HYBRID STRIPED BASS AQUACULTURE

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

Industry Advisory Council Liaison: Forrest Williams, Bay Port, Michigan

Extension Liaison: Joseph E. Morris, Iowa State University

Funding Request: $310,000

Duration: 3 Years (September 1, 2001- August 31, 2004)

Objectives:

1. Marketing

    a. Investigate and document current and potential demand (prices and quantities) for hybrid striped bass (live and processed), clearly identifying consumer groups, processors, and distributors by location, seasonality of demand, size preferences, unique demand attributes, i.e., "healer fish" in Chinese culture, and impact of increased supplies on market prices of hybrid striped bass and competitive species.
    b. Estimate the processing and distribution costs (supply chain costs and margins) to derive expected "farm gate live weight" prices as a function of producer and consumer locations.
    c. Conduct limited taste testing on hybrid striped bass to determine the effect of different feed rations.
    d. Develop a Web page that would be a component of the NCRAC Web site that would provide analysis results to clientele quickly and to allow easy updates.
    e. Design and investigate willingness of hybrid striped bass producers to become a part of a current market information system.

2. Compare phase III production parameters and feed costs of hybrid striped bass/sunshine bass (female white bass × male striped bass) in ponds and recirculating aquaculture systems using commercially available diets (32, 36, and 40% protein) in a minimum of two locations (three feed treatments/location), with 100 g ± 20 g phase III fish (minimum of three replications/treatment), in ponds at least 0.04 ha (0.1 acre), with a stocking density of 7,413 fish/ha (3,000 fish/acre), or in tanks at least 1,893 L/tank (500 gal/tank) with a 60 g/L (0.5 lb/gal) at harvest loading density. A need also exists to identify cost-effective, commercial available diets for phase III production.

Proposed Budgets:

Institution	Principal Investigator(s)	Objec-tive	Year 1	Year 2	Year 3	Total
North Dakota State University	William C. Nelson	1	$13,650	$22,487	$23,863	$60,000
Purdue University	Paul B. Brown	2	$39,000	$35,000	$38,000	$112,000
Southern Illinois University-Carbondale	Christopher C. Kohler	2	$45,393	$46,213	$46,394	$138,000
		Totals	**$98,043**	**$103,700**	**$108,257**	**$310,000**

Non-funded Collaborator:

Facility	Collaborator
Genesis, Inc., Cedar Rapids, Iowa	David LaBomascus

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JUSTIFICATION

The North Central Regional Aquacultre Center (NCRAC) Industry Advisory Council (IAC) identified hybrid striped bass to be a priority for development in the region. Based on a white paper (Kohler 2000b) developed at NCRAC request and with IAC input, the IAC recommended that research be conducted to determine the feasibility of raising hybrid striped bass to market size in both earthen ponds and in indoor water recirculating systems. Also held to be a high priority is the identification of economical feeds, specifically, can lower protein levels than those in current commercial practice be successfully used during second-year (phase III) grow out? Various marketing concerns were also prioritized. This proposal represents the efforts of a work group selected by a Peer Review Committee that evaluated statements of interest addressing NCRAC's call for such statements for conducting this research.

The identification of the hybrid striped bass as a candidate for commercial aquaculture development in the North Central Region (NCR) is appropriate because: (1) the fish has been identified by the IAC as a high priority species, (2) a number of fish farmers are producing this fish, and (3) much of the southern half of the region is at approximately the same latitude and has about the same seasonal water temperature conditions as the mid- and southern Atlantic states where hybrid striped bass culture is being pursued.

Hybrid striped bass is a cross between the anadromous striped bass *Morone saxatilis*, which is native to the east coast of North America, and the white bass *M. chrysops*, which is native to the Mississippi drainage (Hodson 1995; Harrell 1997). Both species have been widely introduced elsewhere. The resulting hybrid is similar in appearance to the parental stock but, due to hybrid vigor, possesses superior traits for aquaculture. For example, hybrids grow faster in the first two years of life, readily adapt to dry formulated feeds, and are more resistant to diseases than their parentals. The original cross, produced by Bob Stevens in 1965, is referred to as the palmetto bass. It is a cross between the female striped bass and the male white bass. The female striped bass reaches sexual maturity in the wild at five to seven years of age and will weigh in excess of ten pounds. The male white bass, on the other hand, reaches sexual maturity at one to two years of age and will weigh less than two pounds. The reciprocal cross is referred to as the sunshine bass. It is a cross between the male striped bass and the female white bass. Both of these fishes reach sexual maturity at two to three years of age, and both fish will weigh two pounds or less when they first reach sexual maturity. Due to the difficulty in obtaining and maintaining large female striped bass brood stock, over 80% of the hybrid striped bass produced in the U.S. are the reciprocal cross (sunshine bass).

Hybrid striped bass have been increasing in popularity since first being produced in 1965 (Van Olst and Carlberg 1990). It was initially used for stocking reservoirs as a sport fish, a purpose for which it is still used to this day (Kohler 2000a). Hybrids began to be raised as a food fish in aquaculture by the mid-1980s. By 1990, over 453,600 kg were produced. This figure rose to 2,721 kg by 1993 and to the neighborhood of a little over 4.5 million kilograms today. It is one of the fastest growing aquaculture sectors in the nation. The high interest in hybrid striped bass aquaculture has corresponded with the precipitous decline of the wild striped bass commercial fishery. Although the striped bass fishery has rebounded in recent years, the demand for the hybrid as a food fish continues to grow.

Sunshine bass is the principal cross being produced in the NCR. They are raised in earthen ponds, indoor recirculating aquaculture systems (RASs), and cages in existing farm ponds (Kelly and Kohler 1996). Hybrid striped bass pond grow out is described in three phases. Phase I is from fry to 2.5-cm fingerlings; phase II is fingerling to a 15-cm juvenile; and phase III is a 15-cm juvenile to market size (~680 g). Phases I and II occur during Year 1 and phase III during Year 2. Accordingly, pond grow out occurs over 18 months. Market-size fish can be raised in less than 12 months when the fish are raised in temperature-controlled indoor systems. Cage culture is generally limited to phases II and III. The time element will be identical to fish grown in culture ponds. Only a few NCR aquaculture enterprises spawn their own fry. Fry and/or fingerlings are mostly purchased from producers in Arkansas (Posadas and Homziak 1991).

The FOB farm price was $2.53 for fresh product and $3.06 for live product in 1997 (Kahl 1997). These prices have held steady, but could decline once hybrid striped bass production approaches 5.9 million kilograms as projected for year 2000.

Wholesalers and retailers have an overwhelming preference for fresh rather than frozen hybrid striped bass. Wholesalers prefer whole fish, gutted fish, and skin-on fillets (in that order) while retailers prefer gutted fish, whole fish, and skin-off fillets (Kahl 1997). Both wholesalers and retailers were also reported to prefer whole hybrid striped bass between 680 and 900 g and fillets between 170 and 225 g. About 75–80% of the product

is sold as iced whole fish, 10–15% is sold live, and 5% is processed into fillets (Rawles et al. 1997). Kahl (1997) found that the NCR appears to be the most receptive region for marketing hybrid striped bass to wholesalers. She found the NCR to have the largest percentage of wholesalers selling hybrid striped bass (50%), and the largest percentage of non-sellers (80%) expressing some interest in selling hybrid striped bass in the future.

Seafood is a distant fourth among meat and poultry products, less than 10% of the total U.S. consumption of beef, pork, lamb, seafood, and poultry products (USDA/ERS). Although consumption of seafood has been increasing since the 1970s, it still lags behind chicken, beef, and pork. The National Fisheries Institute set a goal of 9.1 kg per capita consumption by the year 2000, however the latest data show that seafood averaged only 6.8 kg per capita from 1990 to 1996 (Hanson et al. 1995; Hatch and Hanson 2000). Hybrid striped bass is not listed among the top ten fish and seafood products in 1998 (Hatch and Hanson 2000).

Expansion of research on production and encouragement to expand production levels needs to explicitly consider the current and potential markets for the product. Hybrid striped bass has enjoyed relatively high prices in the past (Kohler 2000b), however, this has been at low levels of production. It is unknown what the impact of substantially increased supplies will have upon price. This concept, known as the price elasticity of demand, is extremely useful in making decisions that will expand future supplies. For example, expansion of supply of a product with inelastic demand will decrease price so significantly that the total revenue in the industry will decline.

Knowledge of the relationship of each of the determinants of demand is important. The degree of substitutability with other fish species, the impact of increasing consumer incomes, changes in population, and changes in consumer tastes and preferences all have an impact upon future demand. The catfish industry has been considered one of the success cases in the U.S., however the "real" price (adjusted for inflation) has been declining since the late 1980s (USDA/ERS). This indicates that supply has been increasing more rapidly than demand. The cost/price squeeze has led to a decline in the number of producers even though production levels continue to rise (USDA/ERS).

The American consumer has more choices in the supermarket than ever before. The nearly infinite number of choices means the consumer really is king. Therefore, it is essential to estimate consumer behavior as accurately as possible prior to major changes in the production/processing/marketing system.

Producers also need accurate current market information to make profitable production and marketing decisions. They need information on recent and current prices paid, transportation costs, timing and location of sales, etc. There is no public or private information system which currently provides that information for specific species.

Early diets for hybrid striped bass were basic trout or salmon formulations. Because of the relatively high dietary crude protein and essential amino acid needs of salmonids, those diets generally contain a higher concentration of fish meal and are more expensive than diets formulated with lower levels of crude protein such as those for catfish and tilapia. In the early stage of hybrid striped bass culture, no nutritional requirements had been quantified and it was impossible to formulate diets that met the verifiable needs of the target species. However, given the carnivorous nature of *Morones*, this was a logical beginning. Sufficient information has been developed in the past 10 years that reevaluation of the optimal dietary crude protein is warranted. Further, there are very few recommendations for optimal dietary crude protein for the various life history stages of hybrids.

The hybrid striped bass industry has displayed impressive growth throughout the 1990s. However, little of this growth has occurred in the NCR despite reports (Kahl 1997) indicating that the region's fish wholesalers are highly receptive to the product. NCR producers are clearly geographically positioned to capitalize on the huge market potential of the region. Past NCRAC-supported research has yielded several advances for hybrid striped bass aquaculture.

RELATED CURRENT AND PREVIOUS WORK

As noted previously, hybrid striped bass is a minor player in the seafood industry. Therefore, it is not surprising that a comprehensive source of market information on this fish is not available or that there are relatively few market analyses published. The last study identified that focused on hybrid striped bass marketing was published by Kahl in 1997. Kahl (1997) found substantial interest by distributors in expanded

supplies of hybrid striped bass. However, this is somewhat suspect as distributors will almost always indicate interest in expanded supplies as it is in their self-interest to have additional choices of suppliers and supplies. Retailers and wholesalers rated high price as the most and second-most important disadvantages, respectively, of farm-raised fish. This clearly indicates some sensitivity to price.

The recently published review of "Market Issues in the United States Aquaculture Industry" by Hatch and Hanson did not even mention hybrid striped bass (Hatch and Hanson 2000). The authors did mention several important issues in marketing of aquaculture products. First, successful production, processing, and marketing requires a minimum level of supplies to be successful. Economies of size at the processing and marketing levels are much higher than at the production level, therefore, a substantial number of producers are required to successfully develop the processing and marketing functions. An excellent example in progress is the move of Southern States Cooperative into the processing of tilapia and marketing a consumer-ready fillet simultaneously with the encouragement and support to expand the number of member producers (W.A. Boutwell, Southern States Cooperative, Richmond, Virginia, personal communication).

Hatch and Hanson (2000) do mention two very important economic concepts: comparative advantage and elasticity of supply and demand. Application of the concept of comparative advantage to hybrid striped bass means that the returns to the resources used in the production, processing, and marketing of hybrid striped bass must be greater than the opportunity cost (returns from the next best use of resources), or it will not be a successful enterprise.

The concept of price elasticity of supply and demand is extremely important to analyzing the potential of the hybrid striped bass industry. Price elasticity is a measurement of the percent response of quantity, either supplied by producers or bought by consumers, to a 1% change in the price. It is a measure of producer and consumer market behavior. To maintain a healthy, growing, and profitable industry, one would prefer a relatively price inelastic supply (less than 1.0) and demand plus a growing general demand for hybrid striped bass. This would lead to increasing real prices for the product and increasing profits in the industry. In other words, supplies would increase quite slowly, aggregate demand more rapidly, and real prices increase without a corresponding decrease in quantity demanded. An inelastic demand without an expansion of demand (shift in the demand) will lead to decreased prices.

A significant inverse relationship was found between the seasonal supply of walleye and the price paid by wholesalers (Riepe 1998). Price paid in the high supply months of April through October was only one-third of the price during the low seasonal supply period. Supply in the high period was nearly four times the supply available during the low months. This relationship clearly indicates a strong inverse relationship between seasonal supply and wholesale price paid. A cojoint statistical analysis of the relationship of retailer preferences and price indicated a clear and strong negative relationship between price and preference for tilapia and catfish (Halbrendt et al. 1995). Salmon and trout also exhibited a negative relationship, but not to the same degree. This study also found that even though real prices of catfish declined from nearly $11.00/kg in 1987 to less than $4.40/kg in 1994, consumption did not respond in a similar degree. This is characteristic of a product with a very inelastic demand.

A trend analysis of consumption and price reveal similar results (Hanson et al. 1995). The Consumer Price Index of seafood rose nearly twice as rapidly as poultry and beef from 1985 to 1993 and consumption per capita actually decreased. Most fish species have been found to have inelastic demand with respect to price and positive elastic demand with respect to income (Wellman 1992). The implication is that knowledge of price elasticity of demand enables one to predict the impact of supply changes on total revenue to the producers, and knowledge of the supply elasticity enables one to predict how producers will react to lower or higher prices.

Price is only one of the determinants of demand and supply (Seperich et al. 1994). Other determinants of demand are: (1) incomes, (2) size of the relevant population, (3) tastes and preferences of the consumers, (4) prices of competitive products, and (5) seasonality. Other determinants of supply are: (1) costs of resources used; (2) alternative uses and returns for those resources, (3) number of producers in the industry; (4) barriers to entry, and (5) expectations of future costs and selling prices. Knowledge of the direction and rate of change of each of these factors is needed to accurately predict the future of the industry.

Gempesaw studied examples of nonprice factors. Farm-raised, a preference, was a positive nonprice attribute found for hybrid striped bass (Gempesaw et al. 1995). Consumption of other fish, such as salmon and trout, also increased the probability that the consumer would also purchase hybrid striped bass. Nonprice factors

found to be important to wholesalers and retailers were consistency in supply, quality, size, and price (Kahl 1997).

In the most recent NCRAC-sponsored study, researchers at Southern Illinois University-Carbondale (SIUC) obtained white bass brood stock from three locations in the U.S. encompassing the native range of this species: Arkansas River, Arkansas; Lake Erie, near Cleveland, Ohio; and Lake Poinsett, South Dakota. In spring 1996, white bass eggs of each strain were fertilized with fresh semen from the same strain or with extended striped bass semen pooled from nine males collected from the Arkansas River. Each strain of white bass and sunshine bass was stocked at 500,000/ha as 4-day posthatch larvae into recently filled and fertilized earthen ponds (triplicated for white bass and quadruplicated for sunshine bass). The fish were offered salmonid fry meal (~50% crude protein) 21-days poststocking. Phase I fingerlings were harvested ~40-days poststocking. Sunshine bass mean survival rates (12.5%) were significantly higher than white bass (2.6%). No differences in survival rates existed within the white bass or sunshine bass groups. Phase II sunshine bass were subsequently stocked in triplicated ponds at 25,000/ha. The fish were fed to satiation twice daily with a 40% crude protein salmonid diet and harvested 100-days poststocking. Lake Erie sunshine bass mean weights (90.2 g) were significantly greater than Arkansas fish (58.4 g), but not South Dakota fish (69.0 g). Phase III sunshine bass were stocked in late autumn 1996 in quadruplicated po nds at 4,900/ha and fed beginning the next spring in the same manner as in Phase II. In autumn 1997, ponds were harvested and all fish reached marketable size with Lake Erie sunshine bass averaging 648 g, followed by Arkansas fish at 636 g, and South Dakota fish at 566 g. These weights were not significantly different ($P > 0.05$). However, Lake Erie and South Dakota fish had significantly ($P < 0.05$) higher dress outs (37.3% and 37.8%, respectively) than Arkansas fish (34.6%). These results provide evidence for the feasibility of raising sunshine bass to market size in earthen ponds in the NCR. Lake Erie white bass might offer some advantage as a source of brood fish relative to the strains compared and under the conditions in which they were raised in this study.

Sunshine bass have recently been shown to grow faster than palmetto bass in an indoor RAS (Rudacille and Kohler 2000) and to be more tolerant to salinity changes (Myers and Kohler 2000).

Dietary formulations have been continually modified as nutritional requirements were quantified and alternative feedstuffs evaluated. To date, quantitative requirements for lysine (Griffin et al. 1992), methionine (Griffin et al. 1994a), arginine (Griffin et al. 1994b), threonine (Keembiyehetty and Gatlin 1997), phosphorus (Brown et al. 1993a), and choline (Griffin et al. 1994c) have been published. Additionally, the remaining essential amino acids (EAA) have been predicted from the quantified requirements and whole body EAA profiles (Brown 1993). In a recently completed study at Purdue University (Purdue), weight gain and feed conversion ratio of juvenile hybrid striped bass fed a crystalline amino acid diet containing the predicted requirements was not significantly different from fish fed a fish meal control diet (unpublished data). A large percentage of the cost associated with diets is the feedstuffs supplying EAA. Once requirements are quantified, evaluation of ingredients can begin in a systematic manner.

Brown et al. (1997) reported that juvenile hybrid striped bass tolerated a higher percentage of solvent-extracted soybean meal than roasted or raw soybeans. The maximum level of incorporation was 30% of the diet using a supplemental mineral premix and up to 40% of the diet using a complete mineral premix. Other feedstuff evaluations are underway.

Optimal level of dietary crude protein can be affected by a number of factors including production system, age of fish, EAA balance, ratio of energy to protein, and stocking density. There have been a few studies examining the optimal dietary crude protein concentration for hybrid striped bass. Brown et al. (1993b) reported that juvenile hybrids fed a series of practical diets grew as well when fed 36% crude protein as they did when fed higher levels. Swann et al. (1994) found that phase III hybrids grew best when fed 36% dietary crude protein compared to 32 or 40% in a laboratory setting. However, Gatlin et al. (1994) recommend 40% dietary crude protein and many commercial producers prefer 40–44% dietary crude protein.

Higher dietary crude protein concentrations tend to increase the cost of feeds. If it can be demonstrated that lower levels of dietary crude protein result in the same weight gain as higher levels, commercial producers will realize significant savings in feed costs without sacrificing time to market or quality characteristics. Given that researchers have a better understanding of the critical nutritional requirements of the hybrid, demonstration of this concept has a real chance of being successful.

ANTICIPATED BENEFITS

Field scale evaluations of the type requested by the IAC and proposed in these studies will provide realistic results that are directly applicable to commercial producers. Further, the expected quality of the final product can be assessed for marketing purposes. The dietary formulations used in these studies will also be available for producers to take to their feed mills. Results from studies conducted at Purdue and SIUC will allow for some relative comparisons between experimental and current commercial diets. The studies will be conducted in highly replicated, commercially-simulated experimental designs. Feeds are typically the largest component of annual variable costs in aquaculture operations and any modification can improve overall farm production characteristics. More importantly, there are new formulations that can be manufactured in the NCR, yet those formulations have not been tested in larger scale pond production systems. This project will result in data that should be immediately useful in the NCR. These studies will also clearly demonstrate the commercial feasibility and potential for raising hybrid striped bass in the NCR.

Businesses do not survive without being proficient in marketing and sales. The five sub-objectives of the marketing analysis are intended to provide historical and current information to assist producers in making production and marketing decisions. The first two sub-objectives provide historical and current information on the consumer and marketing industry perspective of hybrid striped bass to the producer. The benefit of the third sub-objective is to determine the influence of diets upon consumers' perception of taste, mouth feel and appearance of hybrid striped bass. Evaluations of diets are based upon efficiency, effectiveness, and consumer acceptance of the product. The fourth sub-objective will improve producer access to current information via a homepage containing output from this project, other studies and links to other relevant pages. A producer owned and controlled current market information organization can provide each member producer with current market information to identify the "best" markets, improve price negotiating ability and to plan production and marketing cycles. It can also be a precursor to a producer owned bargaining organization. National producer owned marketing organizations such as SunKist and Ocean Spray began in this fashion. The last sub-objective is to determine if producers of hybrid striped bass are interested in forming this type of marketing organization.

OBJECTIVES

1. Marketing

    a. Investigate and document current and potential demand (prices and quantities) for hybrid striped bass (live and processed), clearly identifying consumer groups, processors, and distributors by location, seasonality of demand, size preferences, unique demand attributes, i.e., "healer fish" in Chinese culture, and impact of increased supplies on market prices of hybrid striped bass and competitive species.
    b. Estimate the processing and distribution costs (supply chain costs and margins) to derive expected "farm gate live weight" prices as a function of producer and consumer locations.
    c. Conduct limited taste testing on hybrid striped bass to determine the effect of different feed rations.
    d. Develop a Web page that would be a component of the NCRAC Web site that would provide analysis results to clientele quickly and to allow easy updates.
    e. Design and investigate willingness of hybrid striped bass producers to become a part of a current market information system.

2. Compare phase III production parameters and feed costs of hybrid striped bass/sunshine bass (female white bass × male striped bass) in ponds and recirculating aquaculture systems using commercially available diets (32, 36, and 40% protein) in a minimum of two locations (three feed treatments/location), with 100 g ± 20 g phase III fish (minimum of three replications/treatment), in ponds at least 0.04 ha (0.1 acre), with a stocking density of 7,413 fish/ha (3,000 fish/acre), or in tanks at least 1.83 L/tank (500 gal/tank) with a 60 g/L (0.5 lb/gal) at harvest loading density. A need also exists to identify cost-effective, commercial available diets for phase III production.

PROCEDURES

Current and Potential Demand Prices (Objective 1a)

North Dakota State University (NDSU)

1. Conduct a comprehensive review of published information on the markets (historical price and quantity information) and the consumer, distributors, processors, and producers in the industry. Statistical information prices and quantities will also be collected for related species to test the hypothesis: Is the demand for hybrid striped bass unique or does it follow the same trends as other related (as defined by consumers) fish?

2. Conduct a mail survey of processors and distributors to determine size preferences, unique demand characteristics, and impact of increased supplies.

3. Conduct statistical analyses to estimate the relationship of hybrid striped bass prices to other related fish. This also will estimate the probable impact of increased supplies of hybrid striped bass upon market prices.

Estimating Processing and Distribution Costs (Objective 1b)

NDSU

The "law of one price" states that the price is determined by supply and demand at the consumer level and that the price received by lower components of the supply chain is the consumer level price minus costs and profits earned by those components higher on the supply chain (Seperich et al. 1994). For example, the price received by a processor will be the consumer market price minus costs and profits taken by retailers and distributors between the processor and the consumer. In a market economy, there will also be economic pressures to move price toward this value.

The research effort is to estimate the consumer price paid and the margin between each level in the supply chain. It can be as simple as determining the price at each transaction level and assuming the price difference reflects the costs and profits for that firm, or as complicated as developing detailed estimates of costs and required rate of return for each firm by their step in the supply chain. In this study, the simpler approach of discovering the prices at each transaction level in the chain will be taken. This approach is primarily selected due to substantial differences in research costs, and the belief that U.S. markets do operate quite freely and competitively which will result in price margins that accurately reflect true cost and profit margins. Therefore, transaction prices will be gathered by survey, observation, and publicly available data.

Taste Testing (Objective 1c)

NDSU

This objective will be coordinated closely with SIUC and Purdue. The number of tests conducted will depend upon the number of significantly different feed rations used. Blind taste, texture, color, and mouth feel will be conducted under controlled conditions with representative samples of selected populations. To compare acceptance of hybrid striped bass with different rations/production conditions relative to other fish, fillets of each sample will be baked in a 163°C oven in plastic oven bags placed in a glass dish. Fillets from each sample will be divided and each panelist will be given a sample of each fish to evaluate. Each of the participating organizations will conduct these tests to achieve regional diversity of the participants.

Develop a Web Page (Objective 1d)

NDSU

A Web page will be developed to centralize the information on hybrid striped bass production, marketing, consumption, etc. on a "one-stop shopping center" for the industry. This will be part of the NCRAC Web site and be linked to other aquaculture sites throughout the world.

Current Market Information System (Objective 1e)

NDSU

A Web-based current market information system will be designed and placed on the Internet to demonstrate the potential system and provide an example for producers. This system will allow input of market information by members of a closed market information cooperative, analysis and manipulation of the information, and access to the information by all members. It would place all members of the cooperative on an equal basis with respect to information, however, it would not control or limit individual marketing actions by the members. It would require of each member that they provide accurate and timely information to the system of market transactions. In this fashion, each member would have access to current (less than 24 h old) information, and allow them to make more informed and intelligent marketing decisions. Information required from members will include price per unit received from their last sale, average size per fish, quantity, form of fish sold (live, gutted, fillets, etc.), and location attributes (on site, delivered, transportation costs, etc.).

Market information has value; this research component will discover whether hybrid striped bass producers will place sufficient value on accurate and up-to-date marketing information to offset the cost of membership fees and the loss of confidentiality, i.e., sharing their market information with all other members.

Hybrid striped bass producers will be asked to review the Web site and the conditions for its operation prior to being interviewed. They will then be surveyed by telephone and Internet as to their willingness to become part of the information cooperative (or other legal entity). The survey will ask producers what information they are willing to share, prices, quantities, location and timing of sale, and buyers identification, etc. They will also be asked what cost they are willing to pay in order to be part of the system.

Production Parameters and Feed Costs (Objective 2)

Purdue

Prior to starting the formal studies, a laboratory-scale study will be conducted at Purdue using juvenile fish reared in 120-L glass aquaria. The purpose of this initial study is to define protocols for formulating the experimental diets in the larger scale experiments. Specifically, juvenile hybrid striped bass will be fed a series of diets in an incomplete 3 × 2 factorial experiment. The diets will contain 32, 36, or 40% crude protein, and the EAA concentrations will be either at the requirement (as a percent of the diet), or as a constant percentage of the crude protein. For example, the dietary lysine requirement of juvenile hybrid striped bass is 1.4% of the diet or 4.0% of the dietary protein in diets containing approximately 35% crude protein (Griffin et al. 1992). In the diets containing 32% crude protein, one will contain 1.4% lysine and the other will contain 1.28% lysine (32 × 0.04). There will be only one diet containing 36% crude protein and the lysine concentration will be 1.44% of the diet and 4.0% of the crude protein. The diets containing 40% crude protein will contain either 1.4 or 1.6% lysine (40 × 0.04). All other EAA will be adjusted similarly in this experiment and the protein to energy ratio will be maintained near optimal. While all EAA requirements for hybrid striped bass have not been quantified, they have been predicted (Brown 1993) and those values were recently demonstrated as appropriate (unpublished data). This study will be conducted by routine methods used at Purdue over the past 12 years and weight gain, feed conversion ratio, and survival will be used as response variables. Results from this study will be used to formulate diets in the larger-scale experiment.

Three separate, yet related, commercial-scale studies will be conducted at two distinct sites. Earthen culture ponds at Purdue will be used as well as recirculating tank culture systems at Genesis, Inc., Cedar Rapids, Iowa.

Juvenile hybrid striped bass will be acquired from commercial producers prior to starting the experiment and grown to the desired size of 100 g at each site. The projected start date for this project is September 2001; thus, fish will be acquired in June or July of 2001. It is anticipated the experiment at Genesis will begin in October of 2001, or when fish are of the desired size, and in the spring of 2002 at Purdue. In the pond culture experiment, two growing seasons for the first evaluation are anticipated, while the first tank culture study may be completed by May-June of 2002. All fish will be grown to market size (~0.7 kg). Fish will be sampled at 2-month intervals to monitor growth and develop growth curves for each production system.

In the pond culture studies at Purdue, fish will be randomly stocked into nine, 0.1-ha earthen culture ponds at densities of 750 fish/pond, which is equivalent to ~7,500 fish/ha. Assuming a final individual weight of 680

g and complete survival, final density will be ~5,100 kg/ha, which is near the densities used by many producers of this hybrid. Three dietary treatments will be randomly assigned to triplicate groups of fish. Diets will contain 32, 36, or 40% crude protein. All fish will be fed to satiation once daily at approximately 10:00.

Prior to feeding, water quality parameters will be monitored. Dissolved oxygen and temperature will be monitored daily with a dissolved oxygen meter. Ammonia- and nitrite-N will be monitored daily at the beginning of the experiment, then weekly if levels are considered acceptable. Hardness and alkalinity will be monitored weekly. A HACH DREL-1C water quality test kit will be used for monitoring critical parameters.

In the recirculating system experiment at Genesis, fish will be randomly stocked into one of nine existing recirculating systems equipped with a rotating drum solids filter and a trickle filter. Initial stocking density will be 1,700 fish/tank with each culture tank containing 13,250 L. Assuming final individual fish weight of 680 g and complete survival, final density will be approximately 0.09 kg/L. All fish will be fed daily to satiation. Temperature will be maintained at 26–28°C and low level of light will be maintained 24 h/day. The same water quality variables and schedule for sampling will be used in this portion of the study as in the pond portion of the study except that ammonia- and nitrite-N will be monitored daily.

At the end of both studies, personnel from Purdue will harvest, count, and weigh all fish in each replicate for calculation of weight gain, feed conversion ratio, specific growth rate, and survival. Additionally, a subsample of fish will be collected for determination of dress-out percentages. Heads-on eviscerated weights and fillet weights will be expressed as a percentage of whole fish weight using methods described by Swann et al. (1994). Proximate composition of fillets from each replicate will be determined at Purdue using standard methods for fat (Folch et al. 1957) and crude protein, ash, and moisture (Helrich 1990).

Using the data developed in the first laboratory study, as well as ongoing research funded by other groups, the three diets used in the first experiment will be formulated at Purdue and each will contain some minimal concentration of fish meal as a flavor additive (Brown et al. 1993b). Other ingredients will be soybean meal, corn grain, wheat midds, and trace mineral and vitamin premixes, including ascorbic acid polyphosphate. All formulations will be provided to a reputable commercial feed mill for extrusion. Past studies with rainbow trout have used Wenger, Inc. (Sabetha, Kansas), but the volume needed for these studies may be in excess of their capacity. Integral Fish Foods, Grand Junction, Colorado has also extruded diets for Purdue in the past. Once extruded, diets will be shipped to the respective sites and stored under cool, dry conditions. Proximate composition of all diets will be determined at Purdue using the same methods described above for fillets. A need for 3–4 batches of feed for each study period is anticipated. Proximate composition of all feeds will be monitored upon arrival.

A second study will be conducted in the third year of this project, and will build upon the results from the first experiment. At both sites, the same numbers of fish will be acquired, raised to the desired size, and stocked into their respective production systems as described above, and the experiment will be conducted as described above. It is not possible to specifically state the dietary treatments that will be used in the third year, but further refining the optimal dietary crude protein concentration for grow out of hybrid striped bass is anticipated. For example, if fish in one or both systems grow the same in the first study regardless of the dietary crude protein concentration, those levels may be reduced in the third year to 26, 30, or 34%. If growth continually increases in fish as dietary crude protein increases, then higher levels of crude protein may be fed than originally established, such as 38, 42, or 46%. These levels will be established in conjunction with the IAC of NCRAC as progress reports are presented.

All data will be statistically analyzed using the Statistical Analysis System. Accepted level of probability will be 0.05.

SIUC

In the pond studies, 10, 0.04-ha earthen ponds, each equipped with 1.0 HP electric paddlewheel aerators, will be stocked with 1,000 phase-II hybrid striped bass in Year 1. Fish will be fed to satiation twice daily with a 40% crude protein commercial feed. Fish will be harvested in late fall and redistributed for Year 2 phase III production at 300 fish/pond. Samples of fish will be measured for weights and lengths. Feed conversion ratio will be determined.

In Year 2, 15, 0.04-ha ponds, each equipped with 1.0 HP electric paddlewheel aerators, will be employed. Each will have been stocked with 300 phase III advanced fingerlings from the previous year. Each pond will

be randomly assigned one of three treatments: 32, 36, and 40% crude protein commercial diets, resulting in five replications per treatment. Fish will be fed to satiation twice daily. An additional 10 ponds will be started for phase II production to obtain phase III fish for Year 3 grow out. Phase II fish will be fed and harvested as described for Year 1.

In Year 3, phase III grow-out studies will be conducted with modifications to stocking rates and/or feed treatment with a goal to increase cost effectiveness based on the previous year's results. Phase III fish will be harvested in late fall of that year.

In the indoor water recirculating aquaculture system studies, 12, 1,900-L fiberglass tanks, along with one or more solids removers and biofilters combined into a single system will be employed. In Year 1, each tank will be stocked with 500 feed-trained phase II hybrid striped bass. Fish will be fed as described for phase II feeding in the pond studies until reaching phase III size (~100 g mean weight), whereupon density will be reduced to 200 fish/tank. Phase III fish will be fed as described for the pond study (three protein levels), but with four replications per treatment. Water temperature will be maintained at 25 ± 2°C. Studies will be repeated in Years 2 and 3, with modifications to density and/or diets to be more cost effective based on previous results.

Water quality variables (dissolved oxygen, temperature, pH, total ammonia, nitrite, carbon dioxide, alkalinity, and hardness) will be monitored routinely for both pond and indoor tank studies. Some market-size fish will be provided to the Illinois Fish Farmer's Cooperative for "real-world" marketing.

FACILITIES

Marketing (Objectives 1a-e)

NDSU

Facilities required for this objective are not as extensive as in the other objectives. NDSU will provide office space, access to computer facilities, Internet, and telephone services. In addition, it will provide the taste-testing laboratory for testing done on campus.

Production Parameters and Feed Costs (Objective 2)

Purdue

Purdue has a 715 m^2 wet laboratory and 12, 0.1 ha earthen ponds. Five experimental aquaria systems are in place and functional. A dedicated well, equipped with emergency generator, supplies water to the building. Water quality test kits and dissolved oxygen meters are in place. The chemistry laboratory contains, among other things, an analytical microwave for wet digestion of samples and Shimadzu doublebeam spectrophotometer, liquid chromatography system, soxhlet extractors, muffle furnace, and scintillation counter. Kjeldahl equipment is maintained on campus in departmental laboratories.

Genesis, Inc. is an existing commercial operation raising and marketing mainly tilapia. There are 36 systems of the size described for these studies, 12 larger grow-out systems, and numerous smaller systems. All water quality monitoring equipment is on site and used daily. Emergency electrical power is available.

SIUC

Pond studies will be conducted at SIUC's Touch of Nature pond facility. Twenty-five 0.04 ha ponds, each equipped with 1.0 HP electric paddlewheeel aerators, will be allocated. The site includes a large water retention pond, several deepwater wells, and all-weather roads. Graduate student living quarters, various storage facilities, and a tractor with a power-take-off paddlewheel are situated on the site.

A 929 m^2 indoor wet laboratory on the Carbondale campus houses several indoor water recirculating aquaculture systems. For this study, 12, 1900-L fiberglass tanks will be arranged as a single system to include one or more rotating drum solids removers and bead biofilters and/or fluidized bed biofilters. The system will be temperature controlled with constant aeration. Emergency oxygen will be available.

All laboratory equipment to monitor water quality and to conduct proximate analyses is available.

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PROJECT LEADERS

State	Name/Institution	Area of Specialization
Illinois	Christopher C. Kohler	Aquaculture
Indiana	Paul B. Brown	Aquaculture/Nutrtion
North Dakota	William C. Nelson	Agriculture Economics/Marketing

PARTICIPATING INSTITUTIONS AND PRINCIPAL INVESTIGATORS

North Dakota State University
William C. Nelson

Purdue University
Paul B. Brown

Southern Illinois University-Carbondale
Christopher C. Kohler

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

OMB Approved 0524-0022
Expires 5/31/98

BUDGET

ORGANIZATION AND ADDRESS Quentin Burdick Center for Cooperatives Morrill 301 North Dakota State University, Fargo, ND 58102				**USDA AWARD NO.** Year 1: Objective 1 Duration Proposed Months: 12	Duration Awarded Months:
PRINCIPAL INVESTIGATOR(S)/PROJECT DIRECTOR(S) William C. Nelson				**FUNDS REQUESTED BY PROPOSER**	**FUNDS APPROVED BY CSREES** (If Different)
A. Salaries and Wages 1. No. of Senior Personnel	**CSREES FUNDED WORK MONTHS**				$
	Calendar	Academic	Summer		
a. ___ (Co)-PI(s)/PD(s)					
b. ___ Senior Associates					
2. No. of Other Personnel (Non-Faculty) a. _1_ Research Associates-Postdoctorates	3.0			$10,500	
b. ___ Other Professional					
c. ___ Graduate Students					
d. ___ Prebaccalaureate Students					
e. ___ Secretarial-Clerical					
f. ___ Technical, Shop and Other					
Total Salaries and Wages . . . . . →				$10,500	
B. Fringe Benefits (If charged as Direct Costs)				$3,150	
C. Total Salaries, Wages, and Fringe Benefits (A plus B) . . . . . →				$13,650	
D. Nonexpendable Equipment (Attach supporting data. List items and dollar amounts for **each** item.)					
E. Materials and Supplies					
F. Travel 1. Domestic (Including Canada)					
2. Foreign (List destination and amount for each trip.)					
G. Publication Costs/Page Charges					
H. Computer (ADPE) Costs					
I. All Other Direct Costs (Attach supporting data. List items and dollar amounts. Details of subcontracts, including work statements and budget, should be explained in full in proposal.)					
J. Total Direct Costs (C through I) . . . . . →				$13,650	
K. 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.)					
L. Total Direct and Indirect Costs (J plus K) . . . . . →				$13,650	
M. Other . . . . . →					
N. Total Amount of This Request . . . . . →				$13,650	$
O. Cost Sharing (If Required Provide Details)	$5,596				

NOTE: Signatures required only for Revised Budget — This is Revision No. →

NAME AND TITLE (Type or print)	**SIGNATURE**	**DATE**
Principal Investigator/Project Director		
Authorized Organizational Representative		

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BUDGET

ORGANIZATION AND ADDRESS Quentin Burdick Center for Cooperatives Morrill 301 North Dakota State University, Fargo, ND 58102				**USDA AWARD NO.** Year 2: Objective 1	
				Duration Proposed Months: 12	Duration Awarded Months:
PRINCIPAL INVESTIGATOR(S)/PROJECT DIRECTOR(S) William C. Nelson				**FUNDS REQUESTED BY PROPOSER**	**FUNDS APPROVED BY CSREES** (If Different)
A. Salaries and Wages	**CSREES FUNDED WORK MONTHS**				$
1. No. of Senior Personnel	Calendar	Academic	Summer		
a. ___ (Co)-PI(s)/PD(s)					
b. ___ Senior Associates					
2. No. of Other Personnel (Non-Faculty)	4.0			$14,025	
a. _2_ Research Associates-Postdoctorates					
b. ___ Other Professional					
c. ___ Graduate Students					
d. _1_ Prebaccalaureate Students				$1,740	
e. ___ Secretarial-Clerical					
f. ___ Technical, Shop and Other					
Total Salaries and Wages →				$15,765	
B. Fringe Benefits (If charged as Direct Costs)				$4,382	
C. Total Salaries, Wages, and Fringe Benefits (A plus B) →				$20,147	
D. Nonexpendable Equipment (Attach supporting data. List items and dollar amounts for **each** item.)					
E. Materials and Supplies				$500	
F. Travel				$1,000	
1. Domestic (Including Canada)					
2. Foreign (List destination and amount for each trip.)					
G. Publication Costs/Page Charges					
H. Computer (ADPE) Costs					
I. All Other Direct Costs (Attach supporting data. List items and dollar amounts. Details of subcontracts, including work statements and budget, should be explained in full in proposal.) Postage ($240), Photocopying ($600)				$840	
J. Total Direct Costs (C through I) →				$22,487	
K. 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.)					
L. Total Direct and Indirect Costs (J plus K) →				$22,487	
M. Other →					
N. Total Amount of This Request →				$22,487	$
O. Cost Sharing (If Required Provide Details)	$9,220				

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BUDGET

ORGANIZATION AND ADDRESS Quentin Burdick Center for Cooperatives Morrill 301 North Dakota State University, Fargo, ND 58102				**USDA AWARD NO.** Year 3: Objective 1 Duration Proposed Months: 12	Duration Awarded Months:
PRINCIPAL INVESTIGATOR(S)/PROJECT DIRECTOR(S) William C. Nelson				**FUNDS REQUESTED BY PROPOSER**	**FUNDS APPROVED BY CSREES** (If Different)
A. Salaries and Wages	**CSREES FUNDED WORK MONTHS**				$
1. No. of Senior Personnel	Calendar	Academic	Summer		
a. ___ (Co)-PI(s)/PD(s)					
b. ___ Senior Associates					
2. No. of Other Personnel (Non-Faculty)	4.0			$14,576	
a. 2 Research Associates-Postdoctorates					
b. ___ Other Professional					
c. ___ Graduate Students					
d. 1 Prebaccalaureate Students				$1,740	
e. ___ Secretarial-Clerical					
f. ___ Technical, Shop and Other					
Total Salaries and Wages →				$16,316	
B. Fringe Benefits (If charged as Direct Costs)				$4,547	
C. Total Salaries, Wages, and Fringe Benefits (A plus B) →				$20,863	
D. Nonexpendable Equipment (Attach supporting data. List items and dollar amounts for **each** item.)					
E. Materials and Supplies				$500	
F. Travel				$2,500	
1. Domestic (Including Canada)					
2. Foreign (List destination and amount for each trip.)					
G. Publication Costs/Page Charges					
H. Computer (ADPE) Costs					
I. All Other Direct Costs (Attach supporting data. List items and dollar amounts. Details of subcontracts, including work statements and budget, should be explained in full in proposal.)					
J. Total Direct Costs (C through I) →				$23,863	
K. 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.)					
L. Total Direct and Indirect Costs (J plus K) →				$23,863	
M. Other →					
N. Total Amount of This Request →				$23,863	$
O. Cost Sharing (If Required Provide Details)	$9,784				

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Principal Investigator/Project Director		
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Form CSREES-55 (6/95)

BUDGET EXPLANATION FOR NORTH DAKOTA STATE UNIVERSITY

(Nelson)

Objective 1

A. Salaries and Wages. Annual Costs: One or two part-time research associates/postdocs will be hired to assist with data collection and analyses. A student worker will be hired to assist in taste tests, etc.

E. Materials and Supplies. Year 1: None. Years 2 and 3: Purchase of "other species" fish samples for taste testing as well as paper plates, utensils, and miscellaneous ingredients necessary to conduct the taste tests ($500).

F. Travel. Year 1: None. Year 2: $1,000, for three trips to conduct taste testing at various sites, to be determined, in Indiana and Illinois to be coordinated with at least one state association meeting; $450 for mileage (1,500 miles @ $0.30/mile), $250 for lodging ($50/night for 5 nights in a shared room), and $210 for meals ($30/day for 7 days). The remaining $90 will be for mileage for local travel to taste testing sites, locations to be determined. Year 2: $2,500 for a second round of taste testing at various sites, to be determined, in Indiana and Illinois to be coordinated with at least one state association meeting; $450 for mileage (1,500 miles @ $0.30/mile), $250 for lodging ($50/night for 5 nights in a shared room), and $210 for meals ($$30/day for 7 days). The remaining $1,500 will be used for travel ($1,000), lodging ($300), and meals ($200) to attend 2–3 state association meetings to demonstrate and share information, destinations to be determined.

I. All Other Direct Costs: Year 2: Duplicating ($600) and mailing ($240) questionnaires for the market surveys and taste testing.

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Expires 5/31/98

BUDGET

ORGANIZATION AND ADDRESS Purdue Research Foundation Hovde Hall West Lafayette, IN 47907-1021				**USDA AWARD NO.** Year 1: Objective 2 Duration Proposed Months: 12	Duration Awarded Months:
PRINCIPAL INVESTIGATOR(S)/PROJECT DIRECTOR(S) Paul B. Brown				**FUNDS REQUESTED BY PROPOSER**	**FUNDS APPROVED BY CSREES** (If Different)
A. Salaries and Wages 1. No. of Senior Personnel	**CSREES FUNDED WORK MONTHS**				$
	Calendar	Academic	Summer		
a. ___ (Co)-PI(s)/PD(s)					
b. ___ Senior Associates					
2. No. of Other Personnel (Non-Faculty) a. ___ Research Associates-Postdoctorates					
b. ___ Other Professional					
c. 1 Graduate Students				$17,090	
d. 1 Prebaccalaureate Students				$2,000	
e. ___ Secretarial-Clerical					
f. ___ Technical, Shop and Other					
Total Salaries and Wages . . . . . →				$19,090	
B. Fringe Benefits (If charged as Direct Costs)				$805	
C. Total Salaries, Wages, and Fringe Benefits (A plus B) . . . . . →				$19,895	
D. Nonexpendable Equipment (Attach supporting data. List items and dollar amounts for **each** item.)					
E. Materials and Supplies				$18,105	
F. Travel 1. Domestic (Including Canada)				$1,000	
2. Foreign (List destination and amount for each trip.)					
G. Publication Costs/Page Charges					
H. Computer (ADPE) Costs					
I. All Other Direct Costs (Attach supporting data. List items and dollar amounts. Details of subcontracts, including work statements and budget, should be explained in full in proposal.)					
J. Total Direct Costs (C through I) . . . . . →				$39,000	
K. 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.)					
L. Total Direct and Indirect Costs (J plus K) . . . . . →				$39,000	
M. Other . . . . . →					
N. Total Amount of This Request . . . . . →				$39,000	$
O. Cost Sharing (If Required Provide Details)	$78,875				

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Authorized Organizational Representative		

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BUDGET

ORGANIZATION AND ADDRESS Purdue Research Foundation Hovde Hall West Lafayette, IN 47907-1021				**USDA AWARD NO.** Year 2: Objective 2	
				Duration Proposed Months: 12	Duration Awarded Months:
PRINCIPAL INVESTIGATOR(S)/PROJECT DIRECTOR(S) Paul B. Brown				**FUNDS REQUESTED BY PROPOSER**	**FUNDS APPROVED BY CSREES** (If Different)
A. Salaries and Wages	**CSREES FUNDED WORK MONTHS**				$
1. No. of Senior Personnel	Calendar	Academic	Summer		
a. ___ (Co)-PI(s)/PD(s)					
b. ___ Senior Associates					
2. No. of Other Personnel (Non-Faculty) a. ___ Research Associates-Postdoctorates					
b. ___ Other Professional					
c. 1 Graduate Students				$17,603	
d. 1 Prebaccalaureate Students				$2,000	
e. ___ Secretarial-Clerical					
f. ___ Technical, Shop and Other					
Total Salaries and Wages →				$19,603	
B. Fringe Benefits (If charged as Direct Costs)				$873	
C. Total Salaries, Wages, and Fringe Benefits (A plus B) →				$20,476	
D. Nonexpendable Equipment (Attach supporting data. List items and dollar amounts for **each** item.)					
E. Materials and Supplies				$13,524	
F. Travel 1. Domestic (Including Canada) 2. Foreign (List destination and amount for each trip.)				$1,000	
G. Publication Costs/Page Charges					
H. Computer (ADPE) Costs					
I. All Other Direct Costs (Attach supporting data. List items and dollar amounts. Details of subcontracts, including work statements and budget, should be explained in full in proposal.)					
J. Total Direct Costs (C through I) →				$35,000	
K. 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.)					
L. Total Direct and Indirect Costs (J plus K) →				$35,000	
M. Other →					
N. Total Amount of This Request →				$35,000	$
O. Cost Sharing (If Required Provide Details)	$78,560				

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Principal Investigator/Project Director		
Authorized Organizational Representative		

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

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BUDGET

ORGANIZATION AND ADDRESS Purdue Research Foundation Hovde Hall West Lafayette, IN 47907-1021				**USDA AWARD NO.** Year 3: Objective 2	
				Duration Proposed Months: 12	Duration Awarded Months:
PRINCIPAL INVESTIGATOR(S)/PROJECT DIRECTOR(S) Paul B. Brown				**FUNDS REQUESTED BY PROPOSER**	**FUNDS APPROVED BY CSREES** (If Different)
A. Salaries and Wages	**CSREES FUNDED WORK MONTHS**				$
1. No. of Senior Personnel	Calendar	Academic	Summer		
a. ___ (Co)-PI(s)/PD(s)					
b. ___ Senior Associates					
2. No. of Other Personnel (Non-Faculty) a. ___ Research Associates-Postdoctorates					
b. ___ Other Professional					
c. 1 Graduate Students				$18,131	
d. 1 Prebaccalaureate Students				$2,000	
e. ___ Secretarial-Clerical					
f. ___ Technical, Shop and Other					
Total Salaries and Wages →				$20,131	
B. Fringe Benefits (If charged as Direct Costs)				$947	
C. Total Salaries, Wages, and Fringe Benefits (A plus B) →				$21,078	
D. Nonexpendable Equipment (Attach supporting data. List items and dollar amounts for **each** item.)					
E. Materials and Supplies				$15,922	
F. Travel 1. Domestic (Including Canada) 2. Foreign (List destination and amount for each trip.)				$1,000	
G. Publication Costs/Page Charges					
H. Computer (ADPE) Costs					
I. All Other Direct Costs (Attach supporting data. List items and dollar amounts. Details of subcontracts, including work statements and budget, should be explained in full in proposal.)					
J. Total Direct Costs (C through I) →				$38,000	
K. 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.)					
L. Total Direct and Indirect Costs (J plus K) →				$38,000	
M. Other →					
N. Total Amount of This Request →				$38,000	$
O. Cost Sharing (If Required Provide Details)	$79,560				

NOTE: Signatures required only for Revised Budget — This is Revision No. →

NAME AND TITLE (Type or print)	**SIGNATURE**	**DATE**
Principal Investigator/Project Director		
Authorized Organizational Representative		

Form CSREES-55 (6/95)

BUDGET EXPLANATION FOR PURDUE UNIVERSITY

(Brown)

Objective 2

A. Salaries and Wages. Annual costs: One graduate student is needed to acquire experimental animals, manufacture feeds, and scientifically feed experimental fish. An additional person (an undergraduate student) is needed to help the graduate student.

B. Fringe Benefits. Annual costs: The fringe benefit rate at Purdue is 0.36% for graduate students and 0.25% for prebaccalaureate students.

E. Materials and Supplies. Year 1: Fish ($4,500), feeds and feed ingredients ($12,500), and chemicals for analytical work ($1,000); Year 2: Fish ($3,500), feeds and feed ingredients ($8,000), and chemicals for analytical work ($2,024); Year 3: Fish ($4,000), feeds and feed ingredients ($8,000), and chemicals for analytical work ($3,922).

F. Travel. Annual costs: $100 for mileage and $400 for meals and lodging (8 days @ $50/day) for two people to make two annual trips to the Genesis site and partial support ($500) for transportation, lodging and meal expenses for P.I. to make a presentation of project results at a 3-day national aquaculture conference, destination to be determined.

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

OMB Approved 0524-0022
Expires 5/31/98

BUDGET

ORGANIZATION AND ADDRESS Board of Trustees Southern Illinois University-Carbondale Carbondale, IL 62901				**USDA AWARD NO.** Year 1: Objective 2 Duration Proposed Months: 12	Duration Awarded Months: _____
PRINCIPAL INVESTIGATOR(S)/PROJECT DIRECTOR(S) Christopher C. Kohler				**FUNDS REQUESTED BY PROPOSER**	**FUNDS APPROVED BY CSREES** (If Different)
A. Salaries and Wages 1. No. of Senior Personnel	**CSREES FUNDED WORK MONTHS**				$
	Calendar	Academic	Summer		
a. ___ (Co)-PI(s)/PD(s)					
b. ___ Senior Associates					
2. No. of Other Personnel (Non-Faculty) a. ___ Research Associates-Postdoctorates					
b. ___ Other Professional					
c. _2_ Graduate Students				$26,410	
d. _1_ Prebaccalaureate Students				$5,000	
e. ___ Secretarial-Clerical					
f. _1_ Technical, Shop and Other				$5,000	
Total Salaries and Wages . . . . . →				$36,410	
B. Fringe Benefits (If charged as Direct Costs)				$383	
C. Total Salaries, Wages, and Fringe Benefits (A plus B) . . . . . →				$36,793	
D. Nonexpendable Equipment (Attach supporting data. List items and dollar amounts for **each** item.)					
E. Materials and Supplies				$6,100	
F. Travel 1. Domestic (Including Canada)				$1,000	
2. Foreign (List destination and amount for each trip.)					
G. Publication Costs/Page Charges					
H. Computer (ADPE) Costs					
I. All Other Direct Costs (Attach supporting data. List items and dollar amounts. Details of subcontracts, including work statements and budget, should be explained in full in proposal.) Telephone ($400), Fax ($100), Photocopying ($500), Equipment Repair ($300), and Photos ($200)				$1,500	
J. Total Direct Costs (C through I) . . . . . →				$45,393	
K. 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.)					
L. Total Direct and Indirect Costs (J plus K) . . . . . →				$45,393	
M. Other . . . . . →					
N. Total Amount of This Request . . . . . →				$45,393	$
O. Cost Sharing (If Required Provide Details)	$43,582				

NOTE: Signatures required only for Revised Budget — This is Revision No. →

NAME AND TITLE (Type or print)	**SIGNATURE**	**DATE**
Principal Investigator/Project Director		
Authorized Organizational Representative		

Form CSREES-55 (6/95)

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

OMB Approved 0524-0022
Expires 5/31/98

BUDGET

ORGANIZATION AND ADDRESS Board of Trustees Southern Illinois University-Carbondale Carbondale, IL 62901				**USDA AWARD NO.** Year 2: Objective 2 Duration Proposed Months: 12	Duration Awarded Months:
PRINCIPAL INVESTIGATOR(S)/PROJECT DIRECTOR(S) Christopher C. Kohler				**FUNDS REQUESTED BY PROPOSER**	**FUNDS APPROVED BY CSREES** (If Different)
A. Salaries and Wages 1. No. of Senior Personnel	**CSREES FUNDED WORK MONTHS**				$
	Calendar	Academic	Summer		
a. ___ (Co)-PI(s)/PD(s)					
b. ___ Senior Associates					
2. No. of Other Personnel (Non-Faculty) a. ___ Research Associates-Postdoctorates					
b. ___ Other Professional					
c. 2 Graduate Students				$27,730	
d. 1 Prebaccalaureate Students				$5,000	
e. ___ Secretarial-Clerical					
f. 1 Technical, Shop and Other				$5,000	
Total Salaries and Wages →				$37,730	
B. Fringe Benefits (If charged as Direct Costs)				$383	
C. Total Salaries, Wages, and Fringe Benefits (A plus B) →				$38,113	
D. Nonexpendable Equipment (Attach supporting data. List items and dollar amounts for **each** item.)					
E. Materials and Supplies				$5,600	
F. Travel 1. Domestic (Including Canada)				$1,000	
2. Foreign (List destination and amount for each trip.)					
G. Publication Costs/Page Charges					
H. Computer (ADPE) Costs					
I. All Other Direct Costs (Attach supporting data. List items and dollar amounts. Details of subcontracts, including work statements and budget, should be explained in full in proposal.) Telephone ($400), Fax ($100), Photocopying ($500), Equipment Repair ($300), and Photos ($200)				$1,500	
J. Total Direct Costs (C through I) →				$46,213	
K. 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.)					
L. Total Direct and Indirect Costs (J plus K) →				$46,213	
M. Other →					
N. Total Amount of This Request →				$46,213	$
O. Cost Sharing (If Required Provide Details)	$44,928				

NOTE: Signatures required only for Revised Budget — This is Revision No. →

NAME AND TITLE (Type or print)	**SIGNATURE**	**DATE**
Principal Investigator/Project Director		
Authorized Organizational Representative		

Form CSREES-55 (6/95)

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

OMB Approved 0524-0022
Expires 5/31/98

BUDGET

ORGANIZATION AND ADDRESS Board of Trustees Southern Illinois University-Carbondale Carbondale, IL 62901				**USDA AWARD NO.** Year 3: Objective 2 Duration Proposed Months: 12	Duration Awarded Months:
PRINCIPAL INVESTIGATOR(S)/PROJECT DIRECTOR(S) Christopher C. Kohler				**FUNDS REQUESTED BY PROPOSER**	**FUNDS APPROVED BY CSREES** (If Different)
A. Salaries and Wages 1. No. of Senior Personnel	**CSREES FUNDED WORK MONTHS**				$
	Calendar	Academic	Summer		
a. ___ (Co)-PI(s)/PD(s)					
b. ___ Senior Associates					
2. No. of Other Personnel (Non-Faculty) a. ___ Research Associates-Postdoctorates					
b. ___ Other Professional					
c. 2 Graduate Students				$29,116	
d. 1 Prebaccalaureate Students				$3,795	
e. ___ Secretarial-Clerical					
f. 1 Technical, Shop and Other				$5,000	
Total Salaries and Wages →				$37,911	
B. Fringe Benefits (If charged as Direct Costs)				$383	
C. Total Salaries, Wages, and Fringe Benefits (A plus B) →				$38,294	
D. Nonexpendable Equipment (Attach supporting data. List items and dollar amounts for **each** item.)					
E. Materials and Supplies				$5,600	
F. Travel 1. Domestic (Including Canada) 2. Foreign (List destination and amount for each trip.)				$1,000	
G. Publication Costs/Page Charges					
H. Computer (ADPE) Costs					
I. All Other Direct Costs (Attach supporting data. List items and dollar amounts. Details of subcontracts, including work statements and budget, should be explained in full in proposal.) Telephone ($400), Fax ($100), Photocopying ($500), Equipment Repair ($300), and Photos ($200).				$1,500	
J. Total Direct Costs (C through I) →				$46,394	
K. 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.)					
L. Total Direct and Indirect Costs (J plus K) →				$46,394	
M. Other →					
N. Total Amount of This Request →				$46,394	$
O. Cost Sharing (If Required Provide Details)	$46,490				

NOTE: Signatures required only for Revised Budget — This is Revision No. →

NAME AND TITLE (Type or print)	**SIGNATURE**	**DATE**
Principal Investigator/Project Director		
Authorized Organizational Representative		

Form CSREES-55 (6/95)

BUDGET EXPLANATION FOR SOUTHERN ILLINIOS UNIVERSITY-CARBONDALE

(Kohler)

Objective 2

A. Salaries and Wages. Salaries are needed for two 50% FTE graduate students per year, one student worker at minimum wage for approximately 1,000 hours per year and extra help (one summer hourly wage employee) each year to conduct the pond and tank feeding trials and collect and collate data.

E. Materials and Supplies. Year 1: Fish ($2,000), fish food ($3,100), fertilizers ($500), general wet-laboratory and office and record keeping supplies ($500) needed for the trials; Year 2: Fish ($1,250), fish food ($3,350), fertilizers ($500), general wet-laboratory and office and record keeping supplies ($500) needed for the trials; Year 3: Fish ($1,250), fish food ($3,350), fertilizers ($500), general wet-laboratory and office and record keeping supplies ($500) needed for the trials.

F. Travel. Annual costs: $1,000 for transportation, lodging, and meal expenses for partial support for the PI to make presentation of project results at a multi-day national aquaculture conference, destinations to be determined.

G. Other Direct Costs. Annual costs: Telephone ($400), fax ($100), photocopying ($500), equipment repair ($300), and photos ($200).

BUDGET SUMMARY FOR EACH PARTICIPATING INSTITUTION

Year 1

	NDSU	Purdue	SIUC	TOTALS
Salaries and Wages	$10,500	$19,090	$36,410	$66,000
Fringe Benefits	$3,150	$805	$383	$4,338
Total Salaries, Wages and Fringe Benefits	$13,650	$19,895	$36,793	$70,338
Nonexpendable Equipment	$0	$0	$0	$0
Materials and Supplies	$0	$18,105	$6,100	$24,205
Travel	$0	$1,000	$1,000	$2,000
All Other Direct Costs	$0	$0	$1,500	$1,500
TOTAL PROJECT COSTS	**$13,650**	**$39,000**	**$45,393**	**$98,043**

Year 2

	NDSU	Purdue	SIUC	TOTALS
Salaries and Wages	$15,765	$19,603	$37,730	$73,098
Fringe Benefits	$4,382	$873	$383	$5,638
Total Salaries, Wages and Fringe Benefits	$20,147	$20,476	$38,113	$78,736
Nonexpendable Equipment	$0	$0	$0	$0
Materials and Supplies	$500	$13,524	$5,600	$19,624
Travel	$1,000	$1,000	$1,000	$3,000
All Other Direct Costs	$840	$0	$1,500	$2,340
TOTAL PROJECT COSTS	**$22,487**	**$35,000**	**$46,213**	**$103,700**

Year 3

	NDSU	Purdue	SIUC	TOTALS
Salaries and Wages	$16,316	$20,131	$37,911	$74,358
Fringe Benefits	$4,547	$947	$383	$5,877
Total Salaries, Wages and Fringe Benefits	$20,863	$21,078	$38,294	$80,235
Nonexpendable Equipment	$0	$0	$0	$0
Materials and Supplies	$500	$15,922	$5,600	$22,022
Travel	$2,500	$1,000	$1,000	$4,500
All Other Direct Costs	$0	$0	$1,500	$1,500
TOTAL PROJECT COSTS	**$23,863**	**$38,000**	**$46,394**	**$108,257**

RESOURCE COMMITMENT FROM INSTITUTIONS[1]

Year 1

Participant	Source of Match and/or Cost Sharing				Total
	University	Industry	Federal	Other	
NDSU	$5,596				$5,596
Purdue	$78,875				$78,875
SIUC	$43,582				$43,582
Totals	$128,053	$0	$0	$0	$128,053

Year 2

Participant	Source of Match and/or Cost Sharing				Total
	University	Industry	Federal	Other	
NDSU	$9,220				$9,220
Purdue	$78,560				$78,560
SIUC	$44,928				$44,928
Totals	$132,708	$0	$0	$0	$132,708

Year 3

Participant	Source of Match and/or Cost Sharing				Total
	University	Industry	Federal	Other	
NDSU	$9,784				$9,784
Purdue	$79,560				$79,560
SIUC	$46,490				$46,490
Totals	$135,834	$0	$0	$0	$135,834

[1]Because cost sharing is not a legal requirement, participants are not required to provide or maintain documentation of such a commitment.

SCHEDULE FOR COMPLETION OF OBJECTIVES

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

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

LIST OF PRINCIPAL INVESTIGATORS

Paul B. Brown, Purdue University

Christopher C. Kohler, Southern Illinois University-Carbondale

William C. Nelson, North Dakota State University

VITA

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Department of Forestry and Natural Resources
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EDUCATION

B.S. University of Tennessee, 1981, 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) of Fisheries and Aquatic Sciences, Department of Forestry and Natural Resources, Purdue University
Assistant Professional Scientist/Field Station Director (1987-1989), Illinois Natural History Survey
Adjunct Assistant Professor (1988-1989), University of Illinois, Department of Animal Sciences

SCIENTIFIC AND PROFESSIONAL ORGANIZATIONS

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

SELECTED PUBLICATIONS

Twibell, R.G., and P.B. Brown. 2000. Dietary choline requirement of juvenile yellow perch (*Perca flavescens*). Journal of Nutrition 130:95-99.

Kasper, C.S., M.R. White, and P.B. Brown. 2000. Choline is required by tilapia when methionine is not in excess. Journal of Nutrition 130:238-242.

Twibell, R.G., K.A. Wilson, and P.B. Brown. 2000. Dietary sulfur amino acid requirement of juvenile yellow perch fed the maximum cystine replacement value for methionine. Journal of Nutrition 130:612-616.

Twibell, R.G., B.A. Watkins, L. Rogers, and P.B. Brown. 2000. Dietary conjugated linoleic acids alter hepatic and muscle lipids in hybrid striped bass. Lipids 35:155-161.

Twibell, R.G., and P.B. Brown. 2000. Effects of dietary carnitine on growth rates and body composition of hybrid striped bass (*Morone saxatilis* male × *M. chrysops* female). Aquaculture 187:153-161.

Riche, M., and P.B. Brown. 1999. Incorporation of plant protein feedstuffs into fish meal diets for rainbow trout increases phosphorus availability. Aquaculture Nutrition 5:101-105.

Brown, P.B., R. Twibell, Y. Jonker, and K.A. Wilson. 1997. Evaluation of three soybean products in diets fed to juvenile hybrid striped bass *Morone saxatilis* × *M. chrysops*. Journal of the World Aquaculture Society 28:215-223.

Brown, P.B., K. Dabrowski, and D.L. Garling, Jr. 1996. Nutrition and feeding of yellow perch (*Perca flavescens*). Journal of Applied Ichthyology 12:171-174.

VITA

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EDUCATION

B.S. St. Mary's College of Maryland, 1973, Biology
M.S. University of Puerto Rico, 1975, Marine Biology/Aquaculture
Ph.D. Virginia Polytechnic Institute and State University, 1980, Fisheries Science

POSITIONS

Director (1993-present), Fisheries and Illinois Aquaculture Center, Southern Illinois University-Carbondale
Professor (1993-present), Associate Professor (1989-1993), and Assistant Professor (1986-1989), Department of Zoology, Southern Illinois University-Carbondale
Senior Scientist (1980-1986), Fisheries Research Laboratory, Southern Illinois University-Carbondale

SCIENTIFIC AND PROFESSIONAL ORGANIZATIONS

American Fisheries Society (President, Fish Culture Section, 1999–2000)
World Aquaculture Society

SELECTED PUBLICATIONS

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.

Myers, J.J., and C.C. Kohler. 2000. Acute responses to salinity for sunshine bass and palmetto bass. North American Journal of Aquaculture 6:195-202.

Suresh, A.V., J.B. Rudacille, M.L. Allyn, V. Sheehan, R.J. Sheehan, and C.C. Kohler. 2000. Single injections of hCG or mGnRHa at low dosages induce ovulation in white bass. North American Journal of Aquaculture 62:87-94.

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.

Morris, J.E., C.C. Kohler, and C.C. Mischke. 1999. Pond culture of hybrid striped bass in the North Central Region. NCRAC Fact Sheet Series #107, NCRAC Publications Office, Iowa State University, Ames.

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.

Kohler, C.C. 1997. White bass production and broodstock development. Pages 169-184 *in* R. M. Harrell, editor. Striped bass and other *Morone* culture. Elsevier Press, Amsterdam.

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

Woods, III, L.C., C.C. Kohler, R.J. Sheehan, and C.V. Sullivan. 1995. Volitional tank spawning of female striped bass with male white bass produces hybrid offspring. Transactions of the American Fisheries Society 124:628-632.

Kohler, C.C., R.J. Sheehan, C. Habicht, J.A. Malison, and T.B. Kayes. 1994. Habituation to captivity and controlled spawning of white bass. Transactions of the American Fisheries Society 123:964-974.

VITA

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EDUCATION

B.S. North Dakota State University, 1965, Agricultural Economics
M.S. University of Arizona, 1966, Agricultural Economics
Ph.D. Ohio State University, 1971, Agricultural Economics

POSITIONS

Professor (1981-present), Associate Professor (1976-1981), and Assistant Professor (1971-1976), Department of Agricultural Economics, North Dakota State University (NDSU)
Director (1998-present), Quentin Burdick Center for Cooperatives, NDSU
Director (1995-1998), Institute of Natural Resources and Economic Development, NDSU
Provost (1991-1994), Tri-College University (consortium of NDSU, Concordia College, and Minnesota State University-Moorhead).
Coordinator (1986-present), International Agriculture, North Dakota State University

SCIENTIFIC AND PROFESSIONAL ORGANIZATIONS

American Agricultural Economics Association
American Aquaculture Association
Association of Cooperative Educators
Western Agricultural Economics Association

SELECTED PUBLICATIONS

Golz, T., and W.C. Nelson. 1999. Markets for northern plains aquaculture–case study of tilapia. Agricultural Economics Report 429, North Dakota State University, Fargo.

Coyle, K., and W.C. Nelson. 1998. Tourism potential in North Dakota–with emphasis on the Southwest. Agricultural Economics Miscellaneous Report 183, North Dakota State University, Fargo.

Kraenzel, D., T. Petry, W.C. Nelson, M.J. Anderson, D. Mathern and R. Todd. 1998. Industrial hemp as an alternative crop in North Dakota. Agricultural Economics Report 402, North Dakota State University, Fargo.

Janzen, E., and W.C. Nelson. 1998. Final report of the feasibility of the Northern Soybean Processors Plant, Ulen, Minnesota. Agricultural Economics, North Dakota State University, Fargo.

Saxowsky, D., and W. C. Nelson. 1998. Final report of the feasibility of the Farmers Union Feedlot Association, Jamestown, North Dakota. Agricultural Economics, North Dakota State University, Fargo.

Leitch, R., and W.C. Nelson. 1996. Mexican market for five North Dakota value-added agricultural products. Agricultural Economics Report 337, North Dakota State University, Fargo.

Leitch, R., and W.C. Nelson. 1996. The ostrich market. Agricultural Economics Report 336, North Dakota State University, Fargo.