH and consist of weekly application of organic (poultry litter, soybean meal) and inorganic (N and P) fertilizers.

After stocking, researchers will sample fish regularly through the summer to determine fish growth and stomach contents. In the beginning fish will be fed light supplemental feedings 2-3 $\times$ daily with Silver Cup

Steelhead diet (which performed better than two other commercial diets for hornyhead chubs, Gunderson et al. In review), when fish reach 19.0 mm (0.75 in). Supplemental feeding will be increased as stomach content analysis shows that the fish are eating formulated food. The fish will be harvested in autumn for size and survival data, including a comparison between males and females. Subsequently, the fish will be transferred to UW-Stevens Point NADF.

In Year 2 all six ponds will use the most successful density/feeding treatment from Year 1. Three ponds will be used for each of the following treatments: (1) ponds receiving one stocking of fry at the beginning of the season and (2) ponds receiving one stocking of fry at the beginning of the season, and one additional fry stocking one month later. As in Year 1, all production data will be gathered during the summer. In autumn, some of the fish will be transferred to UW-Stevens Point NADF, and the remainder overwintered in ponds.

Recirculating Aquaculture System

In Year 1 Jeff Malison will supply spotfin shiners grown through the first summer in ponds at the LMSFH to Greg Fischer at the UW-Stevens Point NADF for grow out in an indoor recirculating aquaculture system. Prior to being stocked in the recirculating aquaculture system, pond-raised fingerlings will be treated for parasites and other pathogens (using salt, formalin, or hydrogen peroxide at levels determined through small sample testing) and graded for size. Two different grow-out temperatures (approximately 21 and 27°C [70 and 80°F]) will be tested. Fish will be fed Silver Cup Steelhead diet. Growth, fitness, and survival will be monitored. Fingerlings will be stocked at a density whereby they will reach commercial scale loadings by the time they begin to reach market size (51.0–64.0 mm [2.0–2.5 in]). Growth and survival at the temperatures will be followed throughout the first year. Market sized fish will be supplied to Jeff Gunderson for outreach.

In Year 2 spotfin shiners will again be supplied to the UW-Stevens Point NADF by the LMSFH in the fall. Three types of commercially available feeds will be examined. Silver Cup Steelhead diet (45% protein and 16% fat) will be compared to two other diets with less protein (25–35%) but similarly high levels of fat. Although high lipid content in food fish can reduce dress out weight and be undesirable, high body fat in baitfish does not reduce marketability and may be advantageous (Lockmann and Phillips 2001). The optimum water temperature from Year 1 will be used. Growth, fitness, and survival will be monitored. In the spring of Year 2, the feed treatment will end and fish that overwintered in the ponds will be brought into the recirculating aquaculture system for comparison of growth and fitness with fall-stocked recirculating aquaculture system fish. They will be grown until September using the optimum water temperature and feeds from previous experiments. There will be two treatments. One treatment will be overwintered fish alone in tanks. Treatment 2 will combine fish raised indoors over winter with fish that overwintered in the ponds as an attempt to simulate a culture strategy to maximize recirculating aquaculture system production by replacing fish that reach market size with fish that overwintered in ponds.

UW-Milwaukee

In the summer of 2006, UW-Milwaukee staff will collect or purchase several thousand spotfin shiners. These fish will be quarantined and examined for parasites and other pathogens. If necessary, appropriate treatments will be administered, and habituation to laboratory conditions will follow. These fish will be developed into a captive brood stock. Based on Pflieger's (1965) success after holding brood fish in aquaria over winter and inducing spawning of spotfin shiners in advance of their normal spawning period, it is anticipated that the use of an extended period of feeding and warm, constant rearing temperatures will allow fish to mature and spawn well in advance of the normal NCR spawning window. Because optimal temperatures for reproductive maturation and induction of spawning specific for spotfin shiners aren't known, generalized knowledge of similar temperate zone fishes will be used as a guide. To clarify the importance of seasonal change for spotfin maturation versus the suggestion from Pflieger's work that constant extended growth is sufficient for spotfin reproductive maturation, the following investigations will be conducted as part of an effort to accomplish the early season spawning initiative. One experimental trial (Trial 1) will be conducted in duplicate tanks at rapid growth temperatures and a constant 14-h light/10-h dark photoperiod to promote higher food consumption, continued growth, and gonadal maturation in spot fin. The second trial (Trial 2) will be conducted in duplicate tanks at seasonal temperatures, with a summer and fall period at rapid growth temperature, then providing a period of a drop in temperature to simulate winter conditions, then raising the temperature and lengthening the photoperiod to promote spawning in early spring. The temperature and photoperiod cycles for this trial will be shifted back 2–3 months from normal to create an out-of-cycle spawning environment in February or March rather than May or June. This out-of-cycle spawning technique has been used on yellow perch for more than a decade.

During each of these trials, spawning activity and egg production will be recorded and subsamples of shiners will be examined at approximately monthly intervals to assess sexual maturation. Reproductive status will be documented by external sexual-dimorphism and photographs taken illustrating breeding condition, as well as by internal examination of gonads. Spawning activity around the substrates in each tank will be documented by visual and video observation and egg deposition will be determined by counting eggs deposited on spawning substrates. The experimental trials will be conducted in circular flow through commercial-scale rearing tanks.

The initial strategy for spawning and collecting eggs will be to meet the specialized "crevice spawning" needs of these fractional spawning shiners by providing moderate current (directing the inflow of the tank to create a circular moderate current), and by introducing spawning substrates. Both trials will have spawning substrates available in the tanks at all times. Because of their apparent effectiveness and ease of use for egg transfer from spawning tank to rearing tank, a type of egg collection device consisting of suspended horizontal plates with spacers between them will be used to provide appropriate crevices for egg deposition, similar to those that were used by Gale and Gale (1976, 1977) and Snyder (1993) when spotfin eggs were collected from the wild. Previous work collecting wild spawn of spotfin will provide a guide for sizing the crevices. Several-millimeter vertical openings and several-centimeter extension of the crevices are appropriate. This will be large enough to permit the deposition of eggs, but prevent the consumption of eggs by other fish. Starting from that approximate size, if necessary, adjustments will be made based on observation of spawning and crevice orienting behavior. Descriptive statistics of the daily egg deposition on the substrates in relation to the numbers of fish in the tanks for the duration of the trial period will be compiled. The timing and overall deposition of eggs using each maturation strategy will be compared.

In addition to attempting to induce spawning activity in the higher density mass rearing tanks described in Trials 1 and 2, specialized spawning-environment tanks will be constructed and mature male fish will be introduced at a lower density so that they will be more readily able to establish and defend territories. For this lower density spawning, circular, flow through, commercial-scale tanks will be used in which moderate flow conditions simulate normal river environment either by directing the inflow to create circular flow within the tank, or by a combination of the inflow and compressed air lifts to move the water. These spawning units will have photoperiod and temperature controls. For initial spawning trials, this tank environment will be operated on a flow through basis to control temperature and to insure optimum water quality. Subsequent trials will have reduced water flows to create "pond like" situations. This will increase the spawning tank's cost effectiveness and aid in determining how to simulate similar spawning conditions in a pond environment. For these specialized low density spawning tanks, crevice substrates modeled after those used by Gale and Gale (1976, 1977) and Snyder (1993) will also be used. Only enough males will be used to establish territories in relation to the number of artificial spawning substrates that fit in the specialized spawning tanks. Groups of ripe females for each male will be introduced into the specialized spawning tank on a rotational basis. Remote observation by video will be used to document spawning behavior, including hydrophone recording for spawning sounds that are emitted by members of this genus. In the event that it proves to be more difficult than anticipated to induce spawning indoors, these audio recordings may help to induce or manipulate spawning when played back to fish under captive conditions. Based on the work of Gale and Gale (1976), spawning activity is expected to occur between 6 AM and 10 AM. Because the main spawning efforts will take place in indoor tanks, direct visual or remote video observation of spawning behavior will be used. Because it is anticipated that spawning will occur on removable substrates, these surfaces will be examined daily to visually estimate by directly counting eggs (or by subsampling and extrapolating), or through photographic recording and later counting of eggs. Removed substrates will be replaced with egg-free ones; this will permit documentation of the timing of egg production. Eggs deposited on the artificial substrates would be removed on a 24–48 h basis during spawning, and incubated in separate larval rearing tanks. Based on the numbers of eggs collected and observations of spawning activity, additional ripe females will be rotated into this spawning tank and spent females removed. Additional males could also be rotated from the mass rearing tank of Trial 1 into the low density specialized spawning tanks.

Eggs will continue to be collected from both mass rearing tanks (Trials 1 and 2) and the specialized lower density spawning tanks for as long as spawning activity can be maintained. The numbers of breeding fish involved and the estimated numbers of eggs produced will be recorded on a 24–48 h basis and accumulatively over the course of the project.
Incubation and hatching of the eggs will be conducted at 23°C (73°F) in separate hatching tanks prepared for early life stage rearing. Hatching success in relation to numbers of eggs stocked in the incubation and rearing tanks will be determined. Newly hatched larvae are approximately 4.5-mm (0.18-in) total length (Snyder et al. 1977; Auer 1982) and have poorly developed mouths. Although Gale and Gale (1976) indicate that first feeding larvae were able to accept finely textured commercial feed (Tetramin E) at approximately seven days after hatching, ultimate survival and growth were not documented. Consequently, the UW-Milwaukee Great Lakes WATER Institute (UW-Milwaukee GLWI) will employ as necessary a battery of early transitional live foods from a green tank (protozoans, rotifers, copepod nauplii) and Artemia nauplii to develop and insure a successful strategy to rear large numbers of larvae (>5,000) under indoor tank conditions, and habituate them to currently available commercial feed. Growth and survival through incubation, hatching, and feed habituation, as well as the cumulative numbers of feed-habituated spotfins produced over the course of the project will be documented. Growth will be determined using a dissecting microscope, an ocular micrometer, and an analytical balance capable of measuring to 0.1 mg for the larval stage and using a millimeter rule and an electronic balance with a sensitivity to 1.0 mg for the larger shiners. Feed habituation will be assessed through behavioral observations, and through microscopic gut examination of subsamples of larvae. Successive repetitions of the food habituation process over the course of the project period will result in the fine tuning of the habituation process

Advanced spawned food-habituated larvae from the mass rearing tanks (Trials 1 and 2) and the low-density specialized spawning tank will be accumulated for use in a commercial-scale grow-out trial. Fifty percent of the early season feed-habituated spotfins will be used in a recirculating aquaculture system and 50% will be transferred to a fertilized bait pond with supplemental feeding. Shiners will be sampled from both systems on a monthly basis to compare growth. Survival will be measured in terms of numbers produced at harvest, and the proportion of the population at market size at the end of the local growing season. Growth in length and weight over time will be described based on measured subsamples of sufficient numbers of individuals to represent the size distribution of fish at that sampling time for each rearing group. Descriptive statistics of central tendency and size variation will be compiled. Biomass in each system will be estimated based on the sampled size distributions and estimated numbers remaining at sampling as determined by subtracting mortalities from the initial stocking number. Statistical and graphic comparison of the size distribution within the two rearing systems will be made. Final size, numbers of fish at harvest, and the proportion of the population that reaches usable bait size of 5.1–7.6 cm (2.0–3.0 in) will be determined.

All operating expenses will be recorded for the recirculating system and the pond rearing trials to assess the costs of each system. These recorded costs will provide an essential initial approximation toward the ultimate goal of determining the most efficient, cost-effective method of rearing advanced growth spotfin shiners to market size in a commercial-scale system in one growing season.

Indoor rearing techniques, as described, should be sufficient to advance spawning and extend the growing season of spotfin shiners. However, some portions of the NCR with an adequate growing season may find it cost effective to pond rear spotfins if they can be induced to spawn in a pond environment. Although the lower density specialized spawning tanks to be used will initially be operated indoors to permit greater control, adaptations will be made to create successful spawning conditions in ponds. Depending on the success in modifying tanks to inducing spawning indoors, two in-pond specialized spawning tanks or floating raceways (operated by an airlift pump to circulate pond water) will be constructed in Year 2 of the project. These raceways will be designed, based on the indoor specialized spawning tank trials, to create proper flow conditions and provide proper crevice substrates that should induce in-pond spotfin spawning. The floating raceways will be made of plastic using pier floats to keep the edges above the pond's water line. The pond will contain mature spotfin shiners that will have been added since Year 1. One of the raceways will be open, enabling shiners from the pond to enter and use the spawning substrate. The other raceway will have a mesh screen at one end to prevent brood stock from escaping. This raceway will be stocked with mature adults from the indoor facility. Both tanks will use an airlift pump to direct pond water from one end to the other to create the necessary flow for spotfins to spawn. Spawning substrates will be checked regularly for egg deposition. Using the same pond for both raceways will eliminate variables such as water chemistry, temperature, nutrients, etc. that could

cause differences in results. This in-pond spawning environment, although restricted to the normal spawning period, would be suitable for portions of the NCR with sufficiently long growing seasons.

Outreach (Objective 3)

Jeff Gunderson will provide regular research updates related to this project to the baitfish industry through Web-based technologies, fact sheets, workshops, and/or technical bulletins. A video of spotfin shiner spawning behavior will be produced with the assistance of Sea Grant Communications staff. A workshop will be held at the UW-Stevens Point NADF during summer of Year 2 to demonstrate spotfin shiner spawning behavior, spawning substrate construction, hatching protocols, and to highlight the first year's results. Because this baitfish is new to the bait industry, the market demand and market price is relatively unknown. Gunderson will develop a survey to evaluate baitfish retailers' opinions of spotfin shiners. Selected retail outlets throughout the NCR will be sent 3.79 L (1.0 gal) of market-sized spotfin shiners and asked to evaluate their market potential, identify the time of year they think spotfin shiners will be in greatest demand, and to assess their potential wholesale market price. The survey will be developed using good survey design and by enlisting the help of industry, researcher, and extension technical committee members. Gunderson will also plan and conduct a general baitfish workshop more centrally located in the NCR in Year 2. This will provide an opportunity for updates on the currently-funded spotfin and golden shiner research projects, but will also address other research and policy topics of interest to the baitfish industry. Travel money will be provided to the researchers and other needed presenters to allow them to participate in this workshop.

FACILITIES

Golden Shiners (Objective 1)

Six 0.08-ha (0.2-acre) earthen ponds located north of the ISU campus will be used for the pond culture phase. A low humidity, temperature-controlled facility is available for feed storage. A fully equipped water analysis laboratory is located on campus equipped with spectrophotometers, pH meters, glassware, fume hood, and reagent storage.

Two wet labs are located on the ISU campus. Wet Lab 1 (37 m^2 [400 ft^2].) is equipped for flow through or recycle with twelve 1,000-L (264-gal) round tanks. Wet Lab 2 (19 m^2 [200 ft^2].) is equipped for flow through or recycle with 30, 100–150-L (26–40-gal) tanks. Water supply is city tap water that has been dechlorinated, pH adjusted, and temperature controlled.

Spotfin Shiners (Objective 2)

The UW-Madison Aquaculture Program has its main facility at the LMSFH. At this facility the program has twelve 0.04-ha (0.10-acre) ponds for its exclusive use, and also has the shared use of additional 0.1–0.4-ha (0.25–1.0-acre) ponds. All are provided with lake water that is filtered with a rotating drum screen to remove unwanted organisms, and supplied with airlift pumps for water circulation and destratification. The facility has all of the major equipment needed to conduct the proposed studies. For this project six 0.04-ha (0.10-acre) fingerling production ponds will be used.

The UW-Stevens Point NADF is a new, state-of-the-art $4.0 million, 790 m^2 (8,500 ft^2) facility that has automated, cold, cool, and warmwater indoor incubation and culture systems, liquid oxygen, blower aeration capabilities, outdoor raceways, and four 0.2-ha (0.5-acre) drainable ponds with collecting basin. Indoor recirculating systems include two 37,854-L (10,000-gal) warmwater and one 45,424-L (12,000-gal) coldwater commercial-scale systems. NADF has a wet lab, equipment, and shop facilities on site. Water is provided by two high capacity wells pumping up to 6,056 Lpm (1,600 gpm) with complete backup and monitoring systems. For this project, spawning and recycle systems will be set up indoors.

The UW-Milwaukee GLWI has a 1,394 m^2 (15,000 ft^2) aquaculture workspace with both flow-through and recirculating systems. An automated system supplies dechlorinated water as hot water, ambient cold water, and refrigerated water to the fish rearing tanks at a capacity of 3,038 Lpm (800 gpm). Flow-through rearing tanks, including large 2.44-m (8.0-ft) diameter circular and 1.22-m (4.0-ft) diameter circular banks of smaller rectangular fiberglass, and small glass aquaria available to support fish culture investigations. Recirculating systems include two 37,854-L (10,000-gal) commercial-scale systems and two 37,854-L (10,000-gal) commercial-scale systems at the UW-Stevens Point NADF. The UW-Milwaukee GLWI has analytical laboratories and shop facilities to support a wide variety of aquatic research investigations. The fish culture staff has more than 60 years experience with rearing over 40 fresh water species, including yellow perch and largemouth bass. Additionally, it has state-of-the-art technology and experience for successful feeding investigations and fish behavior studies. Other UW-Milwaukee GLWI staff members have in-house expertise in fish reproduction, nutritional physiology, fish behavior, and aquaculture engineering to aid these investigations. Access is available to outdoor ponds ranging in size from 0.12–0.4 ha (0.3–1.0 acre) at the Milwaukee County House of Corrections fish hatchery, at the Barkhausen Waterfowl Reserve, Brown County, Wisconsin; at Alpine Farms, Sheboygan Falls, Wisconsin; and at the UW-Stevens Point NADF.

Outreach (Objective 3)

Minnesota Sea Grant has a video camera, underwater camera, Web design capabilities, and all other equipment and staff necessary to fulfill the obligations in Objective 3.

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PROJECT LEADERS

State	Name	Institution
Iowa	Joseph E. Morris	Iowa State University
Minnesota	Jeffrey L. Gunderson	University of Minnesota-Duluth
Wisconsin	Fred P. Binkowski	University of Wisconsin-Milwaukee
Wisconsin	Gregory J. Fischer	University of Wisconsin-Stevens Point Northern Aquaculture Demonstration Facility
Wisconsin	Jeffrey A. Malison	University of Wisconsin-Madison

PARTICIPATING INSTITUTIONS AND PRINCIPAL INVESTIGATORS

Iowa State University (ISU)
Joseph E. Morris

University of Wisconsin-Stevens Point Northern Aquaculture Demonstration Facility)
Gregory J. Fischer

University of Wisconsin-Madison (UW-Madison)
Jeffrey A. Malison

University of Wisconsin-Milwaukee (UW-Milwaukee)
Fred P. Binkowski

University of Minnesota-Duluth (UMD)
Jeffrey L. Gunderson

PROPOSED ACTIVITIES FOR IOWA STATE UNIVERSITY

(Morris)

Major Actions for Each Objective

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.

    a. Set up captive brood stock in mass rearing tank for advanced spawning under optimal conditions using a combination of light and photoperiod manipulation.

    b. Maintain mass rearing tanks, collect and incubate eggs, and rear young of the year golden shiners.

    c. Assess diets and stocking densities on fry cultured indoors.

    d. Stock young of the year and age-1 golden shiners in earthen ponds and compare respective pond production of market-size fish.

UNITED STATES DEPARTMENT OF AGRICULTURE
COOPERATIVE STATE RESEARCH, EDUCATION, AND EXTENSION SERVICE

OMB Approved 0524-0039
Expires 03/31/2004

BUDGET

ORGANIZATION AND ADDRESS
Department of Natural Resource Ecology and Management
Iowa State University
Ames, IA 50011-3221

PROJECT DIRECTOR(S)
Joseph E. Morris

USDA AWARD NO. Year 1: Objective 1

	CSREES FUNDED WORK MONTHS: Calendar	Academic	Summer	Duration Proposed Months: 12 — **Funds Requested by Proposer**	Duration Proposed Months: ____ — **Funds Approved by CSREES** (If different)	Non-Federal Proposed Cost-Sharing/ Matching Funds (If required)	Non-federal Cost-Sharing/ Matching Funds Approved by CSREES (If Different)
A. Salaries and Wages 1. No. of Senior Personnel							
a. ___ (Co)-PD(s)							
b. ___ Senior Associates							
2. No. of Other Personnel (Non-Faculty) a. ___ Research Associates-Postdoctorates							
b. ___ Other Professionals							
c. ___ Paraprofessionals							
d. 1 Graduate Students				$17,500			
e. 1 Prebaccalaureate Students				$1,440			
f. ___ Secretarial-Clerical							
g. ___ Technical, Shop and Other							
Total Salaries and Wages →				$18,940	$0	$0	$0
B. Fringe Benefits (If charged as Direct Costs)				$2,156			
C. Total Salaries, Wages, and Fringe Benefits (A plus B) →				$21,096	0	$0	$0
D. Nonexpendable Equipment (Attach supporting data. List items and dollar amounts for each item.)							
E. Materials and Supplies				$1,811			
F. Travel				$250			
G. Publication Costs/Page Charges							
H. Computer (ADPE) Costs							
I. Student Assistance/Support (Scholarships/fellowships, stipends/tuition, cost of education, etc. Attach list of items and dollar amounts for each item.)							
J. All Other Direct Costs (In budget narrative, list items and dollar amounts and provide supporting data for each item.)				$1,250			
K. Total Direct Costs (C through I) →				$24,407	0	$0	$0
L. F&A/Indirect Costs. (If applicable, specify rate(s) and base(s) for on/off campus activity. Where both are involved, identify itemized costs in on/off campus bases.)							
M. Total Direct and F&A/Indirect Costs (J plus K) →				$24,407	0	$0	$0
N. Other →							
O. Total Amount of This Request →				$24,407	0	$0	$0

P. Carryover -- (If Applicable) . . . . **Federal Funds: $** **Non-Federal funds: $** **Total $**

Q. Cost Sharing/Matching (Breakdown of total amounts shown in line O)		
Cash (both Applicant and Third Party) →		
Non-Cash Contributions (both Applicant and Third Party) →		

NAME AND TITLE (Type or print)	**SIGNATURE** (required for revised budget only)	**DATE**
Project Director		
Authorized Organizational Representative		
Signature (for optional use)		

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UNITED STATES DEPARTMENT OF AGRICULTURE
COOPERATIVE STATE RESEARCH, EDUCATION, AND EXTENSION SERVICE

OMB Approved 0524-0039
Expires 03/31/2004

BUDGET

ORGANIZATION AND ADDRESS	USDA AWARD NO. Year 2: Objective 1			
Department of Natural Resource Ecology and Management Iowa State University Ames, IA 50011-3221 PROJECT DIRECTOR(S) Joseph E. Morris	Duration Proposed Months: 12 **Funds Requested by Proposer**	Duration Proposed Months: ____ **Funds Approved by CSREES** (If different)	Non-Federal Proposed Cost-Sharing/ Matching Funds (If required)	Non-federal Cost-Sharing/ Matching Funds Approved by CSREES (If Different)

Item	CSREES FUNDED WORK MONTHS: Calendar	Academic	Summer	Funds Requested by Proposer	Funds Approved by CSREES	Non-Federal Proposed Cost-Sharing	Non-federal Cost-Sharing Approved by CSREES
A. Salaries and Wages 1. No. of Senior Personnel							
a. ___ (Co)-PD(s)							
b. ___ Senior Associates							
2. No. of Other Personnel (Non-Faculty) a. ___ Research Associates-Postdoctorates							
b. ___ Other Professionals							
c. ___ Paraprofessionals							
d. 1 Graduate Students				$18,200			
e. 1 Prebaccalaureate Students				$3,315			
f. ___ Secretarial-Clerical							
g. ___ Technical, Shop and Other							
Total Salaries and Wages →				$21,515	$0	$0	$0
B. Fringe Benefits (If charged as Direct Costs)				$2,425			
C. Total Salaries, Wages, and Fringe Benefits (A plus B) →				$23,940	0	$0	$0
D. Nonexpendable Equipment (Attach supporting data. List items and dollar amounts for each item.)							
E. Materials and Supplies				$1,299			
F. Travel				$500			
G. Publication Costs/Page Charges							
H. Computer (ADPE) Costs							
I. Student Assistance/Support (Scholarships/fellowships, stipends/tuition, cost of education, etc. Attach list of items and dollar amounts for each item.)							
J. All Other Direct Costs (In budget narrative, list items and dollar amounts and provide supporting data for each item.)				$750			
K. Total Direct Costs (C through I) →				$26,489	0	$0	$0
L. F&A/Indirect Costs. (If applicable, specify rate(s) and base(s) for on/off campus activity. Where both are involved, identify itemized costs in on/off campus bases.)							
M. Total Direct and F&A/Indirect Costs (J plus K) →				$26,489	0	$0	$0
N. Other →							
O. Total Amount of This Request →				$26,489	0	$0	$0

P. Carryover -- (If Applicable) . . . . **Federal Funds: $** **Non-Federal funds: $** **Total $**

Q. Cost Sharing/Matching (Breakdown of total amounts shown in line O)		
Cash (both Applicant and Third Party) →		
Non-Cash Contributions (both Applicant and Third Party) →		

NAME AND TITLE (Type or print)	**SIGNATURE** (required for revised budget only)	**DATE**
Project Director		
Authorized Organizational Representative		
Signature (for optional use)		

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BUDGET EXPLANATION FOR IOWA STATE UNIVERSITY

(Morris)

Objectives 1

A. **Salaries and Wages.** Year 1: Salary for graduate student to assist PI in research ($17,500) and wages for undergraduate student to assist PI and graduate student in the study (180 hours @$8.00 for a total of $1,440). Year 2: Salary for graduate student to assist PI in research ($18,200 allowing for 4% annual increase) and wages for undergraduate to assist PI and graduate student in the study (390 hours @$8.50 for a total of $3,315).

B. **Fringe Benefits.** Year 1: 11.5% for graduate student ($2,012) and 10% for undergraduate worker ($144). Year 2: 11.5% for graduate student ($2,093) and 10% for undergraduate worker ($332).

E. **Materials and Supplies.** Year 1: Purchase 4,000 pond-run golden shiners ($1,531) and feed costs ($280). Year 2: $1,299 feed costs.

F. **Travel.** Year 1: $250 costs for transportation, lodging, and meal expenses for the PI to transport golden shiner stock from private farm to ISU. Year 2: $500 costs for transportation, lodging, and meal expenses for the PI to present information at a regional aquaculture workshop at a location to be determined.

J. **All Other Direct Costs.** Year 1: $750 rental for ISU ponds, $500 for operational costs for indoor recirculating aquaculture system on campus. Year 2: $750 rental for ISU ponds.

PROPOSED ACTIVITIES FOR UNIVERSITY OF WISCONSIN-STEVENS POINT NORTHERN AQUACULTURE DEMONSTRATION FACILITY

(Fischer)

Major Actions for Each Objective

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

   a. Conduct spawning trials using artificial spawning devices in a recirculating aquaculture system.

   b. Supply fry for subsequent stocking into culture ponds at Lake Mills State Fish Hatchery.

   c. Conduct studies on continued grow-out spotfin shiners in recirculating aquaculture systems (shiners originally raised in pond systems).

UNITED STATES DEPARTMENT OF AGRICULTURE
COOPERATIVE STATE RESEARCH, EDUCATION, AND EXTENSION SERVICE

OMB Approved 0524-0039
Expires 03/31/2004

BUDGET

ORGANIZATION AND ADDRESS	USDA AWARD NO. Year 1: Objective 2			
University of Wisconsin-Stevens Point Northern Aquaculture Demonstration Facility 36445 State Highway 13 Bayfield, WI 54814	Duration Proposed Months: 12	Duration Proposed Months: ____	Non-Federal Proposed Cost-Sharing/ Matching Funds (If required)	Non-federal Cost-Sharing/ Matching Funds Approved by CSREES (If Different)
PROJECT DIRECTOR(S) Gregory J. Fischer	Funds Requested by Proposer	Funds Approved by CSREES (If different)		

	CSREES FUNDED WORK MONTHS: Calendar	Academic	Summer	Funds Requested by Proposer	Funds Approved by CSREES	Non-Federal Proposed Cost-Sharing	Non-federal Cost-Sharing Approved
A. Salaries and Wages 1. No. of Senior Personnel							
a. ___ (Co)-PD(s)							
b. ___ Senior Associates							
2. No. of Other Personnel (Non-Faculty) a. ___ Research Associates-Postdoctorates							
b. ___ Other Professionals							
c. ___ Paraprofessionals							
d. ___ Graduate Students							
e. ___ Prebaccalaureate Students							
f. ___ Secretarial-Clerical							
g. 3 Technical, Shop and Other				$14,400			
Total Salaries and Wages →				$14,400	$0	$0	$0
B. Fringe Benefits (If charged as Direct Costs)				$5,976			
C. Total Salaries, Wages, and Fringe Benefits (A plus B) →				$20,376	0	$0	$0
D. Nonexpendable Equipment (Attach supporting data. List items and dollar amounts for each item.)							
E. Materials and Supplies				$5,074			
F. Travel				$1,550			
G. Publication Costs/Page Charges							
H. Computer (ADPE) Costs							
I. Student Assistance/Support (Scholarships/fellowships, stipends/tuition, cost of education, etc. Attach list of items and dollar amounts for each item.)							
J. All Other Direct Costs (In budget narrative, list items and dollar amounts and provide supporting data for each item.)							
K. Total Direct Costs (C through I) →				$27,000	0	$0	$0
L. F&A/Indirect Costs. (If applicable, specify rate(s) and base(s) for on/off campus activity. Where both are involved, identify itemized costs in on/off campus bases.)							
M. Total Direct and F&A/Indirect Costs (J plus K) →				$27,000	0	$0	$0
N. Other →							
O. Total Amount of This Request →				$27,000	0	$0	$0

P. Carryover -- (If Applicable) . . . . **Federal Funds: $** **Non-Federal funds: $** **Total $**

Q. Cost Sharing/Matching (Breakdown of total amounts shown in line O)		
Cash (both Applicant and Third Party) →		
Non-Cash Contributions (both Applicant and Third Party) →		

NAME AND TITLE (Type or print)	**SIGNATURE** (required for revised budget only)	**DATE**
Project Director		
Authorized Organizational Representative		
Signature (for optional use)		

UNITED STATES DEPARTMENT OF AGRICULTURE
COOPERATIVE STATE RESEARCH, EDUCATION, AND EXTENSION SERVICE

OMB Approved 0524-0039
Expires 03/31/2004

BUDGET

ORGANIZATION AND ADDRESS
University of Wisconsin-Stevens Point Northern Aquaculture Demonstration Facility
36445 State Highway 13
Bayfield, WI 54814

PROJECT DIRECTOR(S)
Gregory J. Fischer

USDA AWARD NO. Year 2: Objective 2

	Calendar	Academic	Summer	Duration Proposed Months: 12 **Funds Requested by Proposer**	Duration Proposed Months: ____ **Funds Approved by CSREES** (If different)	Non-Federal Proposed Cost-Sharing/ Matching Funds (If required)	Non-federal Cost-Sharing/ Matching Funds Approved by CSREES (If Different)
A. Salaries and Wages (CSREES FUNDED WORK MONTHS)							
1. No. of Senior Personnel							
a. ___ (Co)-PD(s)							
b. ___ Senior Associates							
2. No. of Other Personnel (Non-Faculty)							
a. ___ Research Associates-Postdoctorates							
b. ___ Other Professionals							
c. ___ Paraprofessionals							
d. ___ Graduate Students							
e. ___ Prebaccalaureate Students							
f. ___ Secretarial-Clerical							
g. 3 Technical, Shop and Other				$11,100			
Total Salaries and Wages →				$11,100	$0	$0	$0
B. Fringe Benefits (If charged as Direct Costs)				$4,607			
C. Total Salaries, Wages, and Fringe Benefits (A plus B) →				$15,707	0	$0	$0
D. Nonexpendable Equipment (Attach supporting data. List items and dollar amounts for each item.)							
E. Materials and Supplies				$3,793			
F. Travel				$1,000			
G. Publication Costs/Page Charges							
H. Computer (ADPE) Costs							
I. Student Assistance/Support (Scholarships/fellowships, stipends/tuition, cost of education, etc. Attach list of items and dollar amounts for each item.)							
J. All Other Direct Costs (In budget narrative, list items and dollar amounts and provide supporting data for each item.)							
K. Total Direct Costs (C through I) →				$20,500	0	$0	$0
L. F&A/Indirect Costs. (If applicable, specify rate(s) and base(s) for on/off campus activity. Where both are involved, identify itemized costs in on/off campus bases.)							
M. Total Direct and F&A/Indirect Costs (J plus K) →				$20,500	0	$0	$0
N. Other →							
O. Total Amount of This Request →				$20,500	0	$0	$0

P. Carryover -- (If Applicable) . . . . **Federal Funds: $** **Non-Federal funds: $** **Total $**

Q. Cost Sharing/Matching (Breakdown of total amounts shown in line O)		
Cash (both Applicant and Third Party) →		
Non-Cash Contributions (both Applicant and Third Party) →		

NAME AND TITLE (Type or print)	**SIGNATURE** (required for revised budget only)	**DATE**
Project Director		
Authorized Organizational Representative		
Signature (for optional use)		

BUDGET EXPLANATION FOR UNIVERSITY OF WISCONSIN-STEVENS POINT NORTHERN AQUACULTURE DEMONSTRATION FACILITY

(Fischer)

Objective 2

A. **Salaries and Wages.** Year 1: Salary is requested for approximately 1,200 hours of three Laboratory Technical Employees (LTEs) to perform the work indicated. Year 2: Salary is requested for approximately 900 hours of three LTEs is requested to perform the work indicated.

B. **Fringe Benefits.** The UW-Stevens Point fringe benefit rate for LTEs is 41.5%.

C. **Materials and Supplies.** Year 1: Feed ($2,000), chemicals (1,000), miscellaneous recirculating aquaculture system supplies ($1,074) and laboratory testing supplies ($1,000). Year 2: Feed ($2,000), chemicals ($600), miscellaneous recirculating aquaculture system supplies ($653) and laboratory testing supplies ($540).

D. **Travel.** Year 1: $1,550 is requested for transportation, lodging, and meal expenses incurred while locating, capturing, and transporting fish. Year 2: $1,000 is requested for transportation, lodging, and meal expenses incurred while locating, capturing, and transporting fish.

PROPOSED ACTIVITIES FOR UNIVERSITY OF WISCONSIN-MADISON

(Malison)

Major Actions for Each Objective

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

   a. Transport fry from the University of Wisconsin-Stevens Point Northern Aquaculture Demonstration Facility (NADF) to the Lake Mills State Fish Hatchery (LMSFH).

   b. In both years 1 and 2, conduct a grow-out study using and stocked into six 0.04-ha (0.1-acre) ponds. Ponds, one stocking per year all at the same time (beginning of season).

   c. Supply spotfin shiners grown through the first summer in ponds at LMSFH to the UW-Stevens Point NADF for grow out in an indoor recirculating aquaculture system.

   d. Overwinter fish in a minimum of 2 ponds per season.

UNITED STATES DEPARTMENT OF AGRICULTURE
COOPERATIVE STATE RESEARCH, EDUCATION, AND EXTENSION SERVICE

OMB Approved 0524-0039
Expires 03/31/2004

BUDGET

ORGANIZATION AND ADDRESS Board of Regents, University of Wisconsin System 750 University Ave. Madison, WI 53706 PROJECT DIRECTOR(S) Jeffrey A. Malison				USDA AWARD NO. Year 1: Objective 2			
				Duration Proposed Months: 12 Funds Requested by Proposer	Duration Proposed Months: ____ Funds Approved by CSREES (If different)	Non-Federal Proposed Cost-Sharing/ Matching Funds (If required)	Non-federal Cost-Sharing/ Matching Funds Approved by CSREES (If Different)
A. Salaries and Wages 1. No. of Senior Personnel	CSREES FUNDED WORK MONTHS						
	Calendar	Academic	Summer				
a. ___ (Co)-PD(s)							
b. ___ Senior Associates							
2. No. of Other Personnel (Non-Faculty) a. ___ Research Associates-Postdoctorates							
b. ___ Other Professionals							
c. ___ Paraprofessionals							
d. ___ Graduate Students							
e. ___ Prebaccalaureate Students							
f. ___ Secretarial-Clerical							
g. 2 Technical, Shop and Other				$16,418			
Total Salaries and Wages →				$16,418	$0	$0	$0
B. Fringe Benefits (If charged as Direct Costs)				$5,582			
C. Total Salaries, Wages, and Fringe Benefits (A plus B) →				$22,000	0	$0	$0
D. Nonexpendable Equipment (Attach supporting data. List items and dollar amounts for each item.)							
E. Materials and Supplies				$1,000			
F. Travel				$750			
G. Publication Costs/Page Charges							
H. Computer (ADPE) Costs							
I. Student Assistance/Support (Scholarships/fellowships, stipends/tuition, cost of education, etc. Attach list of items and dollar amounts for each item.)							
J. All Other Direct Costs (In budget narrative, list items and dollar amounts and provide supporting data for each item.)							
K. Total Direct Costs (C through I) →				$23,750	0	$0	$0
L. F&A/Indirect Costs. (If applicable, specify rate(s) and base(s) for on/off campus activity. Where both are involved, identify itemized costs in on/off campus bases.)							
M. Total Direct and F&A/Indirect Costs (J plus K) →				$23,750	0	$0	$0
N. Other →							
O. Total Amount of This Request →				$23,750	0	$0	$0

P. Carryover -- (If Applicable) . . . . **Federal Funds: $** **Non-Federal funds: $** **Total $**

Q. Cost Sharing/Matching (Breakdown of total amounts shown in line O)		
Cash (both Applicant and Third Party) →		
Non-Cash Contributions (both Applicant and Third Party) →		

NAME AND TITLE (Type or print)	**SIGNATURE** (required for revised budget only)	**DATE**
Project Director		
Authorized Organizational Representative		
Signature (for optional use)		

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UNITED STATES DEPARTMENT OF AGRICULTURE
COOPERATIVE STATE RESEARCH, EDUCATION, AND EXTENSION SERVICE

OMB Approved 0524-0039
Expires 03/31/2004

BUDGET

ORGANIZATION AND ADDRESS
Board of Regents, University of Wisconsin System
750 University Ave.
Madison, WI 53706

PROJECT DIRECTOR(S)
Jeffrey A. Malison

USDA AWARD NO. Year 2: Objective 2

	CSREES FUNDED WORK MONTHS: Calendar	Academic	Summer	Duration Proposed Months: 12 — **Funds Requested by Proposer**	Duration Proposed Months: ____ — **Funds Approved by CSREES** (If different)	Non-Federal Proposed Cost-Sharing/ Matching Funds (If required)	Non-federal Cost-Sharing/ Matching Funds Approved by CSREES (If Different)
A. Salaries and Wages 1. No. of Senior Personnel							
a. ___ (Co)-PD(s)							
b. ___ Senior Associates							
2. No. of Other Personnel (Non-Faculty) a. ___ Research Associates-Postdoctorates							
b. ___ Other Professionals							
c. ___ Paraprofessionals							
d. ___ Graduate Students							
e. ___ Prebaccalaureate Students							
f. ___ Secretarial-Clerical							
g. 2 Technical, Shop and Other				$16,418			
Total Salaries and Wages →				$16,418	$0	$0	$0
B. Fringe Benefits (If charged as Direct Costs)				$5,582			
C. Total Salaries, Wages, and Fringe Benefits (A plus B) →				$22,000	0	$0	$0
D. Nonexpendable Equipment (Attach supporting data. List items and dollar amounts for each item.)							
E. Materials and Supplies				$1,000			
F. Travel				$750			
G. Publication Costs/Page Charges							
H. Computer (ADPE) Costs							
I. Student Assistance/Support (Scholarships/fellowships, stipends/tuition, cost of education, etc. Attach list of items and dollar amounts for each item.)							
J. All Other Direct Costs (In budget narrative, list items and dollar amounts and provide supporting data for each item.)							
K. Total Direct Costs (C through I) →				$23,750	0	$0	$0
L. F&A/Indirect Costs. (If applicable, specify rate(s) and base(s) for on/off campus activity. Where both are involved, identify itemized costs in on/off campus bases.)							
M. Total Direct and F&A/Indirect Costs (J plus K) →				$23,750	0	$0	$0
N. Other →							
O. Total Amount of This Request →				$23,750	0	$0	$0

P. Carryover -- (If Applicable) . . . . **Federal Funds: $** **Non-Federal funds: $** **Total $**

Q. Cost Sharing/Matching (Breakdown of total amounts shown in line O)		
Cash (both Applicant and Third Party) →		
Non-Cash Contributions (both Applicant and Third Party) →		

NAME AND TITLE (Type or print)	**SIGNATURE** (required for revised budget only)	**DATE**
Project Director		
Authorized Organizational Representative		
Signature (for optional use)		

BUDGET EXPLANATION FOR UNIVERSITY OF WISCONSIN-MADISON

(Malison)

Objective 2

A. Salaries and Wages. Annual costs: The salary for approximately 2.45 months of two technician's time is requested to perform the work indicated.

B. Fringe Benefits. The UW-Madison fringe benefit rate for faculty and academic staff is 34%.

E. Materials and Supplies. Annual costs: Fish food ($750) and other miscellaneous wet laboratory supplies ($250).

F. Travel. Annual costs: $750 is requested for each year to transport shiners in autumn from the LMSFH to UW-Stevens Point NADF, and transportation for one person to attend the Wisconsin Aquaculture conference to present results.

PROPOSED ACTIVITIES FOR UNIVERSITY OF WISCONSIN-MILWAUKEE

(Binkowski)

Major Actions for Each Objective

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

    a. Set up captive brood stock in mass rearing tank for advanced spawning under optimal conditions.

    b. Set up captive brood stock in mass rearing tank for advanced spawning under seasonal conditions.

    c. Set up specialized indoor spawning tank.

    d. Maintain mass rearing tanks, collect and incubate eggs, and rear young of the year spotfins.

    e. Maintain specialized spawning tank, collect and incubate eggs, and rear young of the year spotfins.

    f. Raise spotfins in RAS & pond.

    g. Set up and use of specialized spawning tank apparatus in pond.

Task	2006			2007												2008								
#	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A
1	X	X	X	X	X	X	X	X	X	X	X	X												
2	X	X	X	X	X	X	X	X	X	X	X	X												
3	X	X	X	X	X	X	X	X	X	X	X	X												
4					X	X	X	X	X	X	X	X												
5					X	X	X	X	X	X	X	X												
6									X	X	X	X	X	X										
7																				X	X	X	X	X
7																				X	X	X	X	X

UNITED STATES DEPARTMENT OF AGRICULTURE
COOPERATIVE STATE RESEARCH, EDUCATION, AND EXTENSION SERVICE

OMB Approved 0524-0039
Expires 03/31/2004

BUDGET

ORGANIZATION AND ADDRESS
Great Lakes WATER Institute
University of Wisconsin-Milwaukee
Milwaukee, WI 53204

PROJECT DIRECTOR(S)
Fred P. Binkowski

USDA AWARD NO. Year 1: Objective 2

	CSREES FUNDED WORK MONTHS: Calendar	Academic	Summer	Duration Proposed Months: 12 — **Funds Requested by Proposer**	Duration Proposed Months: ____ — **Funds Approved by CSREES** (If different)	Non-Federal Proposed Cost-Sharing/ Matching Funds (If required)	Non-federal Cost-Sharing/ Matching Funds Approved by CSREES (If Different)
A. Salaries and Wages 1. No. of Senior Personnel							
a. ___ (Co)-PD(s)							
b. ___ Senior Associates							
2. No. of Other Personnel (Non-Faculty) a. ___ Research Associates-Postdoctorates							
b. ___ Other Professionals							
c. ___ Paraprofessionals							
d. ___ Graduate Students							
e. 1 Prebaccalaureate Students				$2,000			
f. ___ Secretarial-Clerical							
g. 1 Technical, Shop and Other				$20,000			
Total Salaries and Wages →				$22,000	$0	$0	$0
B. Fringe Benefits (If charged as Direct Costs)				$6,840			
C. Total Salaries, Wages, and Fringe Benefits (A plus B) →				$28,840	0	$0	$0
D. Nonexpendable Equipment (Attach supporting data. List items and dollar amounts for each item.)							
E. Materials and Supplies				$2,000			
F. Travel				$1,000			
G. Publication Costs/Page Charges							
H. Computer (ADPE) Costs							
I. Student Assistance/Support (Scholarships/fellowships, stipends/tuition, cost of education, etc. Attach list of items and dollar amounts for each item.)							
J. All Other Direct Costs (In budget narrative, list items and dollar amounts and provide supporting data for each item.)							
K. Total Direct Costs (C through I) →				$31,840	0	$0	$0
L. F&A/Indirect Costs. (If applicable, specify rate(s) and base(s) for on/off campus activity. Where both are involved, identify itemized costs in on/off campus bases.)							
M. Total Direct and F&A/Indirect Costs (J plus K) →				$31,840	0	$0	$0
N. Other →							
O. Total Amount of This Request →				$31,840	0	$0	$0

P. Carryover -- (If Applicable) . . . . **Federal Funds: $** **Non-Federal funds: $** **Total $**

Q. Cost Sharing/Matching (Breakdown of total amounts shown in line O)

Cash (both Applicant and Third Party) →		
Non-Cash Contributions (both Applicant and Third Party) →		

NAME AND TITLE (Type or print)	**SIGNATURE** (required for revised budget only)	**DATE**
Project Director		
Authorized Organizational Representative		
Signature (for optional use)		

According to the Paperwork Reduction Act of 1995, an agency may not conduct or sponsor, and a person is not required to respond to a collection of information unless it displays a valid OMB control number. The valid OMB control number for this information collection is 0524-0039. The time required to complete this information collection is estimated to average 1.00 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing the reviewing the collection of information.

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COOPERATIVE STATE RESEARCH, EDUCATION, AND EXTENSION SERVICE

OMB Approved 0524-0039
Expires 03/31/2004

BUDGET

ORGANIZATION AND ADDRESS	USDA AWARD NO. Year 2: Objective 2			
Great Lakes WATER Institute University of Wisconsin-Milwaukee Milwaukee, WI 53204 PROJECT DIRECTOR(S) Fred P. Binkowski	Duration Proposed Months: 12 **Funds Requested by Proposer**	Duration Proposed Months: ____ **Funds Approved by CSREES** (If different)	Non-Federal Proposed Cost-Sharing/ Matching Funds (If required)	Non-federal Cost-Sharing/ Matching Funds Approved by CSREES (If Different)

	CSREES FUNDED WORK MONTHS: Calendar	Academic	Summer	Funds Requested by Proposer	Funds Approved by CSREES	Non-Federal Proposed	Non-federal Approved
A. Salaries and Wages 1. No. of Senior Personnel							
a. ___ (Co)-PD(s)							
b. ___ Senior Associates							
2. No. of Other Personnel (Non-Faculty) a. ___ Research Associates-Postdoctorates							
b. ___ Other Professionals							
c. ___ Paraprofessionals							
d. ___ Graduate Students							
e. 1 Prebaccalaureate Students				$1,000			
f. ___ Secretarial-Clerical							
g. 1 Technical, Shop and Other				$6,300			
Total Salaries and Wages →				$7,300	$0	$0	$0
B. Fringe Benefits (If charged as Direct Costs)				$2,162			
C. Total Salaries, Wages, and Fringe Benefits (A plus B) →				$9,462	0	$0	$0
D. Nonexpendable Equipment (Attach supporting data. List items and dollar amounts for each item.)							
E. Materials and Supplies				$1,802			
F. Travel				$1,000			
G. Publication Costs/Page Charges							
H. Computer (ADPE) Costs							
I. Student Assistance/Support (Scholarships/fellowships, stipends/tuition, cost of education, etc. Attach list of items and dollar amounts for each item.)							
J. All Other Direct Costs (In budget narrative, list items and dollar amounts and provide supporting data for each item.)							
K. Total Direct Costs (C through I) →				$12,264	0	$0	$0
L. F&A/Indirect Costs. (If applicable, specify rate(s) and base(s) for on/off campus activity. Where both are involved, identify itemized costs in on/off campus bases.)							
M. Total Direct and F&A/Indirect Costs (J plus K) →				$12,264	0	$0	$0
N. Other →							
O. Total Amount of This Request →				$12,264	0	$0	$0

P. Carryover -- (If Applicable) . . . . **Federal Funds: $** **Non-Federal funds: $** **Total $**

Q. Cost Sharing/Matching (Breakdown of total amounts shown in line O)		
Cash (both Applicant and Third Party) →		
Non-Cash Contributions (both Applicant and Third Party) →		

NAME AND TITLE (Type or print)	**SIGNATURE** (required for revised budget only)	**DATE**
Project Director		
Authorized Organizational Representative		
Signature (for optional use)		

BUDGET EXPLANATION FOR UNIVERSITY OF WISCONSIN-MILWAUKEE

(Binkowski)

Objective 2

A. **Salaries and Wages**. Two academic staff researchers at 24% effort in Year 1 and one academic staff researcher at 16% effort for Year 2 will assist the PI with all technical aspects associated with brood stock development, spawning, early life stage culture, and recirculating system and pond production of spotfin shiner for Objective 2. Additionally, an undergraduate student will provide student hourly help for this project.

B. **Fringe Benefits**. The fringe benefit rate for UW-Milwaukee is 34% for academic staff and 2% for student hourly help.

E. **Materials and Supplies**. Year 1: General laboratory supplies ($250), plumbing hardware ($250), aquaria supplies ($250), fish food ($1,000), and construction materials ($250). Year 2: General laboratory supplies ($352), plumbing hardware ($150), aquaria supplies ($150), fish food ($1,000), and construction materials ($150). These items are necessary for fish husbandry, fish culture experiments, and experimental apparatus in both laboratory and field research.

F. **Travel**. Annual costs: Partial support for field collection of spotfin shiners and vehicle charges for travel from Milwaukee, Wisconsin to the pond field sites.

Note: University of Wisconsin-Milwaukee Great Lakes WATER Institute will be responsible in part for supporting materials and supplies and associated travel costs.

PROPOSED ACTIVITIES FOR UNIVERSITY OF MINNESOTA-DULUTH

(Gunderson)

Major Actions for Each Objective

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.

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

    b. A video of spotfin shiner spawning behavior will be produced. Sea Grant Communications staff will assist.

    c. A workshop will be held at the UW-Stevens Point NADF during summer of Year 2 to demonstrate spotfin shiner spawning behavior, spawning substrate construction, hatching protocols, and to highlight the first year's results.

    d. Assist UW-Stevens Point and UW-Madison scientists in obtaining the initial brood fish needed for their studies from the Minnesota/Wisconsin baitfish industry.

UNITED STATES DEPARTMENT OF AGRICULTURE
COOPERATIVE STATE RESEARCH, EDUCATION, AND EXTENSION SERVICE

OMB Approved 0524-0039
Expires 03/31/2004

BUDGET

ORGANIZATION AND ADDRESS
Minnesota Sea Grant
2305 E. 5th Street
Duluth, MN 55812

PROJECT DIRECTOR(S)
Jeffrey L. Gunderson

USDA AWARD NO. Year 1: Objective 3

	Calendar	Academic	Summer	Duration Proposed Months: 12 — Funds Requested by Proposer	Duration Proposed Months: ____ — Funds Approved by CSREES (If different)	Non-Federal Proposed Cost-Sharing/ Matching Funds (If required)	Non-federal Cost-Sharing/ Matching Funds Approved by CSREES (If Different)
A. Salaries and Wages (CSREES FUNDED WORK MONTHS)							
1. No. of Senior Personnel							
a. ___ (Co)-PD(s)							
b. ___ Senior Associates							
2. No. of Other Personnel (Non-Faculty) a. ___ Research Associates-Postdoctorates							
b. ___ Other Professionals							
c. ___ Paraprofessionals							
d. ___ Graduate Students							
e. ___ Prebaccalaureate Students							
f. ___ Secretarial-Clerical							
g. _1_ Technical, Shop and Other				$2,224			
Total Salaries and Wages →				$2,224	$0	$0	$0
B. Fringe Benefits (If charged as Direct Costs)				$776			
C. Total Salaries, Wages, and Fringe Benefits (A plus B) →				$3,000	0	$0	$0
D. Nonexpendable Equipment (Attach supporting data. List items and dollar amounts for each item.)							
E. Materials and Supplies				$500			
F. Travel				$1,000			
G. Publication Costs/Page Charges							
H. Computer (ADPE) Costs							
I. Student Assistance/Support (Scholarships/fellowships, stipends/tuition, cost of education, etc. Attach list of items and dollar amounts for each item.)							
J. All Other Direct Costs (In budget narrative, list items and dollar amounts and provide supporting data for each item.)				$500			
K. Total Direct Costs (C through I) →				$5,000	0	$0	$0
L. F&A/Indirect Costs. (If applicable, specify rate(s) and base(s) for on/off campus activity. Where both are involved, identify itemized costs in on/off campus bases.)							
M. Total Direct and F&A/Indirect Costs (J plus K) →				$5,000	0	$0	$0
N. Other →							
O. Total Amount of This Request →				$5,000	0	$0	$0

P. Carryover -- (If Applicable) . . . . **Federal Funds: $** **Non-Federal funds: $** **Total $**

Q. Cost Sharing/Matching (Breakdown of total amounts shown in line O)

Cash (both Applicant and Third Party) →		
Non-Cash Contributions (both Applicant and Third Party) →		

NAME AND TITLE (Type or print)	**SIGNATURE** (required for revised budget only)	**DATE**
Project Director		
Authorized Organizational Representative		
Signature (for optional use)		

UNITED STATES DEPARTMENT OF AGRICULTURE
COOPERATIVE STATE RESEARCH, EDUCATION, AND EXTENSION SERVICE

OMB Approved 0524-0039
Expires 03/31/2004

BUDGET

ORGANIZATION AND ADDRESS	USDA AWARD NO. Year 2: Objective 3			
Minnesota Sea Grant 2305 E. 5th Street Duluth, MN 55812	Duration Proposed Months: 12 **Funds Requested by Proposer**	Duration Proposed Months: ____ **Funds Approved by CSREES** (If different)	Non-Federal Proposed Cost-Sharing/ Matching Funds (If required)	Non-federal Cost-Sharing/ Matching Funds Approved by CSREES (If Different)
PROJECT DIRECTOR(S) Jeffrey L. Gunderson				

	CSREES FUNDED WORK MONTHS: Calendar	Academic	Summer	Funds Requested by Proposer	Funds Approved by CSREES	Non-Federal Proposed	Non-federal Approved
A. Salaries and Wages 1. No. of Senior Personnel							
a. ___ (Co)-PD(s)							
b. ___ Senior Associates							
2. No. of Other Personnel (Non-Faculty) a. ___ Research Associates-Postdoctorates							
b. ___ Other Professionals							
c. ___ Paraprofessionals							
d. ___ Graduate Students							
e. ___ Prebaccalaureate Students							
f. ___ Secretarial-Clerical							
g. 1 Technical, Shop and Other				$1,465			
Total Salaries and Wages →				$1,465	$0	$0	$0
B. Fringe Benefits (If charged as Direct Costs)				$535			
C. Total Salaries, Wages, and Fringe Benefits (A plus B) →				$2,000	0	$0	$0
D. Nonexpendable Equipment (Attach supporting data. List items and dollar amounts for each item.)							
E. Materials and Supplies				$500			
F. Travel				$2,000			
G. Publication Costs/Page Charges							
H. Computer (ADPE) Costs							
I. Student Assistance/Support (Scholarships/fellowships, stipends/tuition, cost of education, etc. Attach list of items and dollar amounts for each item.)							
J. All Other Direct Costs (In budget narrative, list items and dollar amounts and provide supporting data for each item.)				$500			
K. Total Direct Costs (C through I) →				$5,000	0	$0	$0
L. F&A/Indirect Costs. (If applicable, specify rate(s) and base(s) for on/off campus activity. Where both are involved, identify itemized costs in on/off campus bases.)							
M. Total Direct and F&A/Indirect Costs (J plus K) →				$5,000	0	$0	$0
N. Other →							
O. Total Amount of This Request →				$5,000	0	$0	$0

P. Carryover -- (If Applicable) . . . . **Federal Funds: $** **Non-Federal funds: $** **Total $**

Q. Cost Sharing/Matching (Breakdown of total amounts shown in line O)		
Cash (both Applicant and Third Party) →		
Non-Cash Contributions (both Applicant and Third Party) →		

NAME AND TITLE (Type or print)	**SIGNATURE** (required for revised budget only)	**DATE**
Project Director		
Authorized Organizational Representative		
Signature (for optional use)		

According to the Paperwork Reduction Act of 1995, an agency may not conduct or sponsor, and a person is not required to respond to a collection of information unless it displays a valid OMB control number. The valid OMB control number for this information collection is 0524-0039. The time required to complete this information collection is estimated to average 1.00 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing the reviewing the collection of information.

BUDGET EXPLANATION FOR UNIVERSITY OF MINNESOTA-DULUTH UNIVERSITY

(Gunderson)

Objective 3

A. **Salaries and Wages.** Sea Grant Communications staff will assist in development of Web and written communications related to this project. Salary for Year 1 will be 7% FTE or .8 months to help with video development and getting information on the Web. Salary for Year 2 will be 5% FTE or .6 months to help with fact sheet and other written communication product development.

B. **Fringe Benefits.** Annual costs: the UMD fringe rate is 34.9% Year 1 and 36.5% Year 2 for civil service employees.

E. **Materials and Supplies.** Annual costs: $500 is budgeted for each year to cover costs associated with videos, CDs, workshop materials, survey development, and shipping baitfish throughout the region.

F. **Travel.** Travel dollars will be used to cover the cost of researchers and the extension liaison traveling to workshop locations in both years. Travel money will also be used to visit research locations at key times to collect video footage for documenting the aquaculture techniques being evaluated. More travel is budgeted for Year 2 because the workshop planned for that year will include more researchers and other presenters.

J. **All Other Direct Costs.** Annual costs: $500 is budgeted each year to cover costs associated with producing written materials associated with the project.

BUDGET SUMMARY ALL PARTICIPATING INSTITUTIONS

Year 1

	ISU	UW-SP NADF	UW-Mad.	UW-Mil.	UM-D	TOTALS
Salaries and Wages	$18,940	$14,400	$16,418	$22,000	$2,224	$73,982
Fringe Benefits	$2,156	$5,976	$5,582	$6,840	$ 776	$21,330
Total Salaries, Wages, and Fringe Benefits	$21,096	$20,376	$22,000	$28,840	$3,000	$95,312
Nonexpendable Equipment	$ 0	$ 0	$ 0	$ 0	$ 0	$ 0
Materials and Supplies	$1,811	$5,074	$1,000	$2,000	$ 500	$10,385
Travel	$ 250	$1,550	$ 750	$1,000	$1,000	$4,550
All Other Direct Costs	$1,250	$ 0	$ 0	$ 0	$ 500	$1,750
TOTAL PROJECT COSTS	**$24,407**	**$27,000**	**$23,750**	**$31,840**	**$5,000**	**$111,997**

Year 2

	ISU	UW-SP NADF	UW-Mad.	UW-Mil.	UM-D	TOTALS
Salaries and Wages	$21,515	$11,100	$16,418	$7,300	$1,465	$57,798
Fringe Benefits	$2,425	$4,607	$5,582	$2,162	$ 535	$15,311
Total Salaries, Wages, and Fringe Benefits	$23,940	$15,707	$22,000	$9,462	$2,000	$73,109
Nonexpendable Equipment	$ 0	$ 0	$ 0	$ 0	$ 0	$ 0
Materials and Supplies	$1,299	$3,793	$1,000	$1,802	$ 500	$8,394
Travel	$ 500	$1,000	$ 750	$1,000	$2,000	$5,250
All Other Direct Costs	$ 750	$ 0	$ 0	$ 0	$ 500	$1,250
TOTAL PROJECT COSTS	**$26,489**	**$20,500**	**$23,750]**	**$12,264**	**$5,000**	**$88,003**

SCHEDULE FOR COMPLETION OF OBJECTIVES

Objective 1: Initiated in Year 1 and completed in Year 2.

Objective 2: Initiated in Year 1 and completed in Year 2.

Objective 3: Initiated in Year 1 and completed in Year 2.

LIST OF PRINCIPAL INVESTIGATORS

Fred P. Binkowski, University of Wisconsin-Milwaukee

Gregory J. Fischer, University of Wisconsin-Stevens Point Northern Aquaculture Demonstration Facility

Jeffrey L. Gunderson, University of Minnesota-Duluth

Jeffrey A. Malison, University of Wisconsin-Madison

Joseph E. Morris, Iowa State University

VITA

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EDUCATION

B.S. University of Wisconsin-Milwaukee, 1971, Zoology
M.S. University of Wisconsin-Milwaukee, 1974, Zoology (Fisheries Biology)

POSITIONS

Director (1993-present), and Senior Scientist (1991-present) Wisconsin Aquaculture Center, University of Wisconsin System Great Lakes WATER Institute

Associate Scientist (1987-1990), Senior Fisheries Biologist (1984-1986), Associate Fisheries Biologist (1981-1983), and Assistant Fisheries Biologist (1978-1980), Center for Great Lakes Studies/University of Wisconsin Great Lakes Research Facility

Research Specialist (Fisheries) (1975-1978), Department of Zoology, University of Wisconsin-Milwaukee

SCIENTIFIC AND PROFESSIONAL ORGANIZATIONS

American Fisheries Society
Early Life History Section, American Fisheries Society
Fish Culture Section, American Fisheries Society
US Aquaculture Society
World Aquaculture Society

SELECTED PUBLICATIONS

Fontana, F., R.M. Bruch, F.P. Binkowski, M. Lanfredi, M. Chicca, N. Beltrami, and L. Congiu. 2004. Karyotype characterization of the lake sturgeon, *Acipenser fluvescens* (Rafinesque 1817) by chromosome banding and fluorescent in situ hybridization. Genome 47:742-746.

Yeo, S.E., F.P. Binkowski, and J.E. Morris. 2004. Aquaculture effluents and waste by-products: characteristics, potential recovery and beneficial reuse. NCRAC Publications Office, Iowa State University, Ames and the University of Wisconsin Sea Grant, Madison. 50 pp.

Rosenthal, H., R.M., Bruch, F.P. Binkowski, and S.I. Doroshov, editors. 2002. Proceedings of the 4th International Symposium on Sturgeon. Journal of Applied Ichthyology 18 (4-6):219-698.

Bruch, R.M., and F.P. Binkowski. 2002. Spawning behavior of lake sturgeon (*Acipenser fluvescens*). Journal of Applied Ichthyology 18 (4-6):570-579.

Rosenthal, H., R.M., Bruch, and F.P. Binkowski, editors. 2002. Technical compendium to the proceedings of the 4th International Symposium on Sturgeon, Oshkosh, Wisconsin.

Heyer, C.J., T.J. Miller, F.P. Binkowski, E.M. Calderone, and J.A. Rice. 2001. Understanding maternal effects as a recruitment mechanism in Lake Michigan yellow perch (*Perca flavescens*). Canadian Journal of Fisheries and Aquatic Sciences 58:1477-1487.

VITA

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E-Mail: gfischer@uwsp.edu

EDUCATION

B. S. Lake Superior State University, 1992, Fisheries & Wildlife Management
A. A.. Jackson Community College, 1988, Biology

POSITIONS

Facilities Director (2002-present) University of Wisconsin-Stevens Point Northern Aquaculture Demonstration Facility
Natural Resources/Fish Hatchery Program Director (2000-2002), and Fish Hatchery Manager (1994-2000), Red Cliff Tribe, Bayfield, Wisconsin
Aquaculture/Fisheries/Hatchery Design Consultant (2001-present), various firms nationwide
Biological Technician (1993-1994), U.S. Fisheries and Wildlife Service Sea Lamprey Control, Marquette, Michigan
Fish Hatchery Technician (1990-1991), Lake Superior State University, Sault Ste. Marie, Michigan
Fisheries Aid (1989), U.S. Fisheries and Wildlife Service, Pendills Creek National Fish Hatchery, Brimley, Michigan

SCIENTIFIC AND PROFESSIONAL ORGANIZATIONS

American Fisheries Society (Fish Culture Section)
Native American Fish and Wildlife Society
Wisconsin Aquaculture Advisory Committee

VITA

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Minnesota Sea Grant Extension Program
University of Minnesota-Duluth
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Duluth, MN 55812

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Fax: (218) 726-6556
E-mail: jgunde1@umn.edu

EDUCATION

B.S. University of Wisconsin-Stevens Point, 1975, Biology
M.S. University of Wisconsin-Stevens Point, 1978, Natural Resources

POSITIONS

Associate Director, Fisheries/Aquaculture Educator and Professor (1998-present), and Fisheries/Aquaculture Educator (1979-1998), University of Minnesota Sea Grant Extension
Fishery Specialist/Fishery Biologist (1978-1979), Missouri Conservation Department

SCIENTIFIC AND PROFESSIONAL ORGANIZATIONS

American Fisheries Society
The Assembly of Sea Grant Program Leaders
International Association of Astacology
World Aquaculture Society

SELECTED PUBLICATIONS

Gunderson, J.L., C. Richards, and P. Tucker. In review) Aquaculture potential for hornyhead chubs. Minnesota Sea Grant and University of Minnesota-Duluth Natural Resources Research Institute Technical Report.

Gunderson, J.L., and R. Kinnunen. 2004. AIS-HACCP: Aquatic invasive species—hazard analysis and critical control point training curriculum. Second Edition. Minnesota Sea Grant Publication No. MN SG-F11. 83 pp.

Richards, C., R.P. Axler, J.L. Gunderson, C.A. Hagley, and M.E. McDonald. 2002. Assessing and communicating risk: a partnership to evaluate a superfund site on Leech Lake Tribal Lands. Final Report to U.S. Environmental Protection Agency, Environmental Justice Program, Grant No. EQ825741. University of Minnesota Sea Grant Program Publication No. CT 13 and Natural Resources Research Institute Technical Report No. NRRI/TR-2002/23.

Bartell, S., C. Richards, R.P. Axler, J.L. Gunderson, and C.A. Hagley. 2002. Human health risk assessment panel report. *In* Richards, C., R.P. Axler, J.L. Gunderson, C.A. Hagley, and M.E. McDonald. Assessing and communicating risk: a partnership to evaluate a superfund site on Leech Lake Tribal Lands. Final Report to U.S. Environmental Protection Agency, Environmental Justice Program, Grant No. EQ825741. University of Minnesota Sea Grant Program, Publication No. CT 13 and Natural Resources Research Institute Technical Report No. NRRI/TR-2002/23.

Gunderson, J.L., and R. Kinnunen. 2002. The HACCP approach to prevent the spread of aquatic nuisance species by aquaculture and baitfish operations. *In* R.E. Kinnunen, editor. Environmental Strategies for Aquaculture Symposium Proceedings. NCRAC CD Series #101, North Central Regional Aquaculture Center Publications Office, Iowa State University, Ames.

Gunderson, J.L., and R. Kinnunen. 2001. ANS-HACCP: aquatic nuisance species—hazard analysis and critical control point training curriculum. Minnesota Sea Grant Publication No. MN SG-F11. 74 pp.

VITA

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EDUCATION

B.S. University of Wisconsin-Stevens Point, 1976
M.S. University of Wisconsin-Madison, 1980
Ph.D. University of Wisconsin-
Madison, 1985

POSITIONS

Director (1995-present), Assistant Director (1990-1995), and Associate Researcher (1987-1990), University of Wisconsin Aquaculture Program, University of Wisconsin-Madison

SCIENTIFIC AND PROFESSIONAL ORGANIZATIONS

American Fisheries Society
World Aquaculture Society
Wisconsin Aquaculture Industry Advisory Council
Wisconsin Aquaculture Association

SELECTED PUBLICATIONS

Lima, L.C., L.P. Ribeiro, J.A. Malison, T.P. Barry, and J.A. Held. 2006. Effects of temperature on performance parameters and the cortisol stress response of Surubim *Pseudoplatystoma* sp. Journal of the World Aquaculture Society 37(1):89-95.

Jentoft, S., N. Topp, M. Seeliger, J.A. Malison, T.P. Barry, J.A. Held, S. Roberts and F. Goetz. In press. Lack of growth enhancement by exogenous growth hormone treatment in yellow perch (*Perca flavescens*) in four separate experiments. Aquaculture.

D'Souza N., D.I Skonberg, M.E. Camire, K.E. Guthrie, J.A. Malison, and L. Lima. 2005. Influence of dietary genistein levels on tissue genistein deposition and on the physical, chemical and sensory quality of rainbow trout, *Oncorhynchus mykiss*. Journal of Agricultural and Food Chemistry 53: 3631-3636.

Malison, J.A., J.A. Held, and T.P. Barry. 2004. Onset of sex-related dimorphic growth in juvenile hybrid walleye (*Sander vitreus* female ×*S. canadensis* male). Pages 41-42 *in* Barry, T.P., and J.A. Malison, editors. Proceedings of Percis III: The Third International Percid Fish Symposium. University of Wisconsin Sea Grant Institute, Madison.

Held, J.A., J.A. Malison, and T.P. Barry. 2004. Production characteristics of hybrid walleye (*Sander vitreus* female × *S. canadensis* male) reared to food size in ponds. Pages 33-34 *in* Barry, T.P., and J.A. Malison, editors. Proceedings of Percis III: The Third International Percid Fish Symposium. University of Wisconsin Sea Grant Institute, Madison.

Malison, J.A., J.A. Held, and T.P. Barry. 2004. Growth and reproductive development of triploid and shocked and unshocked diploid yellow perch (*Perca flavescens*). Pages 43-44 *in* Barry, T.P., and J.A. Malison, editors. Proceedings of Percis III: The Third International Percid Fish Symposium. University of Wisconsin Sea Grant Institute, Madison.

VITA

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EDUCATION

B.S. Iowa State University, 1979, Fisheries and Wildlife Biology
M.S. Texas A&M University, 1982, Wildlife and Fisheries Sciences
Ph.D. Mississippi State University, 1988, Fisheries and Wildlife

POSITIONS

Fisheries and Aquaculture Specialist/Associate Professor (1995-present), Specialist/Assistant Professor (1988-present), Department of Natural Resource Ecology and Management, Iowa State University and Associate Director (1990-present), North Central Regional Aquaculture Center
Graduate Research Assistant (1986-1988), Mississippi State University
Aquaculture Manager (1982-1986), Stiles Farm Foundation
Graduate Research Assistant (1981-1982), and Research Technician I (1980-1981), Texas A&M University
Fisheries Biologist Aide (1979), Indiana Department of Natural Resources

SCIENTIFIC AND PROFESSIONAL ORGANIZATIONS

American Fisheries Society: Iowa Chapter; Education, Fish Culture, Early Life History, and Fish Management Sections
Iowa Aquaculture Association
World Aquaculture Society
Phi Kappa Phi
Sigma Xi

SELECTED PUBLICATIONS

Rogge, M.L., A.A. Moore, and J.E. Morris. 2003. Organic and mixed organic–inorganic fertilization of plastic-lined ponds for fingerling walleye culture. North American Journal of Aquaculture 65(3):179-190.

Boylan, J.D., and J.E. Morris. 2003. Limited effects of barley straw on algae and zooplankton in a midwestern pond. Lake and Reservoir Management 19(3):265-271.

Lane, R.L., and J.E. Morris. 2002. Comparison of prepared feed versus natural food ingestion between pond-cultured bluegill and hybrid sunfish. Journal of the World Aquaculture Society 33:517-519.

Lane, R.L., and J.E. Morris. 2000. Biology, prevention, and effects if common grubs (Digenetic trematodes) in freshwater fish. NCRAC Technical Bulletin Series #115, NCRAC Publications Office, Iowa State University, Ames.

Morris, J.E., and C.C. Mischke. 1999. Plankton management for fish culture ponds. NCRAC Technical Bulletin Series, #114, NCRAC Publications Office, Iowa State University, Ames.

Mischke, C.C., and J.E. Morris. 1997. Out-of-season spawning of sunfish (*Lepomis* spp.) in the laboratory. Progressive Fish-Culturist 59:297-302.