LARGEMOUTH BASS NUTRITION

Chairperson: Christopher C. Kohler, Southern Illinois University-Carbondale

Industry Advisory Council Liaison: William E. Lynch, Jr., Marysville, Ohio

Extension Liaison: Joseph E. Morris, Iowa State University

Funding Request: $170,000

Duration: 2 Years (September 1, 2005 - August 31, 2007)

Objectives:

1. Assess diet and environmental factors that affect growth and health of largemouth bass raised to 1.5 lb in ponds with formulated feed.

2. Develop cost-effective finisher diets that enhance health and growth of largemouth bass.

3. Conduct a region-wide workshop on raising largemouth bass to 1.5 lb in ponds based, at least, on the results of the research activities in Objectives 1 and 2.

Proposed Budgets:

Institution	Principal Investigator(s)	Objective(s)	Year 1	Year 2	Total
Purdue University	Paul B. Brown	1 & 2	$39,678	$40,322	$80,000
Southern Illinois University-Carbondale	Christopher C. Kohler	1 & 2	$39,537	$40,463	$80,000
Iowa State University	Joseph E. Morris	3		$10,000	$10,000
		Totals	**$79,215**	**$90,785**	**$170,000**

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JUSTIFICATION

In February 2004, the Industry Advisory Council (IAC) of the North Central Regional Aquaculture Center (NCRAC) convened at the Annual Program Planning Meeting and identified a problem associated with growing largemouth bass *Micropterus salmoides* to food market size (1.5 lb) in ponds strictly on formulated feeds. Largemouth bass growers in the North Central Region (NCR) have observed the slowing of growth occurs as the fish reach 0.75 lb in size, and culturists currently provide live forage in order to obtain bass of market size. Commercial culturists and scientists at the 2004 NCRAC annual meeting speculated the problem is nutritional, but this needs to be verified. Based on the discussion that ensued, the IAC recommended that a work group be established as a high priority to address this issue in the next funding cycle. The Board of Directors concurred with the ranking and allocated funds for a two-year project focused on assessing nutritional and environmental factors with respect to economically growing this species to a food market size. A Project Review Committee was established by NCRAC and they considered six Statements of Interest submitted by scientists in the NCR. Three scientists were selected to participate in the project. This proposal describes the proposed activities of the three selected participants.

The overarching justification for aquacultural research with largemouth bass is based on market considerations. Tidwell et al. (2000) stated that the demand for largemouth bass greater than 1.0 lb has been identified to exceed 700,000 lb/yr with a value of over $3.00/lb live weight, and made the following cost estimates based on numbers generated for a catfish production system comprised of four, 5-acre ponds under Kentucky conditions. Based on a stocker price of $0.50 per feed trained fingerling, a yield of 4,350 lb/acre, and a selling price of $3.00/lb (live sales), approximately $12,750/acre gross revenues are generated, which allows a return of $6,623/acre above variable costs and $5,950 after operator labor. A break-even estimate under these assumptions would be $1.60/lb. Direct sales of live largemouth bass can exceed $6.00/lb in the Asian market, largely centered in Chicago, New York, San Francisco, and Toronto. The higher price is also received for largemouth bass in excess of 1.0 lb sold to pay fisheries (Heidinger 2000).

Both nutritional and environmental hypotheses have been developed as to why commercial growers have not been able to consistently raise largemouth bass in ponds to market size (1.5 lb) solely on formulated feed. The limitations to grow out of largemouth bass may be related to one or more of these hypotheses.

The first hypothesis is that with largemouth bass being strict carnivores, they may not be able to tolerate the levels of carbohydrates prevalent in many commercial diets. Researchers at Southern Illinois University- Carbondale (SIUC) found that as little as 13% digestible carbohydrate in diets of largemouth bass resulted in significant ($P < 0.01$) reduction in growth and significant ($P < 0.01$) enlargement of livers (Wetzel and Kohler, SIUC, unpublished data). A number of published reports have shown that when carnivorous fishes are fed in excess of 10% digestible carbohydrate, they exhibit clinical signs similar to diabetic animals, being unable to regulate blood glucose (Shimeno 1991; Brauge et al. 1994; Wilson 1994). Levels of dietary starch in excess of 10% have also been shown in rainbow trout *Oncorhyncus mykiss* and Atlantic salmon *Salmo salar* to result in hyperglycemia, increased liver size, and increased glycogen content (Brauge et al. 1994). Blood insulin responses in fish have been linked with elevated glucose levels following the intake of carbohydrates (Stone et al. 2003). Excess glucose may be assimilated and stored as glycogen (glycogenesis) or converted to lipid (Sanchez-Muros et al. 1996). Accordingly, it is possible even low levels of digestible carbohydrate in the diet might be harmful to largemouth bass.

The second hypothesis is that a lack of understanding of the nutritional requirements of largemouth bass results in inadequate dietary formulations that facilitate fatty livers and impair growth at larger sizes. Very few of the nutrient requirements have been quantified for bass (see **RELATED CURRENT AND PREVIOUS WORK**). Several of these are directly involved in mobilization of lipid from the liver and these nutrients all interact with one another to move lipids to muscle and other extraheptic tissues. If these concentrations are inadequate or improperly balanced, liver lipid stores increase and can potentially impair a wide range of metabolic events leading to impaired health and growth. Fatty liver in fishes is similar to the human disease cirrhosis of the liver. This hypothesis begins with the essential amino acid (EAA) methionine, which is one of the first limiting EAA in diets fed to fish. Methionine often becomes the limiting EAA in diets containing low concentrations of fish meal (Brown et al. 1996). Beginning with methionine, catabolism, or breakdown, of methionine can lead to formation of the nonessential amino acid cyst(e)ine, or it can be recycled back to methionine after donating a one-carbon methyl group (Smolin and Benevenga 2000). Choline is an integral component of phosphatidylcholine or lecithin, which is increasingly used in diets fed to fish. Phosphatidylcholine contains several fatty acids, which can also be essential nutrients. The essential fatty acid requirement of largemouth bass is not known, nor are the requirements for methionine, choline, or phosphatidylcholine and deficiencies of each can result in fatty liver in fishes.

The third hypothesis is that because largemouth grown in ponds require two growing seasons to reach marketable size, pellet-feeding behavior may be lost over the course of the first winter. Kubitza and Lovshin (1997) observed young-of-the-year largemouth bass seemed to feed more actively on pellets than did one-year-old bass, which they suggested might be attributable to the influence of alternative natural foods and overwintering on the retainment of pellet feeding behavior.

The fourth hypothesis relates to water temperature and feeding. Coutant (1975) reviewed the effects of water temperature on feed consumption of largemouth bass and stated that growth rates increase with temperature to a maximum of ~80°F, with feed consumption and growth declining thereafter. Coutant (1975) also described daily vertical migrations of largemouth bass relative to temperature, with fish appearing at the surface in early morning and migrating to deeper water in the afternoon in response to elevations in surface water temperatures. Feeding during the second summer when afternoon surface temperatures exceed 80°F may need to be limited to early morning. Providing minnows at this interval may actually exasperate the situation by further prompting the bass to switch off of formulated feed.

The fifth hypothesis deals with type and size of feed offered to age-2 largemouth bass. Largemouth bass do not grow well in murky ponds because they usually feed by sight (Davis and Lock 1997). Sinking feeds should be avoided in the second year of growth because largemouth bass rarely feed on pellets lying on the pond bottom (Kubitza and Lovshin 1997). In addition, because largemouth bass strike at individual pellets, less energy would be expended if larger size food pellets were offered rather than the 7 mm pellets traditionally fed.

The sixth and last hypothesis relates to onset of sexual maturation and differential growth of sexes. Sexual maturity of largemouth bass depends more on size than age (Heidinger 2000). Female bass reach sexual maturity when approximately 10 in total length (TL), while males may be mature at 9 in TL (Davis and Lock 1997). Accordingly, the initial rapid growth of largemouth bass fed formulated feeds may slow when energy begins to be shunted to sexual products.

To date, there have been a limited number of publications related to the culture of largemouth bass for the food-fish market in the United States. To allow for the continued development of this species for the food fish market there needs to be additional extension/outreach publications on all facets of largemouth bass culture as well as hands-on workshops for the regional aquaculture industry.

RELATED CURRENT AND PREVIOUS WORK

Current publications describe the culture of largemouth bass fingerlings, natural history, and general biology (Davis and Lock 1997; Heidinger 2000) as well as a species profile (Tidwell et al. 2000). Most research on largemouth bass has been directed toward hatchery production of fish destined for stocking for recreational fisheries (Heidinger 2000). Studies in the 1960s utilized the Oregon Moist Pellet for feed training purposes (Snow 1968a,b; Snow and Maxwell 1970). Later, Anderson et al. (1981) determined minimum crude protein requirements for age-0 and age-1 largemouth bass to be 39.9 and 40.8%, respectively. More recently, Tidwell et al. (1996) found that largemouth bass are amenable to high-density culture, but that they have relatively high dietary protein requirements (bass fed a 47% crude protein diet grew significantly better than fish fed diets containing 42 and 44% crude protein).

Tidwell et al. (1998b) determined that feed-trained, age-0 largemouth bass are amenable to pond culture at densities of at least 5,000 fish/acre. Kubitza and Lovshin (1997) determined that a density of 3,000/acre was suitable for rearing feed-trained, age-2 largemouth bass. Third-year rearing of largemouth bass has also been successful at 3,000 feed-trained fish/acre (Tidwell et al. 1998a).

Although no carbohydrate requirement exists for any fish, utilization of complex carbohydrates in fish feeds has been steadily increasing, and omitting the carbohydrate portion of some fish diets has resulted in reduced growth. As the dominant portion of grains, legumes, and oilseeds, carbohydrates are an excellent, inexpensive source of chemical energy and seem to be a logical protein sparing ingredient for fish feeds. However, complex carbohydrates cannot be used efficiently by some cool and cold water carnivorous species despite the presence of amylase, disaccharidase, cellulase, and chitinase, which have all been extracted from fish stomachs or intestinal brush borders (Jobling 1995). Also, even though some species exhibit acidic, muscular guts and profuse intestinal micorflora and are morphologically adept at carbohydrate processing, considerable interspecies variation exists (Stickney and Shumway 1974). Often, a lack of the necessary hormonal control over enzymes either directly, or through appreciable gut microflora required to convert the more complex carbohydrates into useable material, has been thought to be the cause. In those cases, simple sugars may comprise the primary dietary energy or carbon sources (Buhler and Halver 1961; Cowey and Walton 1989; Mommsen and Plisetskaya 1991; Singh and Nose 1967).

Commercial diets fed to salmonids and marine fish rarely contain more than 20% complex carbohydrate (Cowey et al. 1975; Hardy 1991; Helland et al. 1991; NRC 1993). Feeding diets containing increased levels of digestible carbohydrate has resulted in increased liver size and glycogen content in salmonids (Hilton and Atkinson 1982; Phillips et al. 1948). Conversely, omnivores or herbivores such as channel catfish *Ictalurus punctatus*, tilapia *Oreochromis* spp., common carp *Cyprinus carpio,* and white sturgeon *Acipenser transmontanus* are very well equipped to digest diets containing as much as 40% dietary carbohydrate (Luquet 1991; Satoh 1991; Wilson 1991), yet perform poorly when fed diets where glucose is a major source of chemical energy (Hung et al. 1989; Wilson and Poe 1987).

Origin of starch, complexity of physical state, and inclusion level all appear to influence carbohydrate digestibility for fishes, regardless of physiology. The crystalline structure of starch granules varies according to source, with wheat having one of the smallest grain sizes of any starch (<0.0008 in), while maize and potato starches consist of larger grain sizes, 0.0004–0.0008 in and 0.0008–0.004 in, respectively. Digestibility of complex carbohydrates can be improved through preconditioning by heat gelatinization, extrusion, or enzymatic treatment (Hilton et al. 1981; Saad 1989; Schwertner et al. 2003; Singh and Nose 1967).

While processing increases the overall digestibility of starches, carbohydrate (glucose) tolerance of fish still must be considered when formulating fish diets. Findings thus far indicate that herbivorous and omnivorous fish, such as common carp, tilapia, and channel catfish, are better able to clear glucose from the bloodstream than carnivorous rainbow trout *Oncorhyncus mykiss* and other salmonids (Furuichi and Yone 1981; Furuichi 1983; Garcia-Riera and Hemre 1996; Peres et al. 1999; Stone et al. 2003). Carnivorous fish fed complex carbohydrate diets exhibit prolonged hyperglycemia similar to diabetic mammals (Brauge et al. 1994; Shimeno 1991; Wilson 1994), followed by hepatic microvessicular degeneration from glycogen accumulation (Brauge et al. 1994). Although herbivorous and omnivorous fish experience a similar hyperglycemic affect following an administration of dietary carbohydrates, the duration is much shorter (Furuichi and Yone 1981; Shimeno et al. 1997; Wilson 1994). This apparent inability of fish to regulate blood glucose may be due to a combination of several factors, including low hexokinase activity and uninducible glucokinase enzyme, and/or the lack the necessary insulin receptors when compared to mammals (Ablett et al. 1983; Palmer and Ryman 1972; Wilson and Poe 1987).

The lack of nutrient requirement data restricts feed choices in the developing largemouth bass industry in the NCR and around the country. Optimum crude protein concentrations have been estimated, as described above, and with the available feeds, trout and salmon diets would appear to be the only viable option for meeting the optimal dietary crude protein of largemouth bass. However, the IAC indicated these diets were problematic. As a prelude to this proposal, the Principal Investigators (PIs) conducted a telephone survey of bass producers in the United States. There was similarity in their choice of macronutrient concentrations fed to bass (most are feeding diets containing 41% crude protein up to a maximum concentration of 45%), and 12–16% dietary fat from three separate feed mills. However, there can be significant variation in response of fish fed diets that contain similar macronutrient concentrations. Several studies at Purdue University (Purdue) have identified significant variation in weight gain and feed conversion ratio (FCR) in new culture species fed trout and salmon diets. This variation was first documented in hybrid striped bass (Brown et al. 1993), but was also observed in yellow perch (Brown et al. 1996), walleye (Bharadwaj et al. 2002), and hybrid and pure bluegill (Twibell et al. 2003). These data indicate that all trout and salmon diets are not alike. It is unclear why the differences exist, but they may be related to choice of ingredients, quality of ingredients, quality control at the mill, manufacturing conditions, or storage and handling. There is wide variation in quantitative nutrient requirements of fish as well as their ability to use diets with similar macronutrient concentrations.

Methionine requirements of fishes range from 1.9–4.0% of the dietary protein (Twibell et al. 2000). Part of this variation can be explained by differing dietary crude protein concentrations (32–44%), but the variation in optimal dietary crude protein concentrations is not as wide as the methionine requirements. One common finding thus far has been the ability of cyst(e)in to spare the methionine requirement. Those values have typically been in the range of 50% (Harding et al. 1977; Moon and Gatlin 1991; Griffin et al. 1994a; Twibell et al. 2000). However, this is only part of the story that must be elucidated if we are to cost-effectively feed fishes in the 21st century.

Ingested methionine can be further metabolized to the water-soluble vitamin choline in vertebrates. This interaction was recently identified in tilapia (Kasper et al. 2000). When methionine was in excess of the dietary requirement, there was no apparent choline requirement. When dietary methionine was at the requirement and not in excess, there was a significant effect of dietary choline indicating a relatively high choline requirement. One of the deficiency signs of choline in fishes has been fatty liver (Griffin et al. 1994b; Halver 1957; Wilson and Poe 1988), although this deficiency sign has not been reported in all fishes (Craig and Gatlin 1991; Rumsey 1991). Choline is an integral component in phosphatidylcholine, or lecithin, and lecithin contains two fatty acid molecules. Lecithin has been evaluated in several species of fish and in virtually all cases a positive effect on growth and other gross response parameters has been reported (Kasper and Brown 2003). In most of those cases, the dietary requirements for methionine, choline, and essential fatty acids were not known for the respective species. In red drum (Craig and Gatlin 1997) and Nile tilapia (Kasper and Brown 2003), the critical dietary requirements were known and maintained at the appropriate levels and lecithin still exerted a positive influence on growth. The conclusion that should be drawn at this time is that the various interactions among critical nutrients involved in the metabolism of methionine have not been fully elucidated. Further, there appears to be differences between species. Given that aquaculture feeds are moving away from fish meal toward plant protein feedstuffs coupled with the fact that methionine is often first limiting in diets fed to fishes, metabolism of methionine has become a focal point within aquaculture nutrition. It is a central consideration in plant-based diets; it can interact with choline and potentially fatty acids. The nutrient requirements discussed above are the most common areas for consideration in fishes displaying fatty liver, but they are not the only nutrients that may be lacking. With a species for which we know very little about formulating diets, the methionine pathway is a logical place to start exploring this problem. Even if this hypothesis proves not to be the problem with grow out of largemouth bass, a significant amount of new information will be developed that will facilitate culture of this important species.

ANTICIPATED BENEFITS

Currently, the live largemouth bass market for Asian populations in North America is not being met and prices being paid are as high or higher than for virtually any other species raised in or outside the NCR. With producers experiencing difficulties rearing largemouth bass from 0.75–1.5 lb in ponds without using live forage, it is necessary to develop procedures to address this limitation to economically rearing this species. The studies and outreach activities proposed would address the problem based on the two major dietary energy groups, carbohydrates and lipids, as well as studies that will address feed management and sexual maturation.

Given the previous extension appointment of Morris as the Fisheries and Aquaculture Extension Specialist for Iowa State University (ISU), he is expected to present information garnered from this research in a format acceptable to individuals in the aquaculture industry. Tools used in this activity will allow for the timely dissemination of information through the use of cutting edge technology as well as time-honored methods of fact sheets and workshops. Extension and outreach activities are both part of the Land Grant mission of ISU.

OBJECTIVES

1. Assess diet and environmental factors that affect growth and health of largemouth bass raised to 1.5 lb in ponds with formulated feed.

2. Develop cost-effective finisher diets that enhance health and growth of largemouth bass.

3. Conduct a region-wide workshop on raising largemouth bass to 1.5 lb in ponds based, at least, on the results of the research activities in Objectives 1 and 2.

PROCEDURES

Assess Diet and Environmental Factors (Objective 1)

Purdue

Research at Purdue will focus initially on defining the critical nutrient requirements that may be involved in fatty liver syndrome, data that will also be critical in dietary formulation. Specifically, the following studies will be conducted:

1. Evaluation of commercially available and experimental diets;
2. Dietary methionine requirement;
3. Evaluation of cyst(e)ine sparing of the methionine requirement;
4. Interactions of choline and methionine;
5. Requirement for phosphatidylcholine; and
6. Evaluation of dietary lipid sources and levels.

It is anticipated that the first two studies will be conducted prior to formally starting this project, so the final four evaluations serve as the scope of research in the first 18 months of the project. General methods used in all experiments will be similar.

Juvenile (~0.08 lb mean weight, age 0+) feed-trained largemouth bass will be acquired from a private producer in the NCR, transported to the Purdue Aquaculture Research Laboratory (PARL), and quarantined for a minimum of two weeks prior to experimentation. If signs of disease become evident during quarantine, samples of fish will be submitted to the Purdue Animal Disease Diagnostic Laboratory for full-scale evaluation of disease causing agents, including evaluation of viruses. In this scenario, treatment recommendations will be implemented. A full and complete report of any disease situations will be submitted to NCRAC as part of Progress or Termination Reports so the methods used in diagnosis and treatment will be available for all producers in the region.

After quarantine, randomly selected groups will be stocked into 30 or 50 gal aquaria depending on initial size of fish and dietary treatments randomly assigned to triplicate groups of fish. All fish will be fed a commercial diet the first week after stocking into experimental aquaria, then their respective experimental diets for one week prior to beginning the experiments. All fish will be fed to apparent satiation twice daily. Feed containers will be weighed daily and consumption will be determined by slowly offering feed to each replicate tank until feeding stops. Daily consumption will be graphed and comprise part of the Progress or Termination reports. Water quality parameters will be monitored daily and maintained at levels considered safe for largemouth bass. Temperature will be maintained at 77°F. The experimental systems can be operated as flow-through or recirculating and a commercial-size water heater capable of supplying heated water to the entire laboratory on demand is available. Actual operation of the system will be determined at the time of the experiments as a function of other activity in the laboratory and time of year. Each aquarium study will have an 8-week duration.

The first experiment will be conducted in Summer 2005 and will serve as the foundation for future research efforts. Similar studies have been conducted with a variety of new culture species and have a standard protocol. A series of experimental diets have been developed containing casein (negative control), casein + arginine, casein + gelatin, or crystalline amino acids as the sources of essential and nonessential amino acids.

All diets will contain 15–20% carbohydrate supplied by dextrin, 10–15% lipid supplied by fish oil, and complete mineral and vitamin premixes. Specific levels of carbohydrate and lipid will be determined in conjunction with the co-PI once the results of the telephone survey are thoroughly evaluated. In conjunction with these diets, commercial diets that range in crude protein and lipid concentrations will be acquired. The low end of the range (32% protein and 4% fat) will be a commercial catfish diet and the high end of the range (44% protein and 18% fat) will be high-energy trout diets, plus two diets in between containing intermediate levels of protein and lipid. This initial evaluation provides recommendations for private producers as well as identifying experimental diets for use in future studies. Researchers at Purdue have been successful identifying experimental diets for all but one species groups, the lepomids (Twibell et al. 2003). If largemouth bass follow the same pattern as bluegill, practical dietary formulations will be used in all future studies. However, the preference is to use semi-purified diets for the precision they provide. Response parameters measured in this study will be weight gain, FCR, survival, and intraperitoneal fat ratio. Livers will be examined histologically for indications of fat and glycogen accumulation.

In the dietary methionine requirement study, the appropriate basal diet identified in the first study will be used and gradations of L-methionine in increments of 0.1% of the dry diet established. Response parameters will include weight gain, FCR, survival, and serum methionine concentrations.

In the cyst(e)ine sparing study, ratios of methionine to cyst(e)ine in 10% increments will be established. For example, in a previous study, ratios ranging from 70:30–30:70 in 10% increments were established. Response parameters will include weight gain, FCR, survival, and serum methionine and cyst(e)ine concentrations.

Using the requirement for methionine and the maximum concentration of cyst(e)ine, gradations will be established for dietary choline encompassing the range of published choline requirements (0.008–0.048 oz/lb diet) in approximately equal increments. Response parameters will include weight gain, FCR, survival, liver lipid and glycogen concentrations, and liver histology. A second study will be designed as a factorial experiment with a minimum of three methionine and three choline concentrations. Response parameters will be the same as those listed above for the choline study.

Holding all previously described requirements at the minimum, graded levels of a purified source of phosphatidylcholine (93% pure) will be evaluated. Range of concentrations will be 0–0.048 oz/lb in approximately equal gradations. Response parameters will include weight gain, FCR, survival, liver lipid and glycogen concentrations, and liver histology.

In the final study, a factorial design with four lipid sources and four levels of each lipid source will be established. It is anticipated fish oil, soybean oil, a 1:1 mixture of fish and soybean oils, and tallow will be used. Response parameters will include weight gain, FCR, survival, and fatty acid concentrations of liver and muscle.

Data in all studies will be statistically analyzed by parametric methods. Either one-way ANOVA or factorial designs will be the model. The Statistical Analysis System for personal computers will be used for all evaluations. Accepted level of probability will be <0.05.

The PI involved in this study has conducted similar studies with hybrid striped bass, yellow perch, and tilapia and is familiar with all procedures. These studies will be completed prior to Spring 2007 so the results can be incorporated into practical dietary formulations for grow out during the final year of the project (methods described below under Objective 2).

<u>SIUC</u>

A series of controlled experiments with three size groups of largemouth bass (fingerlings, ~0.011 lb, age-0; juveniles, ~0.275 lb, age-1+; and young adults, ~0.66 lb mean weight, age 1+) will be conducted in 29-gal aquaria configured in a recirculating system to assess growth and physiological performance relative to graded levels of dextrin (0, 10, 20, and, 30% dry basis) as a carbohydrate source. All treatments will be triplicated with 20, 10, and 5 fish/aquaria for the three respective size groups. An experimental diet (40% crude protein) similar to that proposed by Brown et al. (1993) for hybrid striped bass *Morone saxatilis* × *M.*

chrysops will be used. The hybrid striped bass experimental diet is casein based, but experience at SIUC suggests porcine gelatin is a more palatable protein source for largemouth bass and consequently the latter will be used. Fish will be fed set daily rations (5, 4, 3% wet body weights for fingerlings, juveniles, and adults, respectively) divided into two feedings/day over a 10-week period. Standard water quality variables (Stickney and Kohler 1990) will be monitored, and individual tanks will be siphoned daily to remove feces and uneaten feed. Plasma samples for baseline insulin (radioimmunoassay following procedures of Plisetskaya et al. 1986) and glucose levels (Freestyle Blood Glucose Monitoring System, TheraSense, Alameda, California) will be taken from a random sample of 10 fish for each size group at day 0 (these fish will be from a larger population from which test fish will be size graded and will not be used in the subsequent feed trials). At the completion of the 10-week trials, plasma will be drawn from three fish from each replicate for determination of insulin and glucose levels. In addition to survival, growth, and FCR information, three fish from each replicate will be subjected to necropsy for determining liver condition (color, fat deposits, and liversomatic index) as well as whole body proximate analyses (AOAC 1990).

The environmental factors that affect growth and health of largemouth bass that will be addressed fall into two major categories: (1) feed management and (2) onset of sexual maturation. Feed management will consist of three studies. The first study will assess whether a portion of the largemouth bass pond population loses some or all habituation to pelleted feed during the first winter. Two triplicated treatments will be used: (1) bass not fed over winter and (2) bass fed once weekly at 1% wet body weight, excluding any weeks of ice cover (rarely lasting more than a week or two in southern Illinois). All ponds (0.1 acre) will be stocked at a density of 4,000 0.011-lb, feed-trained largemouth bass (age-0)/acre in early summer and maintained on a 40% crude protein trout diet with a 3–5% daily ration. Standard water quality variables (Stickney and Kohler 1990) will be monitored over the course of the study. In late winter/early spring, 25 bass from each of the six ponds will be randomly sampled and placed in one of six replicate indoor 500-gal fiberglass tanks maintained at equivalent temperatures to the ponds (~54°F). Tank temperatures will be increased ~1.8°F/day until reaching 72°F at which time the same pelleted feed provided the previous fall will be offered. Comparisons will be made on a daily basis as to the relative percent of bass that go onto feed over a two-week period.

The second feed management study will assess the affect of time of feeding/temperature on growth of age-1+, feed-trained largemouth bass in 0.1-acre ponds stocked at a density of 1,250 0.275-lb fish/acre. Two triplicated treatments will be used: (1) bass fed once daily during summer in early morning and (2) bass fed twice daily in summer in early morning and late afternoon (ration to be equivalent to once-fed treatment). Standard water quality variables (Stickney and Kohler 1990) will be monitored over the course of the study. Water temperatures will be measured daily at the surface and mid-depth (~3 ft) over the summer at both feeding periods. In particular, water temperatures at the time bass approach ~0.66 lb or anytime when bass appear to be going off feed, will be closely monitored, as will other water quality variables. In late fall, at least 50 bass will be randomly sampled from each pond and comparisons with respect to growth and FCR will be made between the two treatments.

The third feed management study will evaluate the affect of pellet size on growth of age-1+ largemouth bass (~0.275 lb initial weight) stocked in early spring in 0.1-acre ponds at a density of 1,250 0.275-lb fish/acre. Two triplicated treatments will be used: (1) bass fed a floating 0.28-in pellet for the entire year and (2) bass initially fed a floating 0.28-in pellet but switched to a floating 0.39-in pellet once they reach a size where they can swallow the larger feed. Standard water quality quality variables (Stickney and Kohler 1990) will be monitored over the course of the study. In late fall, all bass should be in excess of 1.0 lb and will be harvested. Differences in growth, FCR, and survival will be compared between treatments.

The effect, if any, of onset of sexual maturation and differential growth of sexes will be examined by sampling at least 10 age-1+ bass monthly as part of the third feed management study (above), taking their TLs (nearest 0.05 in) and weights (nearest 0.035 oz), and determining their sex and state of maturation using ultrasound. At harvest, at least 25 fish from each of the six ponds will be necropsied for determination of sex and gonadosomatic index.

Develop Cost-effective Finisher Diets (Objective 2)

Purdue

In Spring or early Summer 2006, juvenile feed-trained largemouth bass will be acquired from a private producer in the NCR, transported to PARL, and stocked into one of twelve earthen culture ponds. All ponds are 0.25 surface acres and are equipped with water supply, drain, and electrical outlets with agitators. All ponds will be stocked at a density of 4,000 0.011-lb fish (age 0)/acre and all fish will be fed a commercial diet during 2006. The commercial diet used during the first year will be the most commonly used one in the NCR. All fish will be fed to apparent satiation and feed consumption will be monitored daily and graphed as a function of water temperature. Winter-feeding regimes will be determined based on weather conditions, but feeding when the weather and temperatures allowed is anticipated. Based on the results of laboratory studies, two experimental diets will be formulated and manufactured (extruded) by a commercial feed mill. It is difficult to predict the nature or composition of those diets at this time, but the PI anticipates taking the same general approach incorporated in a recent pond production study with hybrid striped bass. With similar lab data proposed in this series of experiments, plus an evaluation of soybean products, the PI will attempt to acquire complementary funding for a soybean meal evaluation with largemouth bass prior to the 2007 pond grow-out study. The experimental diets fed to hybrid striped bass contained relatively high levels of soybean meal (40%), plus fish meal and whole ground wheat. Those diets were manufactured by Nelson and Sons (Murray, Utah). Final mean weight of hybrid striped bass was 1.8 lb and mean final standing crop was in excess of 6,000 lb/acre. There will be three dietary treatments with four replications of each treatment. One commercial control diet (the same commonly used one in the NCR fed during the first year of the pond grow out) will also be used. In early spring, populations in each pond will be graded to size and reduced to 3,125 age 1+ bass, which are anticipated to initially weigh ~0.275 lb. All fish will be fed seven days per week from May through October, when all fish in all ponds will be harvested and should weigh in excess of 1.0 lb. The size of feed and timing/number of feedings will be based on results from the SIUC study. Survival of fish from each pond will be determined and total weight data will be collected. Samples of fish from each pond will also be used for determination of dress-out percentage, and liver samples will also be collected for determination of liver lipid concentration and histopathological evaluation.

SIUC

Based on results from Objective 1, one or more "finishing" diets containing carbohydrate levels determined to be suitable for largemouth bass grow out in the second year will be evaluated and compared to the industry standard (Purdue to determine). The study will be conducted in triplicated 0.1 acre earthen ponds using a density of 1,250 0.275-lb fish (age 1+)/acre. In addition to using experimental diets, the size of feed and timing/number of feedings will be based on results from Objective 1.

Conduct a Region-wide Workshop (Objective 3)

ISU

During the conduct of the pond culture study of this project, Morris or his associate in cooperation with the local PIs, Brown and Kohler, will collect video and still images. A CD will be produced in 2007 for later distribution to the aquaculture community in the NCR. This CD will contain images related to field operations of largemouth bass food fish operations, a fact sheet on the use of largemouth bass for food fish with particular emphasis on fish health and growth, and a guide for the selection of commercial diets for largemouth bass operations in the NCR.

This CD, along with additional supporting material, will be presented at a region-wide workshop to be located at Purdue on raising largemouth bass to 1.5 lb in ponds based, at least, on the results of the research activities in Objectives 1 and 2. This day-long workshop will include presentations from both NCRAC-funded investigators as well as established largemouth producers located in the NCR. This workshop will be scheduled in conjunction with the largemouth bass harvest at Purdue to be held in fall 2007. Participants will be presented current information related to largemouth bass culture as well as given the opportunity to have hands-on experiences working with this species.

The outputs will be:

- CD depicting operational aspects of producing largemouth bass for the food-fish market,
- Fact sheet depicting the production of largemouth bass fingerlings and food fish, and
- Conference proceedings to be distributed to the NCR community.

All written materials will be made available through the NCRAC Web site (http://ag.ansc.purdue.edu/aquanic/ncrac) and distributed to aquaculture specialists, and other Cooperative Extension Service and Sea Grant Advisory Service personnel.

EXTENSION PLAN

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 from input by the PIs. These reports are available on the NCRAC Web page (http://ag.ansc.purdue.edu/aquanic/ncrac/fprojects/fprojects.htm).

FACILITIES

Purdue

Purdue has a wet laboratory fully equipped to conduct the proposed research. Five experimental aquaria systems are in place and functional. A dedicated well, equipped with emergency generator, supplies water to the building. There are 36 water outlets in the building each equipped with temperature control. Water quality test kits and dissolved oxygen meters are in place. Water quality in each experimental system and each holding tank are checked daily. The chemistry laboratory contains, among other things, an analytical microwave for wet digestion of samples and Shimadzu double-beam spectrophotometer, liquid chromatography system, and scintillation counter. Kjejdahl equipment is maintained on campus in departmental laboratories. A Perkin-Elmer atomic absorption spectrophotometer is also maintained by the Department of Forestry and Natural Resources. Twelve earthen culture ponds (0.25 surface acres) are also present at the same site as the wet laboratory. All ponds have independent water supplies, drains, and electrical supply. Surface agitators are available for all ponds.

The workshop will be held at University Inn-Conference Center & Suites (3001 Northwestern Ave., West Lafayette, Indiana, (765) 463-5511). University Inn is a 15,000 ft^2 facility capable of hosting conferences of up to 400 people in a variety of settings. There are two rooms (6,700 ft^2, 82 ft × 82 ft and 3,500 ft^2, 72 ft × 49 ft) large enough to host the workshop. Conference rooms can be arranged to meet the specific needs of the workshop (i.e., classroom setting with tables, lecture setting, etc.).

SIUC

The SIUC proximate analyses laboratory is fully equipped to perform all standard AOAC methods to estimate crude protein, crude fat, moisture, crude fiber, and ash in fish/feeds. The lipid laboratory is fully equipped with glassware and modern instrumentation with analytical software to perform all of the lipid and fatty acid assays, and includes a Shimadzu Gas Chromatograph (GC-FID; GC17-A) fitted with an auto-sampler (AOC-20i), Iatroscan (TLC-FID; MK-6s), and developing chambers for thin layer chromatography. The lipid laboratory also houses analytical balances, spectrophotometers, a freeze dryer, and an –112°F freezer. An 8,300 ft^2, temperature-controlled wet laboratory building houses approximately 150 tanks of varying sizes. At least 15 recirculating systems are employed allowing for numerous studies to be conducted simultaneously. In addition, the wet laboratory building houses feed storage and an equipped feed manufacturing room (pelleted feeds), as well as a new water chemistry laboratory. Field facilities include eighteen 0.1-acre ponds contiguous to campus and, at the nearby SIUC Touch of Nature Park, ninety 0.1-acre ponds (38 equipped with 1.0 hp electric paddlewheel aerators). The Touch of Nature site includes a 14-acre retention pond, several deepwater wells, and all-weather roads. Graduate student living quarters and various storage facilities are situated at the site.

ISU

There are modern services for publication and printing at ISU. The extension liaison for the project and associate director of NCRAC is located at ISU. The Information Development Expanding Awareness (IDEA) located on the ISU campus, partners with Land-Grant institutions, researchers, extension professionals, faculty, and related agencies to communicate program progress, impacts, and research results. The IDEA office will assist the PI in the development of the three outputs of this objective (CD, fact sheet, and conference proceedings).

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PROJECT LEADERS

State	Name/Institution	Area of Specialization
Illinois	Christopher C. Kohler Southern Illinois University-Carbondale	Aquaculture/Nutrition
Indiana	Paul B. Brown Purdue University	Aquaculture/Nutrition
Iowa	Joseph E. Morris Iowa State University	Aquaculture

PARTICIPATING INSTITUTIONS AND PRINCIPAL INVESTIGATORS

Southern Illinois University-Carbondale (SIUC)
Christopher C. Kohler

Purdue University (Purdue)
Paul B. Brown

Iowa State University (ISU)
Joseph E. Morris

UNITED STATES DEPARTMENT OF AGRICULTURE

COOPERATIVE STATE RESEARCH, EDUCATION, AND EXTENSION SERVICE

OMB Approved 0524-0039
Expires 03/31/2004

BUDGET

ORGANIZATION AND ADDRESS	USDA AWARD NO. Year 1: Objectives 1 & 2			
Purdue University Sponsored Program Services 610 Purdue Mall, West Lafayette, IN 47907-2040	Duration Proposed Months: 12 **Funds Requested by Proposer**	Duration Proposed Months: ____ **Funds Approved by CSREES** (If different)	Non-Federal Proposed Cost-Sharing/ Matching Funds (If required)	Non-federal Cost-Sharing/ Matching Funds Approved by CSREES (If Different)
PROJECT DIRECTOR(S) Paul B. Brown				

	CSREES FUNDED WORK MONTHS: Calendar	Academic	Summer	Funds Requested by Proposer	Funds Approved by CSREES	Non-Federal Proposed Cost-Sharing	Non-federal Cost-Sharing Approved
A. Salaries and Wages 1. No. of Senior Personnel							
a. ___ (Co)-PD(s)							
b. ___ Senior Associates							
2. No. of Other Personnel (Non-Faculty) a. ___ Research Associates-Postdoctorates							
b. ___ Other Professionals							
c. ___ Paraprofessionals							
d. 1 Graduate Students				$18,677			
e. 1 Prebaccalaureate Students				$3,000			
f. ___ Secretarial-Clerical							
g. ___ Technical, Shop and Other							
Total Salaries and Wages →				$21,677	$0	$0	$0
B. Fringe Benefits (If charged as Direct Costs)				$1,315			
C. Total Salaries, Wages, and Fringe Benefits (A plus B) →				$22,992	0	$0	$0
D. Nonexpendable Equipment (Attach supporting data. List items and dollar amounts for each item.)							
E. Materials and Supplies				$14,686			
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.)							
K. Total Direct Costs (C through I) →				$39,678	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) →				$39,678	0	$0	$0
N. Other →							
O. Total Amount of This Request →				$39,678	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.

Form CSREES-2004 (12/2000)

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

OMB Approved 0524-0039
Expires 03/31/2004

BUDGET

ORGANIZATION AND ADDRESS
Purdue University
Sponsored Program Services
610 Purdue Mall, West Lafayette, IN 47907-2040

PROJECT DIRECTOR(S)
Paul B. Brown

USDA AWARD NO. Year 2: Objectives 1 & 2

	CSREES FUNDED WORK MONTHS: Calendar	Academic	Summer	Duration Proposed Months: 12 — Funds Requested by Proposer	Duration Proposed Months: ____ — Funds Approved by CSREES (If different)	Non-Federal Proposed Cost-Sharing/ Matching Funds (If required)	Non-federal Cost-Sharing/ Matching Funds Approved by CSREES (If Different)
A. Salaries and Wages							
1. No. of Senior Personnel							
a. ___ (Co)-PD(s)							
b. ___ Senior Associates							
2. No. of Other Personnel (Non-Faculty)							
a. ___ Research Associates-Postdoctorates							
b. ___ Other Professionals							
c. ___ Paraprofessionals							
d. 1 Graduate Students				$19,238			
e. 1 Prebaccalaureate Students				$3,000			
f. ___ Secretarial-Clerical							
g. ___ Technical, Shop and Other							
Total Salaries and Wages →				$22,238	$0	$0	$0
B. Fringe Benefits (If charged as Direct Costs)				$1,401			
C. Total Salaries, Wages, and Fringe Benefits (A plus B) →				$23,639	0	$0	$0
D. Nonexpendable Equipment (Attach supporting data. List items and dollar amounts for each item.)							
E. Materials and Supplies				$14,683			
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.)							
K. Total Direct Costs (C through I) →				$40,322	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) →				$40,322	0	$0	$0
N. Other →							
O. Total Amount of This Request →				$40,322	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.

Form CSREES-2004 (12/2000)

BUDGET EXPLANATION FOR PURDUE UNIVERSITY

(Brown)

Objectives 1 and 2

A. Salaries and Wages. Annual costs: one graduate student, and extra help (one summer hourly wage employee) to conduct the feeding trials and collect data.

B. Fringe Benefits. Annual costs: benefit rates at Purdue are 0.4% for graduate students plus insurance ($937 in Year 1 and $1,021 in Year 2) and 10.1% for prebaccalaureate students.

E. Materials and Supplies. Year 1: fish ($9,000), fish food ($3,000), feed ingredients ($2,000), analytical reagents ($686). Year 2: fish ($6,000), fish food ($5,000), feed ingredients ($3,000), and analytical reagents ($683).

F. Travel. Annual costs: transportation, lodging, and meal expenses for PI to present project results at a multi-day conference in the United States at a location to be determined. 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 United States are the likely meetings where presentations will be made.

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)
Christopher C. Kohler

USDA AWARD NO. Year 1: Objectives 1 & 2

	CSREES FUNDED WORK MONTHS: Calendar	Academic	Summer	Duration Proposed Months: 12 — **Funds Requested by Proposer**	Duration Proposed Months: ____ — **Funds Approved by CSREES** (If different)	Non-Federal Proposed Cost-Sharing/ Matching Funds (If required)	Non-federal Cost-Sharing/ Matching Funds Approved by CSREES (If Different)
A. Salaries and Wages							
1. No. of Senior Personnel							
a. ___ (Co)-PD(s)							
b. ___ Senior Associates							
2. No. of Other Personnel (Non-Faculty)							
a. 1 Research Associates-Postdoctorates	6.0			$19,800			
b. ___ Other Professionals							
c. ___ Paraprofessionals							
d. ___ Graduate Students							
e. ___ Prebaccalaureate Students							
f. ___ Secretarial-Clerical							
g. ___ Technical, Shop and Other							
Total Salaries and Wages →				$19,800	$0	$0	$0
B. Fringe Benefits (If charged as Direct Costs)				$11,673			
C. Total Salaries, Wages, and Fringe Benefits (A plus B) →				$31,473	0	$0	$0
D. Nonexpendable Equipment (Attach supporting data. List items and dollar amounts for each item.)							
E. Materials and Supplies				$3,064			
F. Travel				$4,000			
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.)				$1,000			
K. Total Direct Costs (C through I) →				$39,537	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) →				$39,537	0	$0	$0
N. Other →							
O. Total Amount of This Request →				$39,537	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)		

Form CSREES-2004 (12/2000)

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)
Christopher C. Kohler

USDA AWARD NO. Year 2: Objectives 1 & 2

	CSREES FUNDED WORK MONTHS: Calendar	Academic	Summer	Duration Proposed Months: 12 — Funds Requested by Proposer	Duration Proposed Months: ____ — Funds Approved by CSREES (If different)	Non-Federal Proposed Cost-Sharing/ Matching Funds (If required)	Non-federal Cost-Sharing/ Matching Funds Approved by CSREES (If Different)
A. Salaries and Wages							
1. No. of Senior Personnel							
a. ___ (Co)-PD(s)							
b. ___ Senior Associates							
2. No. of Other Personnel (Non-Faculty) a. 1 Research Associates-Postdoctorates . . .	6.0			$20,400			
b. ___ Other Professionals							
c. ___ Paraprofessionals							
d. ___ Graduate Students							
e. ___ Prebaccalaureate Students							
f. ___ Secretarial-Clerical							
g. ___ Technical, Shop and Other							
Total Salaries and Wages . . . . →				$20,400	$0	$0	$0
B. Fringe Benefits (If charged as Direct Costs)				$11,748			
C. Total Salaries, Wages, and Fringe Benefits (A plus B) . . . . . . →				$32,148	0	$0	$0
D. Nonexpendable Equipment (Attach supporting data. List items and dollar amounts for each item.)							
E. Materials and Supplies				$3,065			
F. Travel				$4,000			
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.)				$1,250			
K. Total Direct Costs (C through I) . . . . →				$40,463	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) . . . . . . →				$40,463	0	$0	$0
N. Other . . . . →							
O. Total Amount of This Request . . . . →				$40,463	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)		

Form CSREES-2004 (12/2000)

BUDGET EXPLANATION FOR SOUTHERN ILLINOIS UNIVERSITY-CARBONDALE

(Kohler)

Objectives 1 and 2

A. Salaries and Wages. Salaries are needed for one 50% FTE postdoctorate researcher each year to conduct the feeding and environmental trials, collect and collate data, and assist in analysis of results.

B. Fringe Benefits. Annual costs: retirement at 11.05%, Medicare at 1.45%, and Health/Dental/Life at $1,533/month × 6 months.

E. Materials and Supplies. Annual costs: supplies needed include fish ($1,000), fish food ($1,564), general aquaculture supplies including nets, fertilizers, and graders ($250), and general laboratory supplies including chemicals reagents and glassware ($250) needed for the trials and analyses.

F. Travel. Annual costs: transportation, lodging, and meal expenses for PI to present project results at a multi-day conference in the United States at a location to be determined ($1,500). 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 United States are the likely meetings where presentations will be made. All of these venues routinely hold sessions dealing with bass aquaculture and nutrition. Additionally, a leased pickup truck will be partially supported ($2,500 annually) for daily round trips (20 miles) to the SIUC aquaculture pond facility.

J. All Other Direct Costs. Year 1: Telephone/fax ($250), photocopying ($250), equipment repair ($250), photos ($250); Year 2: Telephone/fax ($250), photocopying ($250), equipment repair ($250), photos ($250), and final report preparation in second year only ($250).

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

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BUDGET

ORGANIZATION AND ADDRESS Iowa State University Department of Natural Resource Ecology and Management 124 Science II, Ames, IA 50011-3221	USDA AWARD NO. Year 2: Objective 3
PROJECT DIRECTOR(S) Joseph E. Morris	

	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	Calendar	Academic	Summer				
1. No. of Senior Personnel							
a. ___ (Co)-PD(s)							
b. ___ Senior Associates							
2. No. of Other Personnel (Non-Faculty) a. _1_ Research Associates-Postdoctorates . . .	1.0			$2,720			
b. ___ Other Professionals							
c. ___ Paraprofessionals							
d. _1_ Graduate Students				$1,600			
e. ___ Prebaccalaureate Students							
f. ___ Secretarial-Clerical							
g. ___ Technical, Shop and Other							
Total Salaries and Wages . . . . →				$4,320	$0	$0	$0
B. Fringe Benefits (If charged as Direct Costs)				$1,024			
C. Total Salaries, Wages, and Fringe Benefits (A plus B) . . . . →				$5,344	0	$0	$0
D. Nonexpendable Equipment (Attach supporting data. List items and dollar amounts for each item.)							
E. Materials and Supplies				$656			
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.)				$1,000			
K. Total Direct Costs (C through I) . . . . →				$10,000	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) . . . . →				$10,000	0	$0	$0
N. Other . . . . →							
O. Total Amount of This Request . . . . →				$10,000	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)		

Form CSREES-2004 (12/2000)

BUDGET EXPLANATION FOR IOWA STATE UNIVERSITY

(Morris)

Objective 3

A. Salaries and Wages. Includes $2,720 for 1-month support of Rich Clayton, extension associate at ISU, and $1,600 for graduate student support to assist in developing materials for the extension outputs.

B. Fringe Benefits. ISU's fringe benefit rates are 31% for the extension associate and 11.3% for the graduate student.

E. Materials and Supplies. General office supplies including paper, pens, and file folders ($156); video media and folders for workshop ($500).

F. Travel. Transportation, lodging, and meal expenses for the PI or his staff to make two trips each to Purdue and SIUC (4 trips) to collect video or still images of the ongoing research projects and one trip to Purdue to conduct the workshop. Additional funds being requested for transportation, lodging, and meal expenses for presenters for the workshop ($1,000).

J. All Other Direct Costs. Postage ($300), photocopying ($150), and room and equipment rental for the workshop ($550).

BUDGET SUMMARY

Year 1

	PURDUE	SIUC	ISU	TOTALS
Salaries and Wages	$21,677	$19,800	$0	$41,477
Fringe Benefits	$1,315	$11,673	$0	$12,988
Total Salaries, Wages and Fringe Benefits	$22,992	$31,473	$0	$54,465
Nonexpendable Equipment	$0	$0	$0	$0
Materials and Supplies	$14,686	$3,064	$0	$17,750
Travel	$2,000	$4,000	$0	$6,000
All Other Direct Costs	$0	$1,000	$0	$1,000
TOTAL PROJECT COSTS	$39,678	$39,537	$0	$79,215

Year 2

	PURDUE	SIUC	ISU	TOTALS
Salaries and Wages	$22,238	$20,400	$4,320	$46,958
Fringe Benefits	$1,401	$11,748	$1,024	$14,173
Total Salaries, Wages and Fringe Benefits	$23,639	$32,148	$5,344	$61,131
Nonexpendable Equipment	$0	$0	$0	$0
Materials and Supplies	$14,683	$3,065	$656	$18,404
Travel	$2,000	$4,000	$3,000	$9,000
All Other Direct Costs	$0	$1,250	$1,000	$2,250
TOTAL PROJECT COSTS	$40,322	$40,463	$10,000	$90,785

SCHEDULE FOR COMPLETION OF OBJECTIVES

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

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

Objective 3: Initiated and completed in Year 2.

LIST OF PRINCIPAL INVESTIGATORS

Paul B. Brown, Purdue University

Christopher C. Kohler, Southern Illinois University-Carbondale

Joseph E. Morris, Iowa State University

VITA

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Purdue University
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EDUCATION

B.S. University of Tennessee, 1980, Wildlife and Fisheries Sciences
M.S. University of Tennessee, 1983, Aquatic Animal Nutrition
Ph.D. Texas A&M University, 1987, Aquatic Animal Nutrition

POSITIONS

Professor (1997-present), Associate Professor (1993-1997), and Assistant Professor (1989-1993), Aquaculture, Purdue University

SCIENTIFIC AND PROFESSIONAL ORGANIZATIONS

American Society of Nutritional Sciences
Society for Comparative Nutrition
World Aquaculture Society

SELECTED PUBLICATIONS

Kasper, C.S., and P.B. Brown. 2003. Growth improved in juvenile Nile tilapia fed phosphatidylcholine. North American Journal of Aquaculture 65:39-43.

Wan, P., C.R. Santerre, P.B. Brown, and D.C. Deardorff. 2003. Chlopyrifos residues before and after cooking of catfish fillets. Journal of Food Science 68:12-15.

Gould, N.L., M.M Glover, L.D. Davidson, and P.B. Brown. 2003. Dietary flavor additives influence consumption of feeds by yellow perch, *Perca flavescens*. Journal of the World Aquaculture Society 34:412-417.

Pangle, K.L., T.M. Sutton, and P.B. Brown. 2003. Evaluation of practical and natural diets for juvenile lake herring. North American Journal of Aquaculture 65:91-98.

Twibell, R.G., K.A. Wilson, S. Sanders, and P.B. Brown. 2003. Evaluation of experimental and practical diets for bluegill (*Lepomis macrochirus*) and hybrid bluegill (*L. cyanellus* × *L. macrochirus*). Journal of the World Aquaculture Society 34:487-495.

Twibell, R.G., M.E. Griffin, B. Martin, J. Price, and P.B. Brown. 2003. Predicting dietary essential amino acid requirements for hybrid striped bass. Aquaculture Nutrition 9:373-382.

Brown, P.B., K.A. Wilson, Y. Jonker, and T.E. Nickson. 2003. Glyphosate-tolerant canola meal is equivalent to the parental line in diets fed to rainbow trout. Journal of Agricultural and Food Chemistry 51:4268-4272.

Kasper, C.K., M.R. White, and P.B. Brown. 2002. Betaine can replace choline in diets fed to juvenile Nile tilapia, *Oreochromis niloticus*. Aquaculture 205:119-126.

Twibell, R.G., B.A. Watkins, and P.B. Brown. 2001. Dietary conjugated linoleic acids and lipid source alter fatty acid composition of juvenile yellow perch, *Perca flavescens*. Journal of Nutrition 131:2322-2328.

VITA

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Fisheries & Illinois Aquaculture Center
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Carbondale, IL 62901-6511

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EDUCATION

B.S. St. Mary's College of Maryland, 1973, Biology
M.S. University of Puerto Rico, 1975, Aquaculture
Ph.D. Virginia Tech, 1980, Fisheries

POSITIONS

Professor (1993-present) and Director (1999-present), SIUC Fisheries and Illinois Aquaculture Center
Associate Professor (1989-1993), Assistant Professor (1986-1989), and Senior Scientist (1980-1986), SIUC Department of Zoology

SCIENTIFIC AND PROFESSIONAL ORGANIZATIONS

American Fisheries Society (President, Fish Culture Section, 1999 – 2000; AFS 2nd Vice President-President, 2002-2006)
World Aquaculture Society

SELECTED PUBLICATIONS

Wonnacott, E.J., R.L. Lane, and C.C. Kohler. In press. Influence of dietary replacement of menhaden oil with canola oil on fatty acid composition of sunshine bass. North American Journal of Aquaculture.

Kelly, A.M., and C.C. Kohler. 2003. Utilization of Micro-Aid (*Yucca* sp.) as a feed additive for channel catfish *Ictalurus punctatus* and the tilapia hybrid *Oreochromis mossambicus* × *O. niloticus*. Journal of the World Aquaculture Society 34:156-161.

Kelly, A.M., C.C. Kohler, and D.M. Hughes. 2002. Menhaden meal in practical diets for channel catfish fry and fingerlings reared in indoor recirculating systems. North American Journal of Aquaculture 64:290-293.

Kohler, C.C., R.J. Sheehan, J.J. Myers, J.B. Rudacille, M.L. Allyn, and A.V. Suresh. 2001. Performance comparison of geographic strains of white bass to produce sunshine bass. Aquaculture 202:351-357.

Kohler, C.C. 2000. Striped bass and hybrid striped bass culture. Pages 898-907 *in* R.R. Stickney, editor. Encyclopedia of Aquaculture. John Wiley & Sons, Inc., New York.

Rudacille, J.R., and C.C. Kohler. 2000. Aquaculture performance comparison of sunshine bass, palmetto bass, and white bass. North American Journal of Aquaculture 62:114-124.

Kelly, A.M., and C.C. Kohler. 1999. Cold tolerance and fatty acid composition in striped bass, white bass, and their hybrids. North American Journal of Aquaculture 61:278-285.

Kelly, A.M., and C. C. Kohler. 1996. Sunshine bass performance in ponds, cages, and indoor tanks. The Progressive Fish-Culturist 58:55-58.

Brecka B.J., C.C. Kohler, and D.H. Wahl. 1995. Effects of dietary protein concentration on growth, survival, and body composition of muskellunge and tiger muskellunge fingerlings. Journal of the World Aquaculture Society 26:416-425.

VITA

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EDUCATION

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

POSITIONS

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

SCIENTIFIC AND PROFESSIONAL ORGANIZATIONS

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

SELECTED PUBLICATIONS

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

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

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

Mischke, C. C., G. Dvorak, and J. E. Morris. 2001. Comparison of growth and survival of hybrid larval sunfish in the laboratory under different feeding regimes. The North American Journal of Aquaculture 63: 265-271.

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

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

Mischke, C.C., and J.E. Morris. 1998. Sunfish (*Lepomis* spp.) culture. NCRAC Video Series, #104, NCRAC Publications Office, Iowa State University, Ames.

Mischke, C.C., and J.E. Morris. 1998. Growth and survival of larval bluegills in the laboratory under different feeding regimes. Progressive Fish-Culturist 60:206-213.

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

Bryan, M.D., J.E. Morris, and G.J. Atchison. 1994. Methods for culturing bluegill in the laboratory. Progressive Fish-Culturist 56:217-221.