FEED TRAINING CARNIVOROUS FISH

Chairperson:	Anita M. Kelly, Southern Illinois University-Carbondale
Industry Advisory Council Liaison:	William W. West, Black Creek, Wisconsin
Extension Liaison:	Joseph Morris, Iowa State University
Funding Request:	$300,000
Duration:	2 Years (September 1, 2006 - August 31, 2008)

Objectives:

1. Evaluate strategies including harvest, transport, environmental, and husbandry, to increase survival, growth, to maximize the percent of advanced yellow perch fingerlings trained to accept formulated feeds

2. Evaluate strategies including harvest, transport, environmental, and husbandry, to increase survival, growth, to maximize the percent of advanced yellow perch fingerlings and largemouth bass fingerlings retained on formulated feeds after restocking into commercial-scale culture systems.

Proposed Budgets:

Institution	Principal Investigator(s)	Objective(s)	Year 1	Year 2	Total
University of Wisconsin-Milwaukee	Fred P. Binkowski	1 & 2	$41,916	$21,044	$62,960
University of Wisconsin-Madison	Jeffrey A. Malison	1 & 2	$49,950	$49,950	$99,900
University of Missouri-Columbia	Robert S. Hayward	2	$52,080	$43,560	$95,640
Southern Illinois University-Carbondale	Anita M. Kelly	2	$21,500	$20,000	$41,500
		Totals	**$165,446**	**$134,554**	**$300,000**

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BUDGETS

JUSTIFICATION

Many of the factors that have spurred the development and growth of the aquaculture industry during the last decade will remain potent forces behind its growth in the years to come. As the human population continues to expand, bringing with it increasing demands on worldwide food production and distribution, suppliers must come up with more seafood each year. Adding to this growing demand for seafood products are higher disposable incomes in many countries and gradually changing dietary patterns with an increase in the variety of food and the amount of food prepared outside the home. While numerous efforts are underway to preserve wild fisheries, there still appears to be strong pressures on a wide number of stocks. Therefore, most increases in seafood supply will have to come from higher aquacultural production.

In the North Central Region (NCR) of the United States, aquaculture production is increasing. Consumption of seafood by the populace is about 453,592,370 kg/yr but aquaculture production is less than 2% of this amount. The estimated annual farm gate value of products from the NCR is $70 million. In a survey conducted by the University of Wisconsin Great Lakes Water Institute and presented at the North Central Regional Aquaculture Center planning meeting in 2005, yellow perch (*Perca flavenscens*) and largemouth bass (*Micropterus salmoides*) were the top species of interest for culture in the NCR.

The culture of yellow perch for food is a result of the declining returns of the commercial fisheries in the Great Lakes region; yellow perch is one of the most highly valued Great Lakes food fish. The current market for yellow perch in the Great Lakes region alone has been estimated at over 22.7 million kg (50.0 million lb) annually (Malison 2003). For many years, commercial harvests of yellow perch from the Great Lakes and Canada failed to keep pace with market demands. The total Great Lakes catch of yellow perch has dropped from peak harvests of greater than 13.6 million kg/yr (30.0 million lb/yr) in the 1960s to less than 4.54 million kg (10 million lb) annually since the mid-1970s. Because of changes in the ecology and management of the Great Lakes, most fisheries biologists predict that the peak wild harvests of the 1950s and 1960s will never return.

This imbalance between supply and demand for yellow perch has resulted in prices that have remained high for over 20 years. For example, in 1990-91 fresh yellow perch fillets retailed for $17–25/kg ($8–11/lb) in most markets, and subsequently rose to $22–32/kg ($10–15/lb) from 1998-2002 (Malison 2003). The reduction of domestic supplies of yellow perch, together with concerns over microcontaminant levels in Great Lakes fish, has created tremendous interest in yellow perch aquaculture.

Traditionally, largemouth bass have been produced by state and federal fish hatcheries for stocking into waters throughout the United States, as the largemouth bass is the top freshwater sportfish (Heidinger 2000). In recent years, interest in the culture of largemouth bass to sizes larger than those normally produced for sportfish stocking has increased (Brandt et al. 1987). Demand for large (>100 g; 3.53 oz) largemouth bass has grown dramatically in the past few years and now far exceeds availability (JSA 1983). This demand is based largely on increasing utilization in fee-fishing (JSA 1983), managed trophy fisheries (Dupree and Huner 1984), and as live food products in ethnic markets. In the United States, the Joint Subcommittee on Aquaculture listed determination of efficient grow out procedures, evaluation of effects of water quality (metabolic wastes) under intensive culture conditions, and development of species-specific, cost-efficient, diets utilizing practical feed ingredients as research priorities for largemouth bass aquaculture (JSA 1983). If this information can be generated, there appears to be a favorable financial potential for commercial production of this species (JSA 1983).

Not only is there a high demand for largemouth bass, they also command a relatively high market price. The demand for largemouth bass weighing 450 g (0.99 lb) or more has been estimated to exceed 310,000 kg/yr (683,432 lb/yr) with a value of over $6.61/kg ($3.00/lb) live weight. A producer purchasing feed-trained fingerlings for $0.50 each, with an average yield of 4,764 kg/ha (4,250 lb/acre), and a selling price of $6.61/kg ($3.00/lb; live sales), could generate approximately $31,481/ha ($12,750/acre) gross revenues, which allows a return of $16,353/ha ($6,623/acre) above variable costs and $14,691/ha ($5,950/acre) after operator labor, based on cost estimates in numbers generated for a catfish production system comprised of four, 2-ha (5-acre) ponds under Kentucky conditions (Tidwell et al. 2000). A break-even estimate under these assumptions would be $3.50/kg ($1.59/lb). Direct sales of live largemouth bass can exceed $13.00/kg ($5.91/lb) in the Asian market, largely centered in Chicago, New York, San

Francisco and Toronto (Heidinger 2000). The higher price is also received for >450 g (>0.99 lb) largemouth bass sold to pay fisheries (Heidinger 2000). The 1998 Census of Aquaculture reports that the NCR has 44 largemouth bass farms that produced over 2.5 million kg (5.5 million lb).

Largemouth bass and yellow perch have many biological characteristics that make them viable candidates for commercial culture (Heidinger 2000; Manci 2000, 2001). These include their high tolerance of crowding, handling, and marginal water quality (Heidinger and Kayes 1986; Heidinger 2000). Research over the past decade has laid important groundwork and established key production parameters for the commercial culture of these species. For example, methods have been developed for controlling reproduction and inducing synchronous spawning in yellow perch (Malison and Garcia-Abiado 1996; Cierszko et al. 1997) and largemouth bass (Mayes et al. 1993; Isaac et al. 1998), as well as feeding and nutritional requirements for yellow perch (e.g., Brown et al. 1996; Brown and Twibell 1997) and largemouth bass (Portz and Cyrino 2004). In addition to all of the positive attributes that yellow perch and largemouth bass have as aquaculture species, they also have one common drawback. Yellow perch and largemouth bass are carnivores, and consequently do not readily accept commercial diets, although they can be trained to do so. As a result of the necessity to feed train yellow perch fingerlings prior to their being sold to grow-out producers, they are relatively expensive compared to other species. Therefore, the most critical factor that currently constrains the expansion of the yellow perch aquaculture industry (regardless of grow-out method) is the high price of fingerlings (Kelly 2000; Kelly and Kohler 2001). Because yellow perch are marketed at a small size compared to most other cultured fishes (6–9 fish/kg or 3–4 fish/lb), fingerling costs represent an extremely high percentage of total production costs. Whereas a catfish, trout, or striped bass farmer requires one fingerling or less to produce a pound of fish, a yellow perch farmer requires 4–5 fingerlings to produce a pound of fish. Riepe (1997) and Hoven (1998) have estimated that fingerling costs constituted approximately 35 and 50% of the total operating costs of raising yellow perch in ponds and recirculation systems, respectively, compared to 10–25% for other aquaculture species. Clearly, improved processes are needed to enhance the production efficiency of fingerling producers and thereby reduce high fingerling costs.

Yellow perch and largemouth bass production of fry and subsequent feed-training techniques are similar. Once fish have absorbed their yolk sacs they are stocked into predator free nursery ponds that have been fertilized with organic and inorganic fertilizers approximately 2 weeks prior to stocking. This fertilization scheme allows the production of sufficient zooplankton on which the small fish feed. Once the fish reach a certain size (2.54–5.08 cm; 1.5–2.0 in for largemouth bass and 2.54 cm; 1.0 in for yellow perch) fish are harvested from the pond, graded to equivalent sizes, and placed into raceways or tanks. During this tank phase of production, different producers use different types of feeds and feeding strategies to train the fish to accept formulated foods. For yellow perch, survival during this phase is highly variable. Fish are kept in the training facility for 10–14 days before they are again graded and stocked into ponds. It is during this restocking phase that a bottleneck occurs in both yellow perch and largemouth bass production. Once largemouth bass are stocked into the grow-out ponds, only 40–50% of the fingerlings will normally continue to feed on the prepared diet unless they are confined to one area of the pond for several weeks. In an effort to keep a higher percentage of fish on feed, some producers will stock fingerlings at high densities into 0.2-ha (0.5-acre) ponds (Heidinger 2000). The percentage of yellow perch that remain on feed is currently unknown, but estimated to be similar to largemouth bass.

The varying levels of success that commercial producers of yellow perch and largemouth bass experience with post-stocking feed acceptance in commercial systems may reflect qualities related to the attractiveness of available commercial diets. Diets currently produced by feed manufacturers for carnivorous species are essentially extensions of their standard salmonid diets. The non-availability of diets specifically designed to be acceptable to yellow perch and largemouth bass may be a major constraint on food training and acceptance. Extracts of natural foods like squid and krill are being used to enhance feeding of carnivorous fish (Atlantic salmon, striped bass, sea bream turbot, plaice, and other species). From such extracts some of the generally effective chemicals involved in stimulating fish feeding response have been identified, such as betaine, amino acids, nucleic acids, etc. However, the response to various mixtures of these substances can elicit various degrees of effectiveness with different species. There is a need to investigate whether natural food extracts and attractants can be specifically tailored to be more effective with yellow perch and largemouth bass.

Post-stocking feed acceptance may also be enhanced through a strategy of using sound to control fish behavior. Sound plays an important role in relation to the attraction, avoidance, and communication of fishes. Simpson et al. (2005) recently demonstrated that sounds associated with marine reefs strongly influence the orientation of marine larvae toward and settlement on natal reefs. The concept of utilizing sound to control fish behavior has advantages (Popper and Carlson 1998) over other potential stimuli because sound is rapidly transmitted over long distances and is unaffected by water turbidity or time of day. In a practical application of this strategy, Abbott (1972) successfully broadcast pure 150 Hz and 300 Hz tone sounds and used them to successfully aggregate rainbow trout around a feeder in a large pond.

Studies that have examined the success of poststocking feed acceptance have generally examined survival as the final quantitative value. Survival of fish in commercial aquaculture ponds can be dramatically impacted by stress from husbandry practices, such as handling and hauling, and environmental factors, i.e. water quality and predation, including bird depredation. To date, other than the catfish industry, little documented evidence on the extent of bird-caused losses in aquaculture ponds. It is estimated that catfish farmers loose $3.3 million worth of catfish to bird depredation annually (Stickley and Andrews 1989; Stickley et al. 1992). In tropical fish ponds, losses of $1,350/pond occurred as a result of wading bird depredation (Avery et al. 1999). Because poststocking of largemouth bass and yellow perch can involve the use of mechanical feeders for a period of time, bird depredation is highly possible. A southern Illinois fish producer has noted that the birds actually stand on the feeders, which float in the ponds, and wait for the fish to come and feed. More information is needed on the effects of bird depredation on largemouth bass and yellow perch production ponds.

Similar fingerling production methods are used for other carnivorous fish species including walleye, hybrid striped bass, Eurasian perch, and pike-perch. In these species, intensive rearing strategies have been studied in much greater detail than in yellow perch and largemouth bass. In a number of studies, seemingly minor differences in husbandry procedures have been shown to improve feed training and fingerling survival by 100–200% or more. Some of the most important variables that affect fingerling feed training and survival are (1) stress during pond harvest, transportation, and handling, (2) environmental conditions including fish density, water temperature, and lighting, and (3) feeds and feeding.

All species of fish respond similarly to some husbandry practices. For example, it is widely understood that avoiding poor water quality (e.g., high temperature, low dissolved oxygen [DO]) is critical during pond harvest and transport (Hodson 1995; Summerfelt 1996). The use of proper (species specific) water temperatures and best available diets optimize fingerling survival and growth.

For other husbandry practices, however, there are huge differences among species. For example, walleye become very agitated and excitable when exposed to normal indoor light levels. Consequently, it was shown that dim lighting, internal tank lighting, and high levels of water turbidity greatly improve survival during the feed-training process in this species (Nagel 1996; Rieger and Summerfelt 1997). Also in walleye, successful feed training is closely linked to fish size and condition at the time of pond harvest (Summerfelt 2000). Both walleye and pike-perch fingerlings show much higher survival when tank stocking densities are kept considerably lower than normally used for other fish species (Summerfelt 2000; Molnar et al. 2004). Hybrid striped bass are quite cannibalistic, and regular size-grading greatly reduces losses due to cannibalism (Kohler 2000). Many fish species, however, are very sensitive to handling stressors, and frequent or improper handling procedures can result in disease outbreaks and high levels of mortality (Stickney 2000). A better understanding of the environmental and husbandry conditions that contribute to successful feed training and poststocking feed acceptance is necessary in order to increase production and decrease fingerling cost in yellow perch and largemouth bass.

The overall goal of this proposal is to evaluate strategies including harvest, transport, environment, and husbandry, to increase survival, growth, and percent of yellow perch fingerlings trained to accept formulated feeds and to maximize the percent of advanced yellow perch and largemouth bass fingerlings retained on formulated feeds after restocking into commercial-scale systems.

RELATED CURRENT AND PREVIOUS WORK

Feed Training Yellow Perch (Objective 1)

Virtually all yellow perch fingerlings are commercially produced using the tandem pond-tank production method. The first pond phase of this method involves stocking larval yellow perch into fertilized production ponds in the spring, where they feed on natural food. Once the fish reach approximately 35–50 mm (1.4–2.0 in) total length, a size reached in 6–10 weeks, they are harvested and stocked into tanks where they are feed trained onto conventional starter diets.

Almost no studies comparing different strategies for feed training pond-reared yellow perch fingerlings have been reported. To date, most commercial fingerling producers and researchers have obtained highly variable survival and growth of yellow perch fingerlings during this feed-training process.

The most important variables that affect fingerling feed training, and survival are (1) fish size and condition at harvest, (2) environmental conditions during feed training, including fish density, water temperature, and lighting, (3) feeds and feeding, (4) stress during pond harvest, transportation, and handling, and (5) handling and subsequent culture of feed-trained yellow perch upon receipt for grow out. As part of an upcoming project funded by the University of Wisconsin Sea Grant Program, University of Wisconsin-Madison (UW-Madison) scientists are planning to evaluate the key environmental conditions listed under #2 above. This proposal does not propose duplication of those studies. Rather, for this project work group participants propose to compare fish size at harvest in conjunction with different feeds and feeding strategies (# 1 and 3, as listed above). Together, these projects will provide useful information on the most important parameters affecting success at feed training yellow perch.

In one of the few published studies on feed training yellow perch, Malison and Held (1992) compared feed training success of yellow perch harvested from ponds at mean sizes of approximately 17, 32, and 42 mm (0.67, 1.26, and 1.65 in) total length. This 1992 study demonstrated that yellow perch could be successfully feed trained when harvested as small as 17 mm (0.67 in) total length. For several reasons, however, many of the results of the 1992 study are not directly applicable to commercial fingerling production at the present time. First, the 1992 studies were not done on a commercial scale. Second, on a commercial scale the pond harvest of yellow perch fingerlings as small as 17 mm (0.67 in) total length would be difficult or impossible due to the high potential for physically damaging and otherwise stressing such small fingerlings. Third, and perhaps most importantly, the 1992 study attempted to feed train yellow perch using only conventional, dry salmonid diets. Many yellow perch fingerling producers and researchers now believe that feed-training success can be increased by using krill and/or semi-moist feeds as transitional diets. Krill and semi-moist diets have gustatory properties that make them readily accepted by many species of fingerling fish. They are both expensive, however, and require refrigerated or frozen storage. The effectiveness and cost of using these transitional diets in feed training yellow perch fingerlings has not yet been quantified. The hypothesis of this proposal is that fingerling yellow perch harvested at smaller sizes will show a proportionately greater positive feed-training response to krill and/or semi-moist diets used as transitional feeds.

Although there has been previous work done on food attractants, there has been little effort at screening specific mixtures that are effective specifically on perch and bass fingerlings. Feeding attractants and extracts of natural foods like squid and krill are being used to enhance feeding of carnivorous fish, including Atlantic salmon (Toften and Jobling 2003), striped bass (Papatryphon and Soares 2000), sea bream (Shimizu et al. 1990), turbot (Mackie and Adron 1978), plaice (Reig et al. 2003), and other species. Feeding attractants and stimulants have been used to promote food consumption and overcome the effect of plant substitutes for fish meal and distasteful feed additives such as antibiotics (Toften and Jobling 1997). These substances also have importance and applications in the development of larval diets.

Behavioral tests have been used to identify the attractant and feeding stimulant qualities of prey extracts. Some investigators have introduced these extracts in liquid form and measured changes in strikes on a rubber bulb (Carr 1982) or fish swimming patterns (Pawson 1977; Holland 1978; Atema et al. 1980; Binkowski and Meyers 1983). In relation to the point of introduction, other trials have involved incorporating the extract into a base diet (Oikawa and March 1997) or a solid agar matrix (Adams and

Johnsen 1986b) and comparing food consumption response to the presence of the prey extract as compared to the absence of the prey extract. These approaches have their limitations and advantages, depending on the feeding behavior of the various species and what type of sensory factors are being investigated.

Observation of orientation to liquid extracts may demonstrate “attractant” properties of the compounds, but measures of food consumption can better address the “incitant” and feeding “stimulant” properties of the extracts. From initial extracts of marine squid and krill trials, some of the generally effective component chemicals involved in stimulating fish feeding response have been isolated and identified, such as betaine, amino acids, nucleic acids, etc. The effect of various mixtures of these substances varies with the species involved. Certain mixtures of these isolated compounds have been found to be more effective than the isolated chemicals individually, while in other combinations they can act as effective feeding deterrents (Adron and Mackie 1978; Mackie and Adron 1978; Mackie 1982).

Herbivorous and carnivorous fishes have been found to have preferences for different classes of stimulant chemicals. Carr (1982) identified four major characteristics of feeding stimulants derived from animal tissue: they have low molecular weight (<1000), they contain nitrogen, they are non-volatile and water soluble, and they have both acid and base properties simultaneously. A pattern seems to emerge (NAS 1993) relating to a species’ feeding behavior and the type of chemical compounds that act as feeding stimulants: carnivores show the greatest positive response to alkaline and neutral substances like glycine, proline, taurine, valine, and betaine, while herbivores respond more to acidic substances like aspartic acid and glutamic acid. This relates to the characteristics of the food items that fish encounter in their natural environment (Mackie 1982; Adams and Johnsen 1986a). Currently, marine-derived krill is used as an additive to freshwater carnivorous fish diets including largemouth bass (Kubitza and Lovshin 1997; Tidwell et al. 2000) in part based on its commercial availability. Might other freshwater prey that freshwater fish naturally encounter have gustatory properties that are more effective than marine squid or krill? There is a need to investigate whether natural food extracts and attractants can be specifically tailored to be more effective with yellow perch and largemouth bass. Screening natural prey extracts would seem to be a good approach to possibly identify and tailor a specific mixture for a particular species.

Post-stocking feeding behavior may also be enhanced through a strategy of using sound to control fish behavior. Sound plays an important role in relation to the attraction, avoidance, and communication of fishes. Simpson et al. (2005) recently demonstrated that sounds associated with marine reefs strongly influence the orientation of marine larvae toward and settlement on natal reefs. The concept of utilizing sound to control fish behavior has advantages (Popper and Carlson 1998) over other potential stimuli because sound is rapidly transmitted over long distances and is unaffected by water turbidity or time of day. Establishing this type of conditioned feeding response may enable the producer to train fish to swim to a specific area, aid in developing an aggressive feeding response, and reduce the need for the fish to search for food throughout the pond. It also could be used to aggregate fish for sampling, handling, or harvest. In a practical application of this strategy, Abbott (1972) broadcast pure 150 Hz and 300 Hz tone sounds and used them to successfully aggregate rainbow trout around a feeder in a large pond. Other sounds might be more effective in stimulating feeding by carnivorous fishes. Different species may respond differently, and different levels or frequency of the sound may elicit varying responses, although for rainbow trout Abbott was able to use either 150 or 300 Hz with positive results. Recently underwater acoustic systems that replicate sounds of injured forage fish have been marketed to anglers to attract and elicit feeding by game fish. To our knowledge, such systems have not been applied in commercial aquaculture rearing systems or evaluated fully (in some cases due to proprietary considerations). It may be that for fingerlings, as opposed to larger more experienced fish, such sounds would be no more effective than conditioning to a simple audible sound during pellet feeding, as shown by Abbott (1972).

Retention of Feed-trained Yellow Perch and Largemouth Bass on Commercial Feeds (Objective 2)

Feed training of carnivorous fish was recorded in the early 1900s (Hayford 1927, 1933). However, strides towards current methodologies were not made until the early 1960s (Snow 1960, 1963, 1968). Initially techniques were developed that enabled fingerlings of 40–60 mm (1.57–2.36 in) to be trained to accept ground fish and moist feeds (Snow 1960, 1963, 1968; Lovshin and Rushing 1989; Williamson and Carmichael 1990). However, the high cost of moist feeds and the required cold storage limited their use to the feed-training period or to small-scale bass production. Consequently, research turned to using dry feeds, which are cheaper and easier to store than moist feeds and more suitable in large-scale operations.

Freeze-dried krill (FDK) was found to be an attractive starter diet to feed train 40–60-mm (1.57–2.36-in) largemouth bass fingerlings, but bass trained on FDK did not easily switch to a commercial dry pellet (Sloane 1993). Differences in flavor and texture among FDK and commercial dry pellets seemed to be the major limiting factors during feed training of largemouth bass.

FDK and krill meal are suitable components in diets to wean 1 g (0.03 oz) largemouth bass from natural food to dry pellets; 79–95% of bass fed FDK accepted it. However, only 50–65% of largemouth bass started on FDK accepted dry pellets after a gradual feed ingredient transition (Kubitza 1995). Differences in texture between FDK and dry pellets and an apparent genetic influence on the ability to feed on dry pellets may partially explain the 30–45% difference between percent fish feeding on FDK and on a final dry pellet (Kubitza 1995).

Genetic factors seem involved with the ability of largemouth bass to accept formulated feeds. Northern largemouth bass were easier to train on moist pellets than Florida largemouth bass (Williamson 1983; Williamson and Carmichael 1990). Kubitza (1995) observed that 40% of largemouth bass trained on FDK but unable to learn to feed on a dry pellet could be retrained on FDK and weaned from FDK to the same dry pellet in a second opportunity. However, bass retrained on FDK had a poorer weaning from FDK to dry pellets compared to bass trained on FDK once, suggesting the existence of a genetic component controlling the ability of largemouth bass to feed on pellets. Identification of strains that readily accept formulated feeds would improve the intensive culture of largemouth bass. Identification of alternative starter diets and improvements in feed formulation and processing are still required and may improve feed training of largemouth bass. Ground fish flesh has been widely used to feed train largemouth bass because of its availability and low cost. The use of ground fish as starter diet for largemouth bass has been investigated (Snow 1960, 1963; Lovshin and Rushing 1989; Sloane 1993). Vitamin deficiency, risk of introducing diseases, and variable weaning success to dry pellets are potential limiting factors in feeding ground fish to largemouth bass.

Largemouth bass fed actively on ground fish, but few fish weaned from ground fish to dry pellets using gradual feed transition (Sloane 1993). Gradual feed transition (GFT) is the progressive replacement of the starter diet with the final diet. Kubitza (1995) observed that gradual feed ingredient transition using diets with krill meal was more effective than GFT during weaning of largemouth bass from FDK to dry pellets. Gradual feed ingredient transition replaces a particular starter diet by a sequence of feeds containing decreasing amounts of the main component of the starter diet. Gradual feed ingredient transition using diets with ground fish improved the weaning of fish trained on ground fish to dry pellets.

At the present time, pond culture is the most common method used for yellow perch grow out, and data presented at the 2005 North Central Regional Aquaculture Center (NCRAC) annual meeting strongly suggests that pond culture systems are the most efficient and economical method for yellow perch grow out. Pond culture of yellow perch is currently one of the more rapidly growing segments of aquaculture in the NCR (Laura Tiu, Ohio State University extension, personal communication).

Subsequent to feed training, advanced yellow perch fingerlings are stocked back into ponds and fed formulated food for continued Year 1 grow out. At the present time, yellow perch fingerling producers use various means to determine when a group or tanks of fingerlings are considered feed trained. Some producers simply watch for an aggressive feeding response within a tank, which normally occurs within 7–14 days. This method does not insure that 100% of the fish in a tank are feed trained. Another approach is to keep fingerlings in tanks until the non-eating fish starve. The drawback to this approach is that starvation may not occur for 4 weeks or longer (Malison and Held 1992), and many producers either lack the facilities or are otherwise unwilling to keep fingerlings in tanks for such an extended period.

A third approach is to use repetitive size-grading to separate eating fish from non-eating fish. Within any tank of fingerlings, some fish begin actively eating sooner than others. Fish that begin eating will show a rapid increase in condition factor (“plumpness”), and can be separated from non-eating fish with conventional bar size-graders. In theory, fish that are removed from feed-training tanks using the size-grading method should show improved survival and growth when restocked into grow-out ponds. Other potential benefits to this size-grading method are that it can reduce problems of cannibalism, and the removal of large fish may stimulate the feeding behavior and growth of small fish.

The potential drawbacks to size-grading are recognized—that it is labor intensive and stressful on the fish, and may result in problems leading to disease and mortality. Wallat et al. (2005), however, recently reported that size grading yellow perch prior to stocking into ponds for Year 2 grow out "should be advantageous to those wishing to culture yellow perch to food size."

In the opinion of many yellow perch fingerling producers, the most important environmental variable affecting the survival and growth of age-0 yellow perch fingerlings restocked into ponds is stocking density. Some producers (e.g., David Northey, Coolwater Farms, LLC, Deerfield, Wisconsin; Randy Van Haren, Willow Creek Aquaculture, LLC, Berlin, Wisconsin, personal communications) have reported excellent survival and growth when age-0, feed-trained yellow perch were stocked into ponds at relatively low densities (30,000–60,000 fish/ha; 12,146–24,291 fish/acre) in mid-summer, fed twice daily, and harvested at the end of the growing season. Other producers (Marty Domer, Domer's Fish Hatchery, New Philadelphia, Ohio), however, have indicated that many fingerlings will go off feed and stop growing when stocked at these low densities.

Little or no information is currently available on production parameters when age-0, feed-trained yellow perch are stocked into ponds at higher densities. Clearly, higher stocking densities have the potential to increase production efficiency, but only if survival and growth rates are not compromised. At the most recent annual NCRAC conference, Malison (2005) reported that a reasonable and attainable production rate for yellow perch in grow-out ponds is 4,000 kg of weight gain/ha/season. Malison's 2005 report did not include information on age-0 feed-trained yellow perch fingerlings. If one extrapolates his production information, however, it seems reasonable that fingerling stocking rates as high as 190,000 fish/ha (76,923 fish/acre) might be possible (using the following assumptions: the growing season after fingerling stocking = 0.67 of an entire growing season, fingerling survival = 90%, and the mean gain per fingerling = 15 g; 0.53 oz).

ANTICIPATED BENEFITS

The proposed studies on Objective 1 will document the relative success that can be expected at feed training pond-reared yellow perch fingerlings harvested at different sizes, and using different dietary regimes. These studies will provide valuable information to yellow perch producers for maximizing the productivity and efficiency of their operations. The studies will also provide valuable cost/benefit information on the use of krill and semi-moist feeds as transitional diets. The proposed studies on Objective 2 will document the extent to which repetitive size grading can be used during the feed-training process to improve poststocking survival and growth of age-0 yellow perch and largemouth bass fingerlings. They will also provide key data on the performance of age-0 feed-trained yellow perch and largemouth fingerlings restocked into ponds at different densities. These studies will provide valuable information to producers of these species for maximizing the productivity and efficiency of their operations. The prediction is that this project will elucidate methods for increasing the efficiency of yellow perch fingerling production by 20–40%, and thereby reduce fingerling production costs. This, in turn, will significantly reduce the cost of raising yellow perch to food size, providing a strong stimulus to the growth of this important industry.

Successful poststocking feeding promotes increased growth and survival. Aggregation of fish through attractants and audible signals could potentially enhance feeding, including the delivery of medication, and also aggregation of fish by these means could facilitate handling and harvest in commercial situations. Increased growth and survival from improved feeding and handling translates into increased profit for producers. The strategies used in this study are likely to be easily transferred from yellow perch and largemouth bass to other fish species produced in the NCR. With the success that researchers have had in defining attractants/stimulants and sound cues as they apply to feeding behavior, researchers are confident that the biological and/or physical technology can be developed for yellow perch and largemouth bass. Additionally, this "silver bullet" technology will be farmer-friendly relative to its application and cost-effectiveness.

Understanding the physiological and environmental factors involved in poststocking feed acceptance by yellow perch and largemouth bass fingerlings will aid in the understanding as to whether lack of feed retention is a result of stress, cannibalism, or predation by birds. These areas will further elucidate potential changes in husbandry practices that will improve the number of feed-trained fingerlings that are produced annually.

OBJECTIVES

1. Evaluate strategies including harvest, transport, environmental, and husbandry, to increase survival, growth, and percent of yellow perch fingerlings trained to accept formulated feeds.

2. Evaluate strategies including harvest, transport, environmental, and husbandry, to increase survival, growth, to maximize the percent of advanced yellow perch and largemouth bass fingerlings retained on formulated feeds after restocking into commercial scale systems.

PROCEDURES

Yellow Perch Feed Training (Objective 1)

UW-Madison

General

All studies will be conducted using the ponds, tanks, and fish at the facilities of the UW-Madison Aquaculture Program at the Lake Mills State Fish Hatchery, Lake Mills, Wisconsin. Academic staff of the Aquaculture Program will lead the project, and will be assisted by several students supported from other sources. All of the fingerlings used for the project will initially be raised in ponds at the Lake Mills State Fish Hatchery. In late April ponds will be filled and fertilized using standard procedures. During the first three weeks of May, the ponds will be stocked with newly-hatched larval perch fry at 740,000 fry/ha (300,000 fry/acre). The fish will reach mean average lengths of 25, 35, and 45 mm (0.98, 1.39, and 1.77 in) during mid-June through mid-July.

For this objective researchers are proposing to compare the survival and growth, during the weaning phase, of fingerlings harvested at mean total lengths of 25, 35, and 45 mm (0.98, 1.39, and 1.77 in). Previous studies have shown that yellow perch harvested at these sizes are able to survive the feed-training process. The harvest of fish at these sizes is commercially feasible, as demonstrated by the fact that seines and other harvesting strategies have been used to successfully harvest large numbers of fish as small as 25 mm (0.98 in) total length without causing extensive physical damage or stress to the fish. The rationale for this comparison is that it is implicit that more fingerlings can be produced in ponds if they are harvested at a small size compared to a large size (due to a number of limiting factors including food availability in ponds, see Malison and Held 1992). In some fish species, however (including the closely related walleye, Summerfelt 2000), fingerling survival and growth during the weaning phase have been shown to decline as harvest size decreases.

A comparison of four feeding regimes in the fingerlings harvested at each of the three fish sizes is proposed. The feeding regimes will be (1) conventional dry salmon starter diet, (2) krill plus conventional dry salmon starter diet, (3) semi-moist diet plus conventional salmon starter diet, and (4) krill plus semi-moist diet plus conventional salmon starter diet. To accomplish the objectives, a 3 (harvest size) × 4 (feeding regime) factorial experiment, using a block design, with 12 tanks per block will be conducted. This experiment will be replicated over three blocks (i.e., 36 total tanks), over a 2-year period.

Yellow perch fry will be stocked into production ponds (500,000 fry/ha; 20,243 fry/acre) in late April of each year. Ponds will be regularly fertilized to promote zooplankton and fish growth. Fish growth will be monitored by sampling fish by seining twice per week. Groups of fish will be seined from the ponds when the fish reach the three different targeted sizes, and stocked into 750-L (198-gal) fiberglass tanks at 4,000 fish/tank (5 fish/L; 20 fish/gal). These tank sizes and rearing densities are typical of what are used by commercial yellow perch farmers. Each tank will be provided with aeration, flow through water (20 L/min, 21 ± 1°C; 5.28 gal/min, 69.8 ± 1°F) and dim lighting using a 16-h light/8-h dark photoperiod. The fish will be fed continuously with "lazy susan" automatic feeders, and also fed by hand three times daily. Obvious cannibals will be removed regularly. Silver Cup (Nelson and Sons, Inc., Murray, Utah) conventional salmon starter dry diet, krill "Pacifica" (Argent Chemical Laboratories, Inc., Redmond, Washington), and Silver Cup semi-moist salmon starter will be used.

For feeding regime #2, the first two days the fish will be fed 100% krill. Subsequently, the fish will be fed the conventional dry diet mixed with a declining percentage of krill (from 50% on day 3 down to 0% on day 7). For feeding regime #3, the first seven days the fish will be fed 100% semi-moist diet. Subsequently, the fish will be fed the conventional dry diet mixed with a declining percentage of moist diet (from 80% on day 8 down to 0% on day 12). For feeding regime #4, the first two days the fish will be fed 100% krill. Subsequently, the fish will be fed the semi-moist diet mixed with a declining percentage of krill (from 50% on day 3 down to 0% on day 7). After day 7, the fish will be fed the conventional dry diet mixed with a declining percentage of moist diet (from 80% on day 8 down to 0% on day 12).

The tanks will be cleaned daily and dead fish counted. At the end of four weeks, all fish will either be trained to accept formulated food, or will have starved or been cannibalized. After feed training is completed, the fish in each tank will be counted, and a sub-sample weighed and measured to determine growth. The number of fish that were feed trained, starved, and cannibalized will be quantified. The added expense of using krill and semi-moist diets will be analyzed. All data will be subject to the appropriate statistical analysis.

University of Wisconsin-Milwaukee (UW-Milwaukee)

Food Attractant Trials

In Year 1 of the project, the feeding response of yellow perch and largemouth bass fingerlings to live food extracts will be tested. Although Objective 1 specifies yellow perch fingerlings, adding largemouth bass fingerlings to the food extract and audible stimulus experiments is proposed because these studies will provide a basis for the proposed work for Objective 2.

For the natural food extract trials, methods similar to those previously used by Binkowski and Meyers (1983) to evaluate lake sturgeon response to chemical food attractants in extracts of artemia, white worms, and tubifex worms will be principally used. Considering that perch and bass may differ somewhat from sturgeon in their dependence on olfactory aspects of their feeding behavior, preliminary trials will evaluate approaches that incorporate the extract into a solid agar matrix (Adams and Johnsen 1986) to determine which approach would be more effective for perch and bass. For these trials, extracts of chironomids, zooplankton, red worms, crayfish, minnows, and krill will be prepared by homogenizing them in a blender and filtering to obtain a solid free filtrate. The use of extract from the krill-based feed ingredient currently added to bass starter diet will provide a comparison of the potential effectiveness in relation to the prey extracts being tested. Trials with a glycine mix and ribotide attractants will also be run for comparison to the natural prey extracts.

Experimental stocks approximately 1,500 each of fingerling yellow perch (30–60 mm; 1.18–2.36 in) and largemouth bass (50–75 mm; 1.97–2.95 in) obtained and acclimated to laboratory conditions in flow-through tanks and commercial feed will be used in the study. Temperatures of 20–23°C (68.0–73.4 °F) will be maintained during acclimation and during trials. For the trials, groups of 10 attractant-naive fish will be drawn from these groups and placed in flow-through circular experimental tanks (approximately 150 L; 39.6 gal) 48 h prior to the trail and allowed to adjust to the trial tanks. The fish would not be fed during this 48 h adjustment period. Trial tanks will be marked on the bottom with a 100 mm (3.94 in) circle delineating an "attractant zone" centered at the extract introduction point.

During trials approximately 1 ml of either an extract or an "extract-free" control would be introduced to the center of the tank through a vertical dispensing tube or alternatively in an agar matrix with or without extract. Timing of each 10 min liquid trial begins when the extract reaches the bottom of the vertical dispensing tube, approximately 5 sec after dispensing. The trials will be recorded by video cameras mounted above the tanks. In the case of the agar matrix, the 10 min trial time might need to be extended because a 2-h period was used by Adams and Johnsen (1986). Response of the fish to the extract is determined in terms of the time it takes for five of the fish to enter the feeding zone (delineated by the concentric circles), and the frequency of fish entering and/or exiting and reentering the attractant zone, or in the case of an agar matrix by consumption of the extract containing agar matrix versus the extract-free agar matrix. For each extract tested, ten trials for each species will be conducted and results analyzed using appropriate parametric or nonparametric statistical methods.

The response to the various extracts will be compared to identify prey extracts that show the best positive response for each species. These will be applied to feeds to be tested for attractant effectiveness in commercial scale systems as part of Objective 2, in Year 2 of the project.

Auditory Conditioning Trials

To evaluate the potential of an audible stimulus to enhance feeding, in Year 1 an investigation of behavioral conditioning to an audible signal using feed-trained yellow perch and largemouth bass fingerlings will be conducted. Fingerlings will be acclimated to flow-through circular, commercial-scale tanks, and water temperatures will be a held at a constant 20–22°C (68.0–71.6°F). Groups of 1,000–1,500 feed-trained yellow perch (30–60 mm; 1.18–2.36 in) and largemouth bass (50–75 mm; 1.97–2.95 in) fingerlings will be conditioned to feed along with the audible signal. The audible underwater sound will be emitted each time the automatic feeder is activated. Feeding events will occur at least once per hour from 7:00 AM to 7:00 PM during this conditioning period. Auditory signals of low frequency (35–300 Hz) created by simple devices that could be readily recreated by producers, and that are likely to be audible by most species of hearing generalists, will be tested (Popper and Carlson 1998; A.N. Popper, University of Maryland, personal communication). Initially the signal used for conditioning could be as simple as an underwater clicking sound. Following the conditioning period (one week to a month as necessary to achieve positive conditioning), this signal sound will be emitted 5 sec prior to the feeder being engaged. The fish response will be videotaped to determine whether the fish respond to the audible signal alone. Results will be recorded as an estimation of percent fish that crowd the feeder prior to food being dispensed. Although these results will be estimations, the use of over-tank video will allow for sufficient image analysis. Subsequently, how the strength and character of the audible signal can be modified to enhance this response will be investigated. For example, different volumes and frequencies will be tested to assure that the sound does not cause an unnecessary “startle response.”

Retention of Feed-trained Yellow Perch and Largemouth Bass on Commercial Feeds (Objective 2)

UW-Madison

In Year 1 of this project an experiment will be conducted on size grading (defined here as Objective 2a), and in the second year of the project an experiment will be conducted on stocking density (defined here as Objective 2b). For both studies, the fingerlings used for the project will initially be raised in ponds. In late April ponds will be filled and fertilized using standard procedures. During the first two weeks of May the ponds will be stocked with newly hatched larval perch fry at 500,000 fry/ha (202,429 fry/acre). The fish will reach a mean average length of 35 mm (1.38 in) in late June. At this time, groups of fish will be seined from the ponds and stocked into 750-L (198-gal) fiberglass tanks at 4,000 fish per tank (5 fish/L; 20 fish/gal). These tank sizes and rearing densities are typical of what are used by commercial yellow perch farmers. Each tank will be provided with aeration, flow through water (20 L/min, 21 ± 1°C; 5.28 gal/min, 69.8 ± 1°F) and dim lighting using a 16-h light/8-h dark photoperiod. The fish will be fed continuously with “lazy susan” automatic feeders, and also fed by hand three times daily. For Objective 2a, the effects of repetitive size grading during the feed-training period on the survival and growth of fingerlings during the post-weaning phase will be evaluated. The experiment will have two treatments: size-graded or non-size-graded. Each treatment will begin with four tanks of fingerlings.

For the size-graded treatment, size grading will be done every five days using conventional bar size graders at 1/64th in size intervals. Large fish retained by the size-grader will be assumed to be feed trained, and removed from the small fish. For the non-size-graded treatment, the fish will be feed trained, obvious cannibals will be individually removed, but otherwise the fish will be left undisturbed until a very strong feeding response is repeatedly observed in each tank. Normally, such a strong, apparently uniform response is observed within 10–20 days.

After feed training, the fish from each treatment group will be stocked into separate 0.04-ha (0.1-acre) ponds (three ponds each for size-graded and non-graded) at 60,000 fish/ha (24,291 fish/acre). To the extent possible, fish will be stocked into ponds together with fish of a similar size. All of the fingerlings will then be reared until the end of the growing season in autumn. The ponds will be provided with air-lift pump aeration, and the fish will be fed twice daily by hand, using a commercial floating food so that feeding behavior can be observed. Water temperature and DO will be measured daily in each pond. At the end of the growing season (late October), the ponds will be harvested and the survival and growth of fish in each group will be compared. All data will be subject to the appropriate statistical analysis.

For Objective 2b, post-weaning survival and growth of fingerlings re-stocked into ponds at 60,000 versus 180,000/ha (24,291 versus 72,874/acre) will be compared. A large, uniform group of yellow perch fingerlings will be feed trained as described under Objective 2a. After feed training, fish will be stocked into replicate 0.04-0.2-ha (0.1-0.5-acre) ponds at each of the two densities (three ponds per stocking density). The fish will be reared as described under Objective 2a until the end of the growing season in October. At that time, the ponds will be harvested and the survival and growth of fish in each group will be compared. All data will be subject to the appropriate statistical analysis.

UW-Milwaukee

Commercial-Scale Food Attractant Trial

In Year 2 of the project, commercial-scale diet trials will be conducted using triplicate groups of each species in commercial scale circular flow-through tanks to compare the feeding acceptance and production of advanced fingerling yellow perch and largemouth bass fed a formulated diet with added natural prey derived attractant versus a control diet without the attractant. The mixture of attractant identified in Objective 1 will be surface applied to a commercial diet for the treatment group, and the unaltered diet will be used for the control group. These trials will observe and compare fish behavior during habituation to their assigned feed with underwater video in the proximity of the feeders, and compare growth performance and survival over several months' duration. Video will provide immediate documentation of comparative feeding response, and growth and food conversion will document possible differences in production of fish. The commercial-scale trials will be conducted in triplicate 2 species × 2 diets design and results analyzed using appropriate parametric or nonparametric statistical methods.

Commercial-Scale Auditory Stimulation Trial

In Year 2 of the project, commercial-scale trials will be conducted in ponds, testing the use of behavioral conditioning with an audible signal to enhance the retention of feeding behavior of yellow perch and largemouth bass fingerlings. The most successful sound stimulation techniques identified in the Objective 1/Year 1 trials will be compared to feeding without using audible signals. Young-of-the-year yellow perch and largemouth bass will be feed trained on commercial pellet diets. The feed-trained perch (30–60 mm; 1.18–2.36 in) and bass (50–75 mm; 1.97–2.95 in) will each be divided in half. One-half of the perch and bass will be conditioned to feed during the audible signal using the procedures of Objective 1/Year 1 in the laboratory. The remaining perch and bass will continue to feed on commercial diet in the absence of any external sound in the laboratory. Once the fish are conditioned to feed with the sound stimulus, the four groups of fish will be transported to ponds. The ponds that will be used are approximately 0.08–0.12 ha (0.2–0.3 acre) and located at the Barkhausen Waterfowl Preserve in Brown County, Wisconsin.

One pond will be used with the sound-conditioned perch, and one pond for the sound-conditioned bass. In these treatments, the previously identified sound will be emitted 5–10 sec prior to the automatic feeder dispensing food. The source of the audio stimulus will be located near the automatic feeder. Because it is known that fish can detect sound directionality, having the sound source near the feeder may eliminate the effects of turbidity and light on newly stocked fish's ability to find a feeder/food. The 5–10 sec delay between the sound being emitted and the feeder dispensing food should result in the fish swimming from all areas of the pond toward the feeder in anticipation of being fed. A hydrophone will be used to make sure the sound can be heard in all areas of the ponds. The other two treatment ponds will be the unconditioned perch and bass being fed without the use of sound (control treatments).

All four ponds will be stocked at low density (29,600 fish/ha; 12,500 fish/acre), as evidence suggests that these species have a more difficult time remaining feed trained at low densities. The automatic feeders will be set to feed four times/day (7:00 AM, 11:00 AM, 3:00 PM, and 7:00 PM). Using these commercial-scale systems (ponds ~0.08–.12 ha; 0.2–0.3 acre), poststocking feeding behavior using underwater and overhead video in the proximity of the feeders, as well as personal pond-side observations will be recorded and compared. The sound treatments will be compared to the control treatments for growth performance and survival over several months' duration. Fish will be sampled every 3–4 weeks for growth, and survival will be determined at the termination of the study. The results of these trials will be analyzed using appropriate parametric or nonparametric statistical methods.

Southern Illinois University-Carbondale (SIUC)

This study proposes to examine the environmental and husbandry aspects with regard to increasing production of largemouth bass fingerlings that are feed trained and remain on feed once stocked into commercial ponds. The industry standard is to train largemouth bass fingerlings in tanks by offering food at frequent intervals either by hand feeding or use of automatic feeders. This intensive method is usually conducted for two weeks; after that time fingerlings are stocked into ponds. The number of fish successfully feed trained is not actually known. While it is easy to separate cannibals from fish that are eating prepared diets and fish that are not eating at all, most producers count fish and stock them into ponds rather than grading them to separate feed-trained fish from non-feeding fish using traditional grading methods. In this study three areas that may result in a decrease in the number of largemouth bass fingerlings that remain on feed once stocked into commercial ponds will be examined. Different types of feed training, grading, and different bird deterrent devices will be examined to ascertain whether it is actually that all fish were not successfully trained to consume prepared diets, whether grading fish before stocking impacts the number of largemouth bass that remain on feed, or whether predation by birds significantly decreases the number of fish that remain on feed once stocked into commercial ponds. To examine feed-training methods, fish will be randomly assigned to four treatment groups; hand fed for twp weeks (control), hand fed for three days then switched to automatic feeders, hand fed for seven days then switched to automatic feeders, or fed using automatic feeders only for the two week training period. Fish will be stocked at 5,000 fish/757-L (200-gal) tank. Fish will be weighed prior to stocking into the tanks. At the end of the two week feeding period all fish will be weighed in each tank. A random sample of 100 fish will be weighed, measured, and examined as to whether they are plump or emaciated. Survival, growth, and the number of fish feed trained will be determined.

Once fish are ready to be stocked into ponds, they will be stocked using one of two methods. The first method is the industry standard where fish are weighed, counted, and stocked. This group will be referred to as the standard group. The second group of fish will be graded, weighed, counted, and stocked and will be referred to as the select group. The standard and select groups of fish will be stocked into two 0.8-ha (2-acre) ponds equipped with an automatic feeder to provide feed several times during the day. Each treatment group will be triplicated, hence six 0.8-ha (2-acre) ponds with feeders will be used for this study. The six ponds will be located at Logan Hollow Fish Farm in Gorham, Illinois. Three ponds will each be stocked with 30,000 largemouth bass fingerlings from the standard group fish and three ponds will be stocked at the same density with the select group fish. Fish will be reared in ponds for a minimum of three months, at which time the fish will be harvested and counted to determine survival in all treatments. Additionally, 100 fish from each pond will be randomly selected, weighed, and measured to determine growth and survival.

The loss of fish once stocked into a commercial pond is not necessarily due to the fact that the fish are not continuing to feed on prepared diets. Instead, the use of automated feeders in ponds to continue to keep the fish on a prepared diet creates another problem for the producer. These feeders allow local bird populations a perch on which to sit and literally feast on the fish that are attracted to the feeder. Researchers propose to use two different types of sound devices and one shocking device to deter birds from perching on the automatic feeders. None of the devices proposed for this research have been reported as used in the aquaculture industry. One device, the Scranimal™, used to deter pets from getting onto household furniture, uses heat and motion to detect animals, and then emits high-pitched sounds to repel them away. Scraminal™ automatically resets itself. The range of the Scraminal™ is up to 15 ft. The Scranimal™ is equipped with a 9-volt battery, which eliminates the need for pond-side electricity; an added benefit to fish farmers without electricity at their ponds. The second sound device that will be used is a peregrine falcon call. These calls are utilized at truck stops and prevent birds from perching and nesting around fueling stations. The static electricity pulse device will be the Scat Mat™, which releases a static electricity type pulse when touched. The Scat Mat™ has three static levels to choose from: low, medium, and high. The setting of the device will be determined by starting on the lowest setting and increasing the static levels until birds are repelled. Similar to the Scranimal™, the Scat Mat™ is equipped with a 9-volt battery, again eliminating the need for pond-side electricity.

Twelve 0.8-ha (2-acre) ponds with feeders will be used for a study utilizing all of the devices except the peregrine falcon call. The twelve ponds will be located at Logan Hollow Fish Farm in Gorham, Illinois. Three ponds will have feeders equipped with sound devices, three ponds will have feeders equipped with static electrical devices, three ponds will have sound and electrical devices, and three ponds will have no sound or static electric devices (control). Each pond will be stocked with 15,000 largemouth bass fingerlings. Fish will be reared in ponds for a minimum of three months. At the completion of the study, the fish will be harvested and counted to determine survival in all treatments. Use of the peregrine falcon call will occur during the second year of the study. Using the falcon call and the Scranimal™ at the same time would make it difficult to determine which sound device was a deterrent to birds. The peregrine falcon call will be utilized around three 0.8-ha (2-acre) ponds stock as previously described. Three ponds located away from the call will also be used to compare effectiveness of the falcon call.

During the study, birds will be observed for behavior on the ponds using cameras. Human observation will not be used as the presence of humans around ponds with birds can alter the birds' behavior. Ponds will be observed for the number of birds landing on the feeders, the number of birds scared from the perch by either the sound and/or electrical device, and if active feeding occurs for any of the treatment groups.

Growth, survival, and the number of fish that remain on feed will be analyzed using a one-way ANOVA. If significant differences are observed Tukey's test will be applied to determine where differences exist. Observational data will be analyzed using logistical regression to analyze potential categorical data, as observations will be dichotomous (binary), i.e., either it did or did not scare the bird away. Qualitative data will be analyzed by the Logistic Model (maximum likelihood estimation) using the Statistical Analysis System version 8.1 software (SAS Institute Inc., Cary, North Carolina). All significance will be determined at the $P<0.05$.

University of Missouri-Columbia (UMC)

General Approach

The proposed study will evaluate relative abilities of three treatments, and one combination of treatments, to increase percentages of feed-trained fingerling largemouth bass that remain on prepared feed after being stocked into grow-out ponds and, in turn, show improved survival and growth relative to a control group. (Hereafter, "restocked largemouth bass" refers to feed-trained fingerlings stocked into grow-out ponds). In addition, conditions under which feed-trained fingerling largemouth bass are transported to the grow-out pond facility will be monitored, and associated mortality rates from transport-related stress estimated. If transport mortality is significant (>5%), adjustments in transport conditions will be made in an attempt to reduce this mortality.

Transport Mortality

Fingerling largemouth bass (5.1–7.6 cm [2–3 in], total length) will be purchased from a Missouri producer and transported to the Missouri Department of Conservation's Little Dixie Lake Pond Facility (LDL ponds) near Columbia, Missouri. Pre-transport conditions applied by the producer, including fish thermal experience, feeding regime, fish handling procedures (frequency and type), and any chemical treatments prior to loading for transport will be directly observed by UMC researchers and documented. Initial and final transport water temperatures, (DO), total ammonia nitrogen, nitrite concentrations, water salt concentration, and fish transport density will be determined and recorded. Also recorded will be trip duration, handling procedures during pond stocking, and temperature of pond water at stocking. Three groups of 100 transported fingerling largemouth bass will be randomly selected and immediately stocked into three floating net pens situated in the study ponds upon arrival; net pens will be fully enclosed to preclude outside predation. Fish that are markedly larger or smaller than the average size will be excluded from the net-pen groups to minimize cannibalism. Fish will be monitored closely for three days to estimate transport-related mortality. Feed identical to that previously used by the producer will be provided to these fish. Close monitoring of the net pens and final fish counts will permit assessments of losses from cannibalism. If 3-days poststocking mortality rates exceed 5%, transport conditions will be reviewed and changes made in an attempt to reduce transport mortality of fish in study Year 2. Changes in transport procedures and conditions that lead to significant improvement in 3-day poststocking survival of fingerling largemouth bass will be identified. Mortality rates of transported fish will again be evaluated in Year 2 even if Year 1 mortality rates are $\leq$ 5%.

Feed Retention, Survival, and Growth

The three treatments that will be evaluated against controls for their capacities to increase percentages of restocked largemouth bass that remain on prepared feed and also improve survival and growth are (1) middle grading—removing the upper and lower 20% of fish by size from stocked groups via mechanical grading, (2) crowding of fingerlings in grow-out ponds for the initial 7–14 days after stocking, and (3) adding flavor-enhanced feed to the standard feed throughout the first two weeks poststocking, and then gradually removing this.

All control and treatment groups, except for the middle-grading treatment group, will receive very modest middle-grading, where only very large and very small fish within a group will be visually identified and removed by hand (as would typically be done by a grower). Only the “crowding” treatment group will receive any form of crowding. All groups will receive only the producer’s feed over the first 40 days, except for the flavor-enhanced-feed treatment group. This group will receive a 50/50 mixture of flavor-enhanced pellet feed and the producer’s feed over the initial two weeks after stocking. The flavor-enhanced feed will have shrimp meal incorporated into the producer’s diet (Campbell and Phelps 2002). During the second two-week period, the percentage of shrimp meal in the flavor-enhanced diet will gradually be reduced to zero. Beginning 40-days poststocking, all groups will be transitioned to Aqua-Max Carnivore Grower diet (floating diet; 45% protein) with pellet sizes in accordance with fish sizes (or to a feed selected for use by all participants in this NCRAC objective). During the initial two weeks, all groups will be fed five times daily by hand to apparent satiation; daily feeding will be reduced to three and then to twice daily by 40-days poststocking, and kept at this rate until the studies’ end.

Eight 0.2-ha (0.49-acre) production ponds with water inflow, drainage, and aeration capacity will each be drained and longitudinally subdivided into two sections by PVC-coated wire nets. Net bottoms will be heavily weighted and buried well into pond substrates; in addition, barriers extending 66 cm (2.17 ft) above the net’s floating surfaces will be affixed to preclude fish from jumping into the parallel halves of ponds. These same pond dividers will be used in both study years. Distinct batch marking (fin clip) of fish stocked into one-half of each pond will indicate any individuals that have relocated to the other pond half. Longitudinal pond division will provide a “paired” experimental design where one longitudinal pond half will serve as the control site and the other as a treatment site in each of the eight ponds. This approach will enhance statistical power by controlling for well-known variability that exists across individual experimental ponds.

In Year 1, treatments of (1) middle grading and (2) crowding will be evaluated. The middle grading treatment will be assigned randomly to four of the eight ponds, and the crowding treatment will be assigned to the remaining four ponds. For each pond, the half that will serve as the control side will be randomly assigned; the remaining side will receive the treatment. Stocking density of 2.54–7.62 cm (1–3 in) fingerling largemouth bass will be 37,000 fish/ha (18,500 fish/0.5 ha pond; 9,250 fish/longitudinal pond half). Fish will be stocked in spring when water temperatures reach 21–23.9°C (70–75 °F). Fish in the “middle-grading” treatment group will be graded 1–2 weeks before transport at the producer’s site by UMC personnel; these fish will be transported in separate holding compartments to the experimental pond site. The “crowding” treatment-group fish will be released into blocked ends of the appropriate pond halves so that fish will remain within one-quarter of the total longitudinal length of these pond sections; water quality in these quarter sections will be frequently monitored to ensure that poor conditions do not develop from the high fish densities. After two weeks, blocks will be removed and fish will have access to full section lengths. Should water quality problems develop within the two-week crowding period, remedial options would include shortening the crowding period or increasing the area in which crowded fish are held (by moving the block nets).

A portion (5–10%) of the fingerling largemouth bass stocked into each pond half will receive numbered subcutaneous tags so that accurate assessments of growth (and survival) will be possible. Temperature and DO will be monitored every 2–3 days in ponds. During the initial 40 days after-stocking period (beginning on day 3 poststocking), percentages of fish consuming prepared feed, relative proportions of prepared and natural feed in stomachs, and cannibalism frequency, will be estimated weekly for control and treatment groups in the eight ponds. Thirty fish representing full fish size ranges in each pond section will be collected by seining on each weekly sampling outing (total of five such samplings over the 40-day period). All fish in samples will be measured for live weight and length, humanely euthanatized with Finquel®, and then quick-frozen on dry ice for subsequent analyses. During work-up, all fish in samples will be partially thawed so that stomachs can be removed and contents evaluated with a dissecting microscope; fish will then be refrozen. Total lipid content will then be determined for 15 of the 30 fish on two sampling occasions early in the 40-day period. Stomach content (and lipid) data for weekly samples will be based on fish that are representative of full size ranges present in the pond halves. Together, the stomach content and total lipid data will be used to define percentages and specific size groups of largemouth bass that may be losing condition due to zero or low consumption of prepared feed. Largemouth bass length-structure progression, change in condition (*Wr*) by size group, growth rates (overall, and by size group based on fish bearing individually numbered tags), and size variation development (percent increase in the coefficient of variation) will be estimated for each pond section over the initial 40-day period. Feed amounts provided will be recorded and biomass increase determined for each pond half such that gross feeding efficiency can be calculated. On day 40, population size in each pond section will be estimated via a single census mark-recapture procedure so that survival over this initial period can be determined. Such estimates of day-40 population size will be augmented by separate estimates of survival based on proportions of fish bearing numbered tags on this date relative to the total number initially tagged.

Differences in largemouth bass survival, growth rate, final condition (*Wr*), and feeding efficiency (FE) for each treatment relative to controls will initially be evaluated for each effect (middle grading and crowding) through paired *t*-tests (or non parametric analogs) based on differences between treatment and control responses in each pond. A multivariate evaluation, Hotelling's T^2, will then be applied to simultaneously evaluate differences in magnitude of improvement between the two treatments, considering all four variables (survival, growth, condition, and FE). Differences in feed retention and cannibalism rates between controls and treatments, and between treatment effects alone, over the initial 40 days will be evaluated by X^2 analysis, while differences in size variation development will be evaluated by paired *t*-test. Trends in the individual metrics over the successive weekly sampling period will be portrayed to facilitate understanding of outcomes up to day 40.

Following the initial 40-day period, sampling frequency will shift to monthly. At the ends of months 1, 2, and 3 following the initial 40-day period, percentages of largemouth bass consuming prepared feed, fish condition (*Wr*), growth in weight, growth in length, size variation development, and frequency of cannibalism will be estimated using procedures similar to those described for the first month. During these three months, lipid analyses will not be continued and fish diets will be sampled by nonlethal, gastric lavage with contents being collected on a fine-mesh screen. At the end of the 3rd month after the initial 40 days, ponds will be drained and all fish collected, measured, and weighed. Overall survival, growth rates, final length- and weight-structures, and fish condition (*Wr*) will be determined, as will total production and feeding efficiency. Data analyses will parallel those described for the initial 40-day period.

In Year 2, the same eight ponds, again each subdivided into halves, will be used to evaluate two additional treatments. One treatment will be the flavor-enhanced diet. The second will be a combination of two treatments. If one of the treatments from Year 1 substantially outperforms the other, the better performing Year 1 treatment will be combined with the flavor-enhanced-diet treatment to serve as the second Year 2 treatment. If both treatments from Year 1 perform similarly well, these two will be combined to serve as the second Year 2 treatment. Variables measured and sampling procedures over the initial 40-day period and subsequent 3-month period will be identical to those in Year 1. Data analyses of Year 2 data will likewise parallel those in Year 1. Ultimately, responses of largemouth bass growth, survival, condition, and feeding efficiency associated with each of the four treatment groups will be evaluated through ANOVA procedures (or nonparametric analogs) with blocking done on ponds and years, to assess whether certain treatments produced greater benefit for individual effects. In addition, multivariate ANOVA (MANOVA) will be applied over all four treatments to determine if one treatment yielded the greatest overall benefit with simultaneous consideration of the growth, survival, condition, and feeding efficiency responses. Differential responses in feed retention rate and cannibalism frequency over the four treatments will be evaluated through X^2- related analyses; those for size variation development will be based on ANOVA.

Extension Plan

Outreach will be accomplished in a timely manner and under terms agreeable among research and extension scientists, and involve industry consultation to effectively fulfill the NCRAC program goal. The extension liaison will determine recommended mechanism(s) for information dissemination of research findings and/or outreach activities that facilitate information transfer to producers of yellow perch and largemouth bass. Results of the experiments, where appropriate, will be presented at scientific meetings and extension workshops and may be published in scientific journals, extension bulletins, or NCRAC fact sheets and bulletins. Research results will also be disseminated through the NCRAC Annual Progress Reports. Annual Progress Reports are assembled and edited by the extension liaison with input by the Principal Investigators. These reports are available on the NCRAC Web site (http://www.ncrac.org/Publications/).

FACILITIES

UW-Madison

The UW-Madison Aquaculture Program has its main facility at the Lake Mills State Fish Hatchery. At this facility the program has 12 0.04-ha (0.1-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 are supplied with airlift pumps for water circulation and destratification. The program also has an extensive indoor laboratory at the Lake Mills facility. The laboratory has 32 750-L (198-gal) fiberglass tanks that will be used for this project. Each tank will be equipped with temperature-controlled, flow-through water, aeration, internal tank lighting with photoperiod control, and automatic feeders as needed. The facility has all of the major equipment needed to conduct the proposed studies.

UW-Milwaukee

The University of Wisconsin Great Lakes Water Institute (UWGLWI) 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 3,028 Lpm (800 gpm). Flow-through rearing tanks, including large 2.44 m (8.0 ft) diameter circular, 1.22 m (4.0 ft) diameter circular, banks of smaller rectangular fiberglass, and small glass aquaria are available to support fish culture investigations. Recirculating systems include two 37,854-L (10,000-gal) commercial-scale systems. UWGLWI has analytical laboratories and shop facilities to support a wide variety of aquatic research investigations. The fish culture staff has more than 60 years of experience with rearing more than 40 fresh water species, including yellow perch and largemouth bass. Additionally, state-of-the-art technology and experience for successful feeding investigations and fish behavior studies are available. Other UWGLWI staff members have in-house expertise in fish reproduction, nutritional physiology, fish behavior, and aquaculture engineering to aid these investigations. Outdoor ponds ranging in size from 0.08–0.12 ha (0.2–0.3 acre) at the Barkhausen Waterfowl Preserve, Brown County, Wisconsin are also available.

SIUC

The Fisheries and Illinois Aquaculture Center has over 1,394 m^2 (15,000 ft^2) of floor space in the Life Science II and Life Science III buildings located on the campus of SIUC. The twelve research laboratories house modern instrumentation for research in nutrition, biochemistry, genetics, water quality, physiology, toxicology, etc. The Center is also equipped with extensive computer software and capabilities including SAS®, Ethernet connections, color scanners, laser printers as well as video capture and digital film transfer.

A 6,940 m^2 (8,300 ft^2), temperature-controlled wet laboratory building houses more than thirty 2,000-L (528.3-gal) tanks, fifteen 1,200-L (317-gal) tanks, eighteen 1,200-L (317-gal) raceways as well as approximately 100 flow-through aquaria varying in size. At least 15 recirculating systems are employed allowing for numerous studies to be conducted simultaneously. Four of the aforementioned recirculating systems have been equipped to manipulate temperature and photoperiod from ambient laboratory conditions, allowing conditioning of brood stock for spawning indoors. Another of the aforementioned recirculating systems was designed especially as a hatchery, consisting of over 24 hatching jars, four Heath Tray racks, and 12 350-L (92.5-gal) tanks. In addition, this wet laboratory building houses feed storage and feed manufacturing rooms, a water chemistry laboratory, a large workshop, and a small toxicology laboratory.

The Fisheries and Illinois Aquaculture Center also has a 90-pond research facility located at SIUC. These ponds have a surface area of 0.04–0.05 ha (0.1–0.12 acre) and are equipped with electricity for aeration. A 10.0-ha (24.7-acre) reservoir serves as a water source. A temperature-controlled building is available for feed storage. Tractors, vehicles, and paddlewheels are available. Additionally, there is a full-time pond manager for this facility.

Logan Hollow Fish Farm is comprised of 75 water ha consisting of thirteen 0.2-ha (0.5-acre) ponds, sixteen 0.8-ha (1.98-acre) ponds, four 1.0-ha (2.47-acre) ponds, eight 1.2-ha (2.97-acre) ponds, seven 1.4-ha (3.5-acre) ponds, five 1.8-ha (4.45-acre) ponds, eight 2.0-ha (4.94-acre) ponds, two 2.4-ha (5.93-acre) ponds, and two 2.8-ha (6.92-acre) ponds. The farm also has 26 tanks used for feed training that are divided into two recirculating aquaculture systems. Additionally they have 36 raceways, several automatic feeders, feed trucks, three hauling trucks, tractors, paddlewheels, and one night shift worker to monitor dissolved oxygen in the ponds throughout the evening.

UMC

Use of eight 0.2-ha (0.5-acre) production ponds at the Missouri Department of Conservation's LDL facility **has been guaranteed** for the two-year period to carry out the proposed study. This facility, located within eight miles of Columbia, Missouri, is protected by fencing. An on-site laboratory and storage facility is present for storage of equipment, materials, and feed. Most sample workup will be performed in the dry laboratory in the Anheuser-Busch Natural Resources Building on the UMC campus, to which the PI has full access. Lipid analysis will be conducted at the USGS laboratory in Columbia, Missouri.

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PROJECT LEADERS

State	Name/Institution	Area of Specialization
Illinois	Anita M. Kelly Southern Illinois University-Carbondale	Aquaculture/Physiology
Missouri	Robert S. Hayward University of Missouri-Columbia	Aquaculture
Wisconsin	Fred P. Binkowski University of Wisconsin-Milwaukee	Fisheries Biologist/Aquaculture
Wisconsin	Jeffery A. Malison University of Wisconsin-Madison	Aquaculture/Physiology

PARTICIPATING INSTITUTIONS AND PRINCIPAL INVESTIGATORS

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

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

University of Missouri-Columbia (UMC)
Robert S. Hayward

Southern Illinois University-Carbondale (SIUC)
Anita M. Kelly

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
600 E. Greenfield Ave., Milwaukee, WI 53204

PROJECT DIRECTOR(S)
Fred P. Binkowski

USDA AWARD NO. **Year 1 Objective 1**

	CSREES FUNDED WORK MONTHS			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)
	Calendar	Academic	Summer				
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. 2 Prebaccalaureate Students				$2,000			
f. ___ Secretarial-Clerical							
g. 2 Technical, Shop and Other				$26,400			
Total Salaries and Wages →				$28,400	$0	$0	$0
B. Fringe Benefits (If charged as Direct Costs)				$9,016			
C. Total Salaries, Wages, and Fringe Benefits (A plus B) →				$37,416	0	$0	$0
D. Nonexpendable Equipment (Attach supporting data. List items and dollar amounts for each item.)							
E. Materials and Supplies				$3,000			
F. Travel				$1,500			
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.)							
K. Total Direct Costs (C through I) →				$41,916	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) →				$41,916	0	$0	$0
N. Other →							
O. Total Amount of This Request →				$41,916	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.

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
600 E. Greenfield Ave., Milwaukee, WI 53204

PROJECT DIRECTOR(S)
Fred P. Binkowski

USDA AWARD NO. Year 2: Objectives 1 & 2

	CSREES FUNDED WORK MONTHS			Duration Proposed Months: 12 **Year 2 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)
	Calendar	Academic	Summer				
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				$12,000			
Total Salaries and Wages →				$13,000	$0	$0	$0
B. Fringe Benefits (If charged as Direct Costs)				$4,100			
C. Total Salaries, Wages, and Fringe Benefits (A plus B) →				$17,100	0	$0	$0
D. Nonexpendable Equipment (Attach supporting data. List items and dollar amounts for each item.)							
E. Materials and Supplies				$ 944			
F. Travel				$3,000			
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) →				$21,044	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) →					0	$0	$0
N. Other →							
O. Total Amount of This Request →				$21,044	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 WISCONSIN-MILWAUKEE

(Binkowski)

Objectives 1 and 2

A. **Salaries and Wages.** Year 1: Two academic staff researchers at 30% effort will assist the PI with all technical aspects associated with the laboratory experiments (Food Attractant Trials and Auditory Conditioning Trials). In addition, two undergraduate students will provide student hourly help for this project. Year 2: One academic staff researcher at 30% effort will assist the PI with all technical aspects associated with the laboratory and field experiments (feeding trials with extracts/diet formulations, auditory application for lab and pond feeding trials). In addition, one undergraduate student will provide student hourly help for this project.

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

E. **Materials and Supplies.** Year 1: Partial support for general laboratory supplies ($250), plumbing hardware ($250), aquaria supplies ($300), fish food ($1,000), audio equipment rental ($200) and experimental apparatus construction materials ($1,000). Year 2: Attractant treated diets ($944).

F. **Travel.** Year 1: 12 day trips @$125 per trip (fleet vehicle mileage and meals) for field collection of yellow perch and largemouth bass gametes and/or young-of-the-year life stages. Year 2: Lodging ($900), fleet vehicle mileage ($840), and meals ($1,260) for 9 overnight sampling trips to remote pond site.

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

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: Objectives 1 & 2**

	CSREES FUNDED WORK MONTHS			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	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				$27,985			
Total Salaries and Wages →				$27,985	$0	$0	$0
B. Fringe Benefits (If charged as Direct Costs)				$9,515			
C. Total Salaries, Wages, and Fringe Benefits (A plus B) →				$37,500	0	$0	$0
D. Nonexpendable Equipment (Attach supporting data. List items and dollar amounts for each item.)							
E. Materials and Supplies				$9,450			
F. Travel				$3,000			
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) →					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) →				$49,950	0	$0	$0
N. Other →							
O. Total Amount of This Request →				$49,950	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

UNITED STATES DEPARTMENT OF AGRICULTURE OMB Approved 0524-0039
COOPERATIVE STATE RESEARCH, EDUCATION, AND EXTENSION SERVICE Expires 03/31/2004

BUDGET

ORGANIZATION AND ADDRESS Board of Regents University of Wisconsin System 750 University Ave., Madison, WI 53706	**USDA AWARD NO.** **Year 2: Objectives 1 & 2**			
PROJECT DIRECTOR(S) Jeffrey A. Malison	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						
A. Salaries and Wages 1. No. of Senior Personnel	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				$27,985			
Total Salaries and Wages →				$27,985	$0	$0	$0
B. Fringe Benefits (If charged as Direct Costs)				$9,515			
C.Total Salaries, Wages, and Fringe Benefits (A plus B)				$37,500	0	$0	$0
D. Nonexpendable Equipment (Attach supporting data. List items and dollar amounts for each item.)							
E. Materials and Supplies				$9,450			
F. Travel				$3,000			
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) →				$49,950	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) →				$49,950	0	$0	$0
N. Other →							
O. Total Amount of This Request →				$49,950	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 WISCONSIN-MADISON

(Malison)

Objectives 1 and 2

A. **Salaries and Wages.** Annual costs: The salary for 4 months of two technicians' 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: Fertilizers and pond maintenance supplies ($2,000), general wet laboratory supplies including automatic fish feeders, size graders, etc. $3,000), fish food and fish food additives ($3,000), and chemicals and analytical laboratory equipment ($1,450).

F. **Travel.** Annual costs: $2,275 for travel between the UW-Madison campus and the Lake Mills State Fish Hatchery (100 trips per year, 70 miles per trip @ $0.325 per mile), and $725 (registration, mileage, lodging, and meals) is requested each year attend the Wisconsin Aquaculture Conference to present our results.

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

OMB Approved 0524-0039
Expires 03/31/2004

BUDGET

ORGANIZATION AND ADDRESS The Curators of the University of Missouri Columbia, MO 65211	**USDA AWARD NO. Year 1: Objective 2**		
PROJECT DIRECTOR(S) Robert S. Hayward	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. 1 Graduate Students				$15,000			
e. 1 Prebaccalaureate Students				$2,556			
f. ___ Secretarial-Clerical							
g. ___ Technical, Shop and Other							
Total Salaries and Wages				$17,556	$0	$0	$0
B. Fringe Benefits (If charged as Direct Costs)				$ 204			
C. Total Salaries, Wages, and Fringe Benefits (A plus B) →				$17,760	0	$0	$0
D. Nonexpendable Equipment (Attach supporting data. List items and dollar amounts for each item.)							
E. Materials and Supplies				$30,320			
F. Travel				$1,500			
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.)				$2,500			
K. Total Direct Costs (C through I) →					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) →				$52,080	0	$0	$0
N. Other →							
O. Total Amount of This Request →				$52,080	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.

UNITED STATES DEPARTMENT OF AGRICULTURE OMB Approved 0524-0039
COOPERATIVE STATE RESEARCH, EDUCATION, AND EXTENSION SERVICE Expires 03/31/2004

BUDGET

ORGANIZATION AND ADDRESS The Curators of the University of Missouri Columbia, MO 65211				**USDA AWARD NO.** **Year 2: Objective 2**			
PROJECT DIRECTOR(S) Robert S. Hayward				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	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. _1_ Graduate Students				$15,500			
e. _1_ Prebaccalaureate Students				$1,630			
f. ___ Secretarial-Clerical							
g. ___ Technical, Shop and Other							
Total Salaries and Wages				$17,130	$0	$0	$0
B. Fringe Benefits (If charged as Direct Costs)				$ 130			
C. Total Salaries, Wages, and Fringe Benefits (A plus B) →				$17,260	0	$0	$0
D. Nonexpendable Equipment (Attach supporting data. List items and dollar amounts for each item.)							
E. Materials and Supplies				$22,000			
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.)				$2,300			
K. Total Direct Costs (C through I) →				$43,560	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) →				$43,560	0	$0	$0
N. Other →							
O. Total Amount of This Request →				$43,560	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 MISSOURI-COLUMBIA

(Hayward)

Objective 2

A. Salaries and Wages. Year 1: Support for a Ph.D.-level graduate student ($15,000) and a part-time undergraduate research assistant ($2,556) at a pay rate of $8.00 per hour. Year 2: Support for a Ph.D.-level graduate student ($15,500) and a part-time undergraduate research assistant ($1,630) at a pay rate of $8.00 per hour.

B. Fringe Benefits. There will be no fringe benefits associated with the graduate student stipend. The University has a required 8% fringe benefit for part-time undergraduates.

E. Material and Supplies. Year 1 only: blocking nets and small sampling nets ($1,500). Years 1 and 2: are for (1) 120,000, 2.5–7.6 cm (0.98–2.99 in), feed-trained largemouth bass and their transport to the study site ($14,000/year); (2) pond-dividing barriers in each of the eight ponds ($3,500 in Year 1 only); (3) fish marking equipment and tags ($2,000 in Year 1 only); (4) standard fish feed ($7,320 and $7,000, in Years 1 and 2, respectively); and flavor-enhanced feed ($2,000 and $1,000 in Years 1 and 2, respectively).

F. Travel. Years 1 and 2: Twenty round trips to the experimental pond site for pond preparation before start of the experiment are anticipated @ 25 miles per round trip and $0.445 per mile = $223. A total of 300 miles is estimated to secure materials/supplies both before and during experiment (including fish feeds, materials for constructing pond barriers; sampling materials; transporting fish for analyses): 300 miles × $0.445 = $134. Round trips to the pond site from Columbia. Missouri throughout the 40-day experiment period for the graduate student and part-time research assistant: 15 round trips × 25 miles per round trip × $0.445 per mile = $167. Living away from home allowance for graduate student and part-time research assistant due to the need to be continually present at study site for such expenses as camper rental and purchase of cooking equipment: $700. Round trip to fish producer's site to evaluate fish handling procedures: 1 round trip @ 300 miles and $0.445 per mile = $134 plus estimated $142 for food and lodging for two people for two days; total = $276. Year 2: Funds to defray half of the cost transportation, lodging, and meals for two persons to travel to a scientific meeting to present results of findings: $500.

I. All Other Direct Costs: Year 1: Lipid analyses ($2,500). Year 2: Lipid analyses ($2,300).

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 Trustees
Southern Illinois University-Carbondale
Carbondale, IL 62901

PROJECT DIRECTOR(S)
Anita M. Kelly

USDA AWARD NO. Year 1 Objective 2

	CSREES FUNDED WORK MONTHS			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	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. _1_ Graduate Students				$15,524			
e. ___ Prebaccalaureate Students							
f. ___ Secretarial-Clerical							
g. ___ Technical, Shop and Other							
Total Salaries and Wages →				$15,524	$0	$0	$0
B. Fringe Benefits (If charged as Direct Costs)				$0			
C. Total Salaries, Wages, and Fringe Benefits (A plus B) →				$15,524	0	$0	$0
D. Nonexpendable Equipment (Attach supporting data. List items and dollar amounts for each item.)							
E. Materials and Supplies				$3,476			
F. Travel				$1,500			
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.)				$1,000			
K. Total Direct Costs (C through I) →				$21,500	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) →				$21,500	0	$0	$0
N. Other →							
O. Total Amount of This Request →				$21,500	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)		

UNITED STATES DEPARTMENT OF AGRICULTURE OMB Approved 0524-0039
COOPERATIVE STATE RESEARCH, EDUCATION, AND EXTENSION SERVICE Expires 03/31/2004

BUDGET

ORGANIZATION AND ADDRESS
Board of Trustees
Southern Illinois University-Carbondale
Carbondale, IL 62901

PROJECT DIRECTOR(S)
Anita M. Kelly

USDA AWARD NO. Year 2 Objective 2

	CSREES FUNDED WORK MONTHS			Duration Proposed Months: _12_ **Year 2 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	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. _1_ Graduate Students				$15,990			
e. ___ Prebaccalaureate Students							
f. ___ Secretarial-Clerical							
g. ___ Technical, Shop and Other							
Total Salaries and Wages →				$15,990	$0	$0	$0
B. Fringe Benefits (If charged as Direct Costs)				$0			
C. Total Salaries, Wages, and Fringe Benefits (A plus B) →				$15,990	0	$0	$0
D. Nonexpendable Equipment (Attach supporting data. List items and dollar amounts for each item.)							
E. Materials and Supplies				$1,510			
F. Travel				$1,500			
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.)				$1,000			
K. Total Direct Costs (C through I) →				$20,000	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) →				$20,000	0	$0	$0
N. Other →							
O. Total Amount of This Request →				$20,000	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)		

BUDGET EXPLANATION FOR SOUTHERN ILLINIOS UNIVERSITY-CARBONDALE

(Kelly)

Objective 2

A. **Salaries and Wages.** Salaries are needed for one 50% FTE graduate student per year to conduct the feeding trials and collect and collate data.

E. **Materials and Supplies.** Year 1: General wet-laboratory, and record keeping supplies ($300) needed for the trials, static electrical devices ($500) and sound devices ($700), fish ($500), fish food ($900), and video cameras ($576). Year 2: Fish ($500) and fish food ($900), and water quality chemicals ($110).

F. **Travel.** Annual costs: Partial support for PI to make presentation of project results at a multi-day conference in the United States. It is estimated that $500 per year will be needed to cover air and/or mileage and that $500 per year will be needed to help cover costs of food and lodging. U.S. Chapter meetings of the World Aquaculture Society, Fish Culture Section meetings of the American Fisheries Society, and World Aquaculture Society meetings, when held in the U.S., are the likely meetings where presentations will be made. $500 in travel is also needed to attend the annual meeting of the Illinois Aquaculture Industry Association to present results there as well.

I. **All Other Direct Costs.** Annual costs: Telephone/fax ($250), photocopying ($250), equipment repair ($250), and vehicle maintenance ($250).

BUDGET SUMMARY FOR EACH PARTICIPATING INSTITUTION

Year 1

	UW-Milwaukee	UW-Madison	UMC	SIUC	TOTALS
Salaries and Wages	$28,400	$27,985	$17,556	$15,524	$89,465
Fringe Benefits	$9,016	$9,515	$ 204	$ 0	$18,735
Total Salaries, Wages, and Fringe Benefits	$37,416	$37,500	$17,760	$15,524	$108,200
Nonexpendable Equipment	$ 0	$ 0	$ 0	$ 0	$ 0
Materials and Supplies	$3,000	$9,450	$30,320	$3,476	$46,246
Travel	$1,500	$3,000	$1,500	$1,500	$7,500
All Other Direct Costs	$ 0	$ 0	$2,500	$1,000	$3,500
TOTAL PROJECT COSTS	**$41,916**	**$49,950**	**$52,080**	**$21,500**	**$165,446**

Year 2

	UW-Milwaukee	UW-Madison	UMC	SIUC	TOTALS
Salaries and Wages	$13,000	$27,985	$17,130	$15,990	$74,105
Fringe Benefits	$4,100	$9,515	$130	$ 0	$13,745
Total Salaries, Wages, and Fringe Benefits	$17,100	$37,500	$17,260	$15,990	$87,850
Nonexpendable Equipment	$ 0	$ 0	$ 0	$ 0	$ 0
Materials and Supplies	$ 944	$9,450	$22,000	$1,510	$33,904
Travel	$3,000	$3,000	$2,000	$1,500	$9,500
All Other Direct Costs			$2,300	$1,000	$3,300
TOTAL PROJECT COSTS	**$21,044**	**$49,950**	**$43,560**	**$20,000**	**$134,554**

SCHEDULE FOR COMPLETION OF OBJECTIVES

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

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

LIST OF PRINCIPAL INVESTIGATORS

Fred P. Binkowski, University of Wisconsin-Milwaukee
Robert S. Hayward, University of Missouri-Columbia
Anita M. Kelly, Southern Illinois University-Carbondale
Jeffrey A. Malison, University of Wisconsin-Madison

VITA

Fred P. Binkowski
UWS/UWM Great Lakes WATER Institute
600 E. Greenfield Ave.
Milwaukee, WI 53204

Phone: (414) 382-1723
Fax: (414) 382-1705
E-mail: sturgeon@csd.uwm.edu

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), Great Lakes 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.

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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.

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Binkowski, F.P., and L.G. Rudstam. 1994. The maximum daily ration of Great Lakes bloater. Transactions of the American Fisheries Society 123:335-343.

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EDUCATION

B.S. Cornell University, 1977, Natural Resources (Fisheries Science)
M.S. Tennessee Technological University, 1980, Biology (Fisheries, Applied Statistics)
Ph.D. Ohio State University, 1988, Zoology (Aquatic Ecology; Fish Bioenergetics)

POSITIONS

Associate Professor (1995-present), and Assistant Professor (1988-1995), Fisheries and Wildlife, University of Missouri
Aquatic Ecologist (1985-1987), Battelle Memorial Institute
Research Associate I&II (1980-1984), Aquatic Ecology Program, Ohio State University

SCIENTIFIC AND PROFESSIONAL ORGANIZATIONS

American Fisheries Society (Sections: Fish Culture; Education; Physiology; Res. Fisheries)
American Institute of Fishery Research Biologists
Missouri Chapter of American Fisheries Society
World Aquaculture Society

SELECTED PUBLICATIONS

Bajer, P.G., G.W. Whitledge, and R.S. Hayward. 2004. Widespread consumption-dependent systematic error in fish bioenergetics models and its implications. Canadian Journal of Fisheries and Aquatic Sciences 61:2158-2167.

Wang, H.P., R.S. Hayward, and G.W. Whitledge. 2003. Prey-size preference, maximum handling size, and consumption rates for redear sunfish *Lepomis microlophus* feeding on two gastropods common to aquaculture ponds. Journal of the World Aquaculture Society 34:379-385.

Hayward, R.S., and H.P. Wang. 2002. Inherent growth capacity and social costs of bluegill and hybrids of bluegill and green sunfish: which fish really grows faster? North American Journal of Aquaculture 64:34-46. (Best Paper Finalist in NAJA)

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

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Wang, N., R.S. Hayward, and D.B. Noltie. 2000. Effects of social interaction on growth of juvenile hybrid sunfish held at two densities. North American Journal of Aquaculture 62:161-167.

Zweifel, R.D., R.S. Hayward, and C.F. Rabeni. 1999. Bioenergetics insight into black bass distribution shifts in Ozark Border Streams. North American Journal of Fisheries Management 19:192-197.

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EDUCATION

B.S.	University of Iowa, 1987, Biology
M.S.	Southern Illinois University-Carbondale, 1990, Zoology/Aquatic Toxicology
Ph.D.	Southern Illinois University-Carbondale, 1995, Zoology/Aquaculture, Physiology

POSITIONS

Assistant Professor (2003-present), Fisheries and Illinois Aquaculture Center and Department of Zoology, Southern Illinois University-Carbondale

Assistant/Associate Professor (1998-2003) Department of Wildlife and Fisheries, Mississippi State University

SCIENTIFIC AND PROFESSIONAL ORGANIZATIONS

American Fisheries Society including the Fish Culture Section, Fish Physiology Section, and Education Section
Mississippi Chapter of the American Fisheries Society
Phi Kappa Phi Honor Society
U.S. Chapter-World Aquaculture Society
World Aquaculture Society

SELECTED PUBLICATIONS

Kelly, A.M., and C.C. Kohler. 2003. Effects of *Yucca shidigera* extract on growth, nitrogen retention, ammonia excretion, and toxicity in channel catfish, *Ictalurus punctatus* and hybrid tilapia *Oreochromis niloticus* × *O. niloticus*. Journal of the World Aquaculture Society 34:156-161.

Kelly, A.M., and C.C. Kohler. 1999. Relationship between cold tolerance and lipid composition of striped bass, white bass and their hybrids. North American Journal of Aquaculture 61:278-285.

Kelly, A.M., and C.C. Kohler. 1996. The use of Chorulon for the induction of brood fish. Final Report to Intervet, Millsboro, Delaware. 313 pages.

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EDUCATION

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M.S. University of Wisconsin-Madison, 1980, Endocrinology-Reproductive Physiology
Ph.D. University of Wisconsin-Madison, 1985, Endocrinology-Reproductive Physiology

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 Association for the Advancement of Sciences
American Fisheries Society
World Aquaculture Society

SELECTED PUBLICATIONS

Jentoft, S., N. Topp, M. Seeliger, J.A. Malison, T.P. Barry, J.A. Held, S. Roberts, and F. Goetz. 2005. Lack of growth enhancement by exogenous growth hormone treatment in yellow perch (Perca flavescens) in four separate experiments. Aquaculture 232:591-602.

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Barry, T.P., and J.A. Malison, editors. 2004. Proceedings of Percis III: The Third International Percid Fish Symposium. University of Wisconsin Sea Grant Institute, Madison, Wisconsin. 136 pages.

Mandiki, R.S.M., J.A. Malison, J.A. Held, C. Rougeot, G. Blanchard, C. Mélard, and P. Kestemont. 2004. Hybridization of Eurasian and yellow perch increases growth rate of offspring. Pages 47-48 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, Wisconsin.

Jentoft, S., J.A. Held, J.A. Malison, and T.P. Barry. 2002. Ontogeny of the cortisol stress response in yellow perch (Perca flavescens). Fish Physiology and Biochemistry 26:371-378.

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Malison, J.A., J.A. Held, L.S. Weil, T.B, Kayes, and G.H. Thorgaard. 2001. Manipulation of ploidy in walleye (Stizostedion vitreum) by heat shock and hydrostatic pressure shock. North American Journal of Aquaculture 63:17-24.