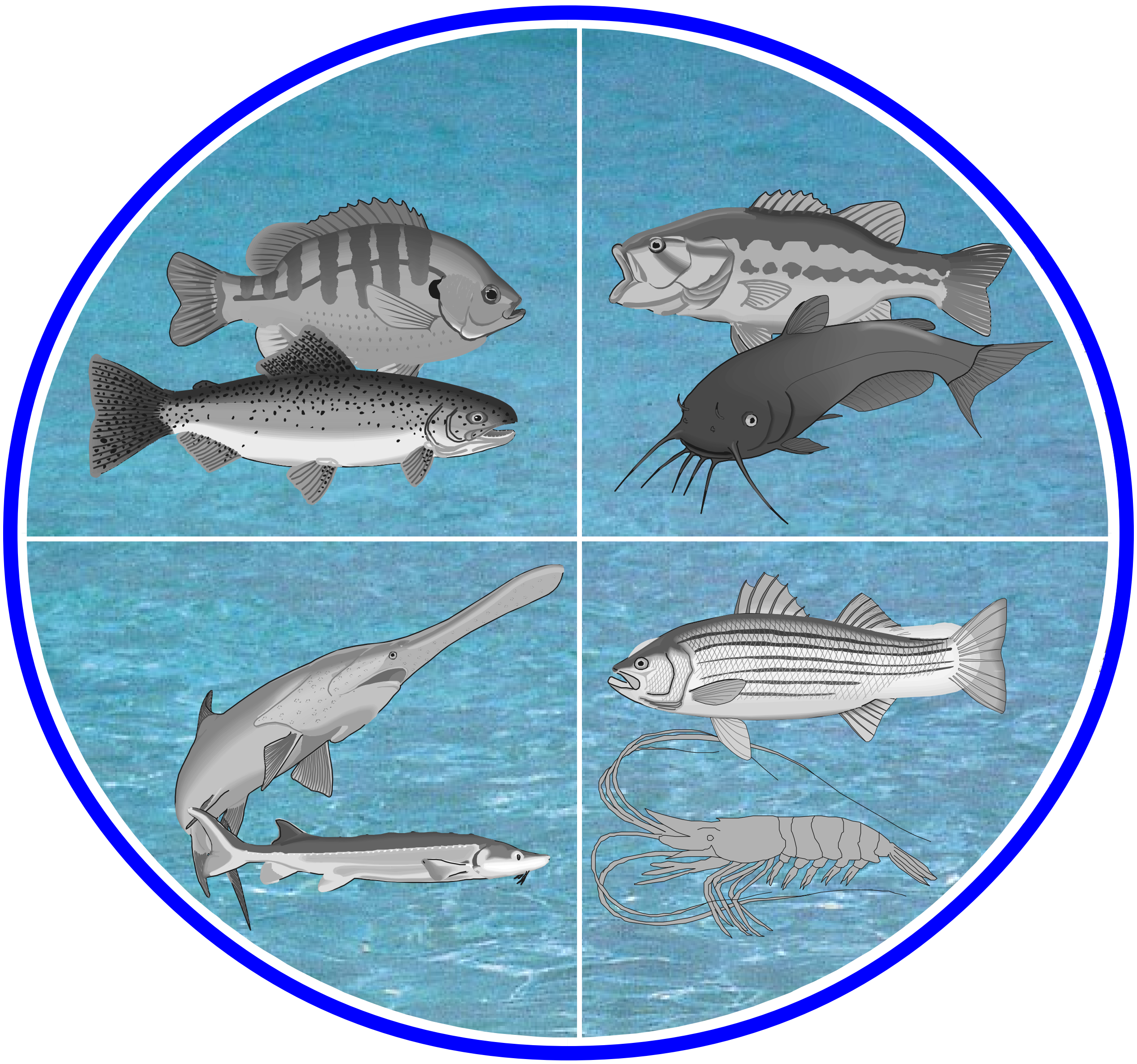
COMMONWEALTH OF KENTUCKY



AQUACULTURE PLAN

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Executive Summary

Aquaculture is one of the fastest growing food production activities in the world. The world supply of seafood from the wild has remained stable for the last ten years and is not likely to increase because fisheries are at their maximum. However, the demand for seafood products is steadily increasing due to the growth of population and consumers recognizing the health benefits of eating fish and shellfish. A large part of the increase in annual global seafood production is attributable to the growth in aquaculture.

Kentucky is well positioned to expand its aquaculture production with a suitable climate, soil and water resources, and an existing aquaculture research and extension program with over ten years of Kentucky-based results. This State Aquaculture Plan developed by the Aquaculture Task Force addresses the production possibilities; marketing and promotional needs; regulatory considerations; research, extension, and educational needs; and the financial needs to fully develop aquaculture in Kentucky.

Seven potential species have been identified as currently holding the best production possibilities for Kentucky. These species are freshwater shrimp, trout, catfish, largemouth bass, paddlefish, hybrid striped bass, and baitfish. Nine other species are also discussed as holding more minor possibilities for production in Kentucky.

The Aquaculture Task Force concluded their work with recommendations including:

à Legislation should be passed which favors the purchase of Kentucky-grown products (including aquaculture products) when available, by all state funded projects, agencies, and institutions.

à In order to offer diversification opportunities for Kentucky agriculture and foster the growth of aquaculture production and processing within the commonwealth, funding should be provided to establish an aquaculture pond construction cost-share program, an infrastructure development grant fund, and a low-interest revolving loan fund for aquaculture producers in Kentucky.

à The Kentucky State University (KSU) Cooperative Extension Program should be funded proportionally, according to the same formula as the University of Kentucky (UK) Cooperative Extension Program, with state funds for cooperative extension work.

à Support funding should be provided for Kentucky Department of Agriculture (KDA) aquaculture marketing programs and KSU aquaculture research programs.

A complete list of Task Force recommendations is included in Chapter Ten.

Introduction

House Joint Resolution 72 (HJR 72) directed the creation of the Aquaculture Task Force and charged the Task Force with developing a state aquaculture plan. The Task Force was directed to report to the Governor and the Legislature the aquacultural policies and practices that result in proper management, use, and marketing of the commonwealth's aquaculture industry.

The aquaculture plan addresses production possibilities; marketing and promotional needs; regulatory considerations; research, extension and educational needs; and the financial needs to fully develop aquaculture in Kentucky.

Members of the Aquaculture Task Force:

- The Honorable Jody Richards, Speaker of the House of Representatives
- The Honorable Larry Saunders, President of the Senate
- The Honorable David Boswell, Chairman of the Senate Agriculture & Natural Resources Committee
- The Honorable Roger Thomas, Chairman of the House Agriculture and Small Business Committee
- Commissioner Billy Ray Smith, Kentucky Department of Agriculture
- Commissioner C. Tom Bennett, Department of Fish and Wildlife Resources
- Mr. John-Mark Hack, Director of Office of Agricultural Policy, Office of the Governor
- Mr. James Mansfield, Chairman of the Aquaculture Task Force, Division Director, Kentucky Department of Agriculture
- Dr. James Tidwell, Coordinator of the Aquaculture Programs, Kentucky State University
- Mr. Steve Price, President of the Kentucky Aquaculture Association
- Mr. Preston Art, Farm Bureau Representative
- Mr. Marshall Taylor, Retailer
- Mr. James Garrison, Producer
- Mr. Lewis B. Shuckman, Shuckman's Fish Company & Smokery, Wholesaler

Ex-Officio Members:

- Mr. Mike Larimore, Frankfort Hatchery
- Mr. Forrest Wynne, Area Specialist for Aquaculture, Kentucky State University
- Dr. Jennifer Marsh, General Counsel, Office of the President of the Senate
- Mr. Ted Crowell, Kentucky Department of Fish & Wildlife Resources

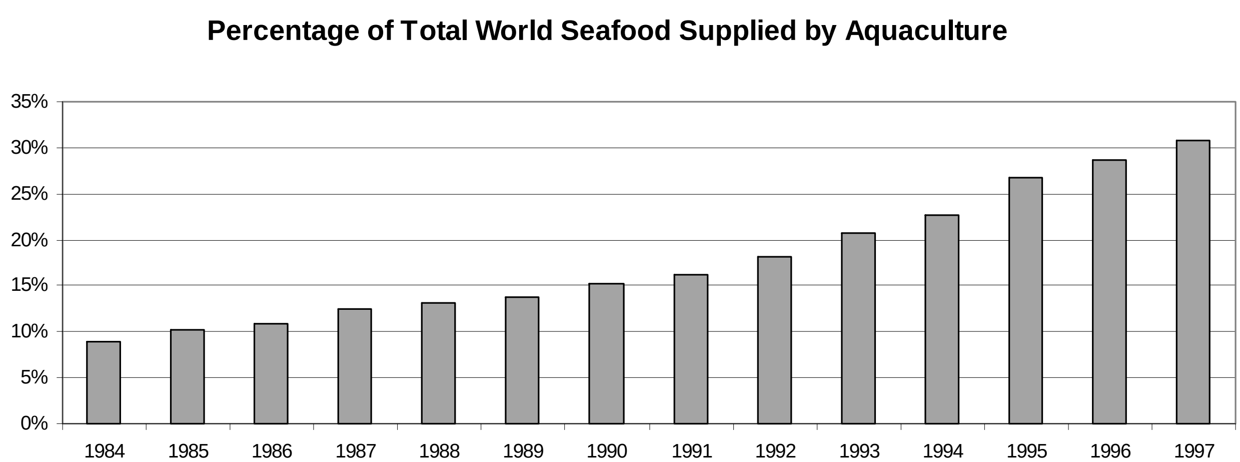
Aquaculture Overview

World supply of seafood from the wild has remained stable for the last ten years and is not likely to increase because fisheries are at their maximum. However, the demand for seafood products is steadily increasing due to the growth of population and consumers recognizing the health benefits of fish and shellfish. The following is an overview of the aquaculture situation in the world, the United States, and in Kentucky.

Internationally

Aquaculture is one of the fastest growing food production activities in the world. A large part of the increase in annual global seafood production is attributable to the growth in aquaculture. The world is increasing by 90 million persons per year, which is equivalent to creating a new United States every three years. Per capita consumption of fish averages 42 pounds per year. In 1996, total aquaculture production was 26,384,000 tons. Aquaculture will need to double in the next fifteen years to keep pace with demand.

Chart 1 – Increases in global seafood has come from increased aquaculture production

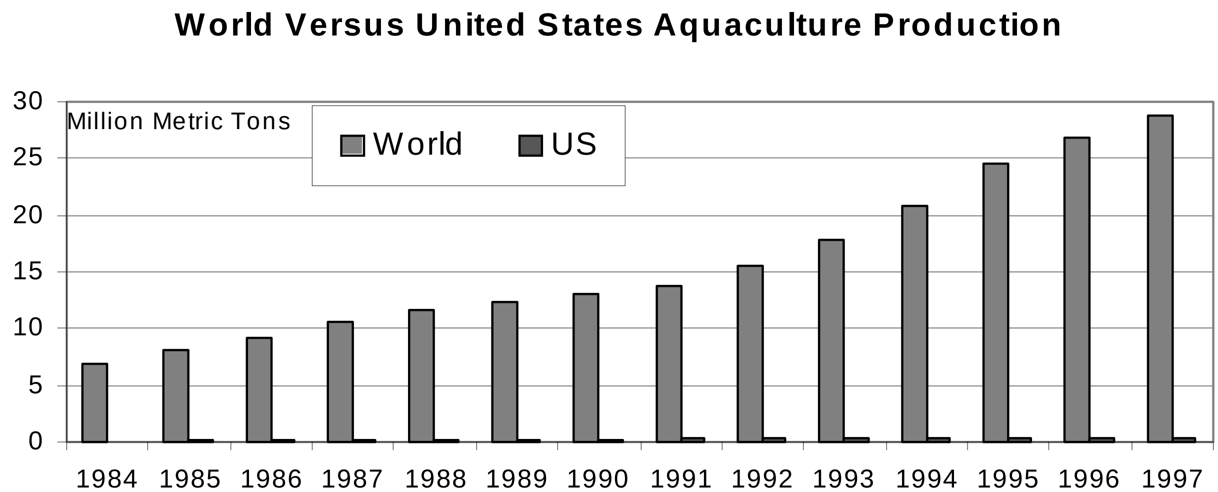


Source: Food and Agriculture Organization of the United Nations Fisheries Department, FISHSTAT Plus Data sets

In the United States

In the U.S. aquaculture is one of the fastest growing segments of U.S. agriculture. Between 1985 and 1996 aquaculture production increased 84.6% (to 693,693,000 pounds) and value increased 155% (to $885,635,000). In 1998, per capita consumption of seafood in the U.S. was 14.6 pounds. The U.S. trade deficit in edible fisheries products is $5 billion per year, with shrimp alone being almost $2 billion. In 1998, total shrimp imports reached $3.1 billion, an increase of 5% from the previous two years. Imports are expected to continue to increase. The demand for fish and shellfish increases 40 million pounds per year based on population growth. Aquaculture products represent 15% of total seafood consumption in the U.S. This percentage is expected to double within the next 10 years.

Chart 2 – Aquaculture production has increase worldwide. The U.S. aquaculture has a great potential for increasing.

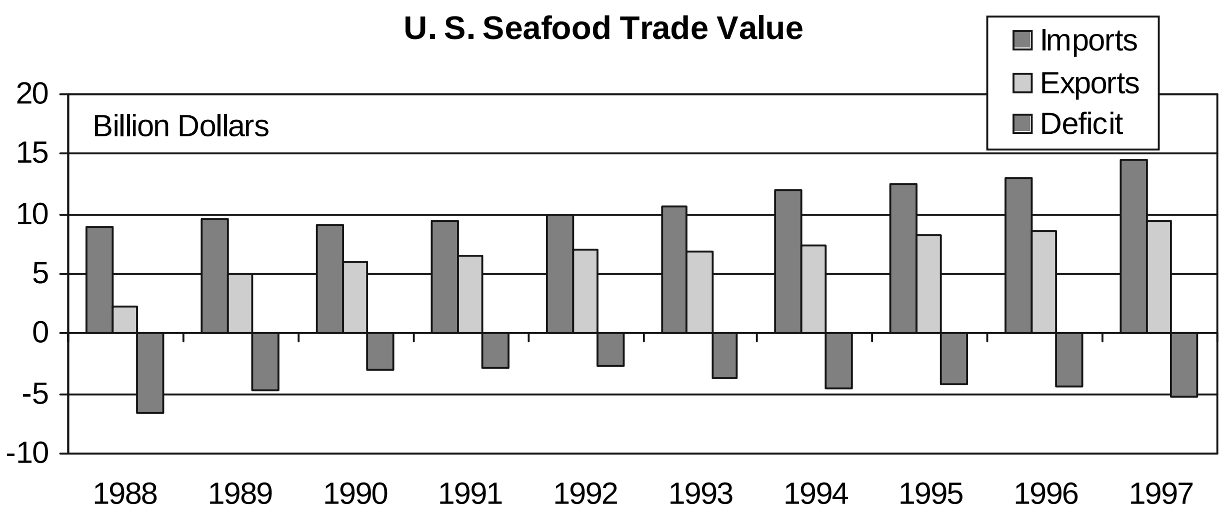


Source: Food and Agriculture Organization of the United Nations Fisheries Department, FISHSTAT Plus Data sets and Fisheries of the United Stats, 1998, U.S. Department of Commerce, National Oceanic and Atmospheric Adminstration, National Marine Fisheries Service

The catfish industry continues to expand, as does per capita consumption of catfish. Catfish farmers' total sales in 1997 were $427 million and increased to $469 million in 1998, setting new records. Fresh catfish sales were up 6 percent while frozen catfish sales increased by 8 percent.

Over 60% of the U.S. seafood supply is imported. Increased seafood demand is being met by imports, making the U.S. the world's second largest importer of fisheries products (behind Japan).

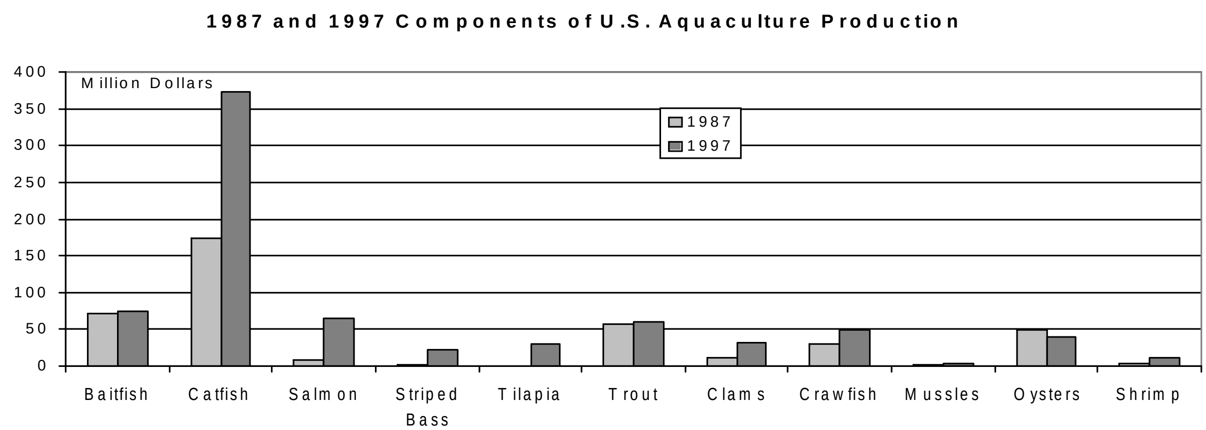
Chart 3 – U.S. imports of seafood have increased.



Source: Fisheries of the United States, 1998; U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service

Domestic wild seafood harvest is not expected to expand given the increased stringent catch limitations. In the last 5 years, there has been increased consumption of farm-raised catfish, tilapia, salmon, and shrimp and to other farm-raised species. Two-thirds of domestic aquaculture production occurs in the southeast United States. The number of growers has increased aquaculture pond acreage to 175,220 acres. The growth in population of the United States should allow for continued aquaculture growth as the traditional, live and food service, markets expand in size. Additionally, due to the forecast of a strong domestic economy and low overall unemployment in the U.S., it is expected there will be increased eating in restaurants, an extremely important outlet for most seafood products.

Chart 4 – Areas of U.S. aquaculture production.



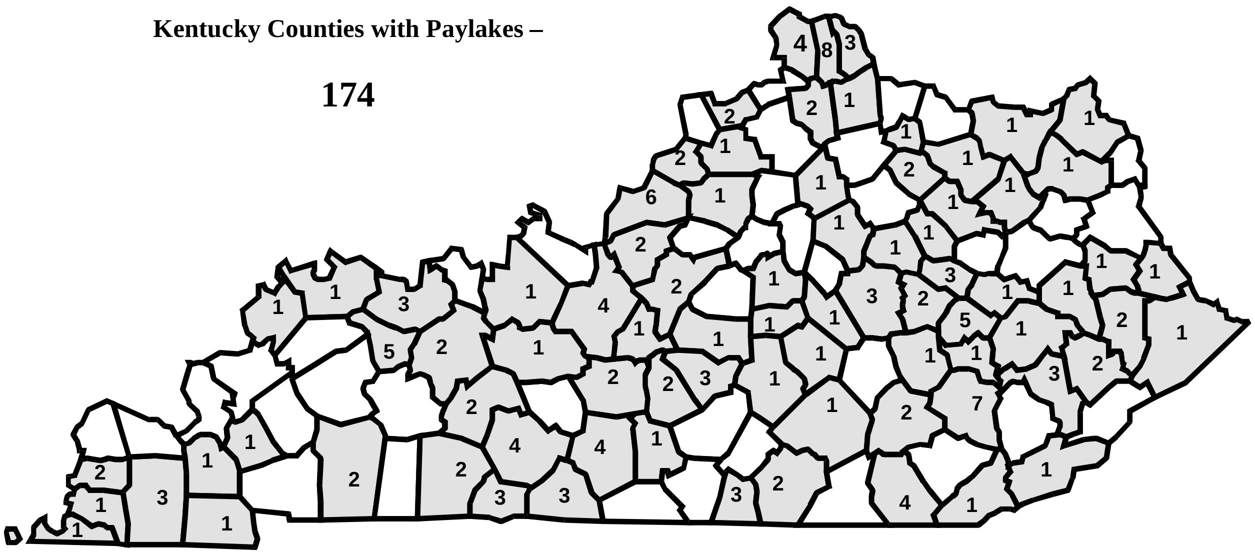
Source: Fisheries of the United States, 1998; U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service

In Kentucky

According to USDA, much of the future growth of U.S. aquaculture will occur in new species and in regions where aquaculture is a new enterprise. Kentucky's climate is well suited for production of new species such as hybrid striped bass, freshwater shrimp, and paddlefish, and is suitable for production of traditional species such as catfish and trout. Kentucky's location is within a day's drive of many major metropolitan centers, making it ideally suited for marketing fresh and even live product, a rapidly increasing product form.

Kentuckians consume over 60 million pounds of seafood per year, worth an estimated $568 million annually. Less than 4% of the seafood consumed is produced within the commonwealth. Approximately one million pounds of both rainbow trout and channel catfish are currently produced annually in Kentucky. Annual catfish production could be tripled if catfish currently stocked in Kentucky pay lakes were purchased from Kentucky producers. Kentucky has over 130,000 existing ponds of which 100,000 may be greater than or equal to ¼ acre in size.

Chart 5 – Pay lakes in Kentucky.



Source: KDA Aquaculture Directory, 1998

Aquaculture, being an agriculture enterprise, is compatible with small farm production and rural lifestyles and economies. Kentucky has a need for additional profitable farm enterprises. Kentucky has a well-qualified team of researchers and extension specialists, with over 10 years of Kentucky-based results to build on.

At Kentucky State University

The KSU Aquaculture Program, through the assistance of a state-supported KDA Grant, is providing hatchery and nursery production of over 400,000 stocker shrimp for grow-out ponds across the commonwealth and is working with private producers to initiate production of fingerling paddlefish. KSU is the national leader in research on freshwater shrimp, paddlefish, and its caviar.

The Aquaculture Research Center and Cooperative Extension Service Programs at KSU provide statewide services of aquaculture production consulting, disease diagnostics, water quality testing, and site evaluations. Additionally, KSU is working with KDA on identifying and developing domestic and export markets for new and traditional species. The program is presently conducting field trials on feed-trained largemouth bass, which have strong market potential in both sportfish and export markets.

Production Systems

Pond Production Systems

Ponds are the oldest, most natural, and usually the most economical, production system for most aquaculture species. All production systems must be able to provide oxygen for the fish and remove toxic waste products produced by the fish. A pond's ability to accomplish these actions is based on naturally occurring processes and the fact that a pond is a small semi-closed ecosystem.

Oxygen production in a pond is primarily based on photosynthesis by the microscopic algae (*phytoplankton*) floating in the pond. Diffusion from the atmosphere contributes very little oxygen to a pond. The ability of a pond to reliably provide oxygen is the first limiting factor in the production capacity of ponds. Without aeration production is limited to approximately 1,500 pounds of fish per acre. With aeration provided production is increased to 4,000-6,000 pounds of fish per acre.

The other function a production system requires is removal of toxic waste products. When fish are fed prepared diets, much of the nitrogen in the feed protein is excreted through the fish's gills into the surrounding water in the form of ammonia. This ammonia is either removed from the water by the phytoplankton, or converted to less toxic forms by naturally occurring bacteria in the pond in a process known as nitrification. The efficiency of nitrification within the pond is currently the primary constraint on the production capacity of ponds for most species.

Types of ponds include watershed and levee style ponds. Watershed ponds are most practical in hilly areas and are constructed by building a dam across a draw or valley. Watershed ponds are sited so that the smallest dam impounds the most water. Because of hilly terrain, watershed ponds can be quite deep near the dam, affecting their use for species such as prawns. Construction prices vary based on terrain and dam size. However, one acre pond with drains should be constructed for $1,500-$2,500. Major considerations are suitability of soils, sufficient water supply based on watershed, ability to handle excess water during heavy rain and rainy periods, proximity to electricity for aeration, and accessibility for daily feeding and maintenance.

Levee style ponds are constructed in flat terrain by shallow excavation, then the soil is used to construct levees around all four sides. Leveed ponds have no watershed so a clean dependable water source must be available. Possible sources are streams or wells, which also allow better control over filling and draining. Leveed ponds are normally more productive per unit of size than watershed ponds because of shallow, uniform depth, and better manageability. Again, construction costs will vary based on location but should average less than $5,000 per acre with a drain.

Pond Construction Considerations

I. Site Selection

1. Pick the areas on your farm where you would most like to have your pond(s).
2. Do not select areas where runoff from feedlots will pollute your pond.
3. Do not select areas where crops are produced that may be sprayed with pesticides that can enter the pond in runoff after heavy rains.
4. Consider the possibility of poaching if the pond(s) are in a remote or secluded area.
5. Choose areas that are easily accessible with equipment, trucks, etc. during the time of year when the product must be stocked, harvested, etc.
6. Choose areas where the cost of running electric lines to the site would be the least expensive.
7. Choose areas close to emergency water sources (creeks, rivers, wells, other ponds etc.), if possible.

Of utmost importance, contact the **Natural Resources Conservation Service (NRCS)** office in your county and have them survey your locations and make recommendations. Also contact the KSU Aquaculture Program and ask to have one of the state aquaculture specialists review and make recommendations.

II. Construction Cost Factor

1. Terrain-Topography - Kentucky has a vast range of terrain and topography from mountains in eastern and southern to rolling hills through central to flat-"bottom-land" in western Kentucky. The terrain-topography, to a great extent, determines the type of pond that can be constructed, the maximum size that can be built and the amount of earth that must be moved.
2. Soils and soil characteristics - Kentucky soils are more varied even than the terrain and topography. For example, in Boone, Kenton, and Campbell Counties there are at least 5 different soil associations and 26 different soil series. Each soil classification has unique characteristics such as permeability and compactability, and while some soils are ideally suited for holding water, others will require installing a liner if a pond is to be built.
3. Contractors fees - There is a wide variation in fees charged by contractors. Factors such as a) the amount and type of equipment the contractor uses, b) prevailing wages of operators in different areas, c) the type of contracting the contractor normally engages in, d) the area in which the contractor is operating (e.g. rural areas vs. metropolitan areas), and e) knowledge and ability of the contractor in the art of pond construction. The NRCS in each locality maintains a list of contractors who build ponds.
5. Ponds used for aquacultural purposes will need to be fenced off from livestock. A watering troughs for livestock must be positioned below the pond. The pond will need piping and valves to control the water level and to drain the pond from time to time. Electric lines for the use of an aerator, and roadways for access to the ponds during inclimate weather, may also have to be laid and constructed.

III. Recommendations

Upon surveying the possibilities for pond sites on your farm, call the NRCS in your county and/or the KSU Cooperative Extension Service and request their assistance in locating the best site for your pond. Once a site is selected and staked out, then contractors can be contacted for bidding. Contact the NRCS office in your area for their list of contractors, or better still, talk with neighbors, friends, etc. who have had ponds dug and get references in this manner. If possible, inspect some of their work. Due to the fact that they don't know what they will hit once the top soil is removed, most contractors will not quote an exact price for the completed job. Most will, however, give an estimate. If absolutely forced to give an exact price, they will make the price high enough to cover the worst of possibilities. It is, therefore, of utmost importance to select a contractor known for his ability, honesty, and integrity.

Currently, in Kentucky, contractors are charging from $2.00 to $4.00 per cubic yard to move dirt with a bulldozer, and hourly rates for dozers are $10.00 to $12.00 times the size of the dozer (caterpillar) per hour (i.e. a D-5 is $50.00 to $60.00 per hour; a D-6 is $60.00 to $72.00 per hour etc.).

Laser-guided, tractor-drawn dirt pans are used in Mississippi and other areas including the purchase area in Kentucky. Contractors using this equipment have been charging from $.70 to $1.00 per cubic yard to move dirt and construct levee ponds.

Do not forget to figure the costs of roads, electricity, fencing, and piping in the total costs. Also, remember that each acre of water contains over 325,000 gallons of water for each foot of depth. Make sure your piping and valves are of sufficient size to remove that much water in a sufficiently short time.

Reservoir Ranching Production Systems

Reservoir ranching is an extensive (low input) aquacultural production system where young fish are stocked into a reservoir, permitted to forage on the natural food supply, and harvested after a period of time. This is a very economical system for fish production, which uses existing reservoirs that were primarily developed for the storage of water, flood control, and hydroelectric purposes. It is used throughout the world, especially in China, the former U.S.S.R., and African countries, to increase inland fisheries production.

Fish most suitable for reservoir ranching are filter feeders, such as paddlefish, bighead, and silver carp. They feed primarily on minute organisms, such as zooplankton, which are naturally present in the water. Therefore, special diets and intensive management are not needed. Fish yield can vary from reservoir to reservoir, depending on the fertility of the water. In China, production of filter-feeding fish stocked into reservoirs averages about 200 pounds per acre. If this production system is adopted in the commonwealth, up to 48 million pounds of fish could be produced in Kentucky reservoirs (240,000 acres available).

KSU has been evaluating the potential in reservoir ranching paddlefish in Kentucky. KSU has recommended that fingerlings should be large enough at stocking (greater than12 inches) to avoid predation; barriers should be installed at spillways and at streams and river inlets to prevent fish from escaping, and the fish should be harvested with entanglement gear such as gill nets when water temperatures are below 50°F (late fall, winter, and early spring) so that fish harvesting does not interfere with public use of reservoirs.

Cage Production Systems

It is not clear when people first used cages to grow fish. It is likely that cages were first used by fishermen to hold captured fish until they could be sold to market. The first documented cages were used in Southeast Asia in the 1800s as a means of growing fish for food and were made of bamboo. Cage culture in the United States began in the 1950s with the production of plastics used for the construction of cages. Many countries in Southeast Asia and Europe use cages to grow fish. In the U.S., cage culture is mainly limited to freshwater ponds and lakes; however, in other countries, fish are grown in freshwater as well as in the ocean. Large cages, called net pens, are placed into the ocean and used to grow marine fish. These net pens often can hold more than 5000 pounds of fish per cage.

The culture of fish in cages is a method for some farmers to grow fish in ponds that may otherwise be unsuitable for aquaculture. Many ponds in Kentucky have irregular bottoms, are too deep (greater than 7 feet), or have obstacles (e.g. stumps) that preclude them from use in standard aquaculture production systems, which require the pond to be seined. However, by growing fish in cages, these ponds may be utilized. The advantages of using cages to grow fish are use of existing ponds that are currently not utilized, ease of feeding, ease of stocking and harvesting, and less expense associated with treating or preventing diseases than free swimming fish. Disadvantages are more stressful conditions for some fish species, the possibility of rapidly spreading diseases, more susceptibility for a fish-kill due to low oxygen conditions, and the economic life of cages, which may be as low as 3 years, depending upon local conditions.

From the research conducted at the cage culture facility at KSU, numerous fish species that appear to be satisfactory for cage culture in Kentucky during the summer growing season. These include channel catfish, blue catfish, hybrid catfish, hybrid striped bass, and hybrid bluegill. However, since the growing season in Kentucky is shorter than for the more southerly states, a second-year of culture may be required. While it appears that channel catfish and hybrid striped bass can be over-wintered in cages, blue catfish should not be. Extremely high mortalities occur in February through April when blue catfish are grown in cages; and thus, it is recommended that blue catfish be harvested from the cage or transferred to ponds in the Fall. Rainbow trout appear to be suitable for growing in cages in the winter (Wynne 1992).

The size of the cage used will depend upon the preferences of the farmer, the level of production desired, and the size of the pond. However, a convenient size cage is a rectangular unit that measures (4' W x 4' D x 8' L; 3.75 m^3). It is recommended that farmers stock a small number of fish per cage until they learn the "art" of culturing fish in cages. Production rates for cages can be 200-300 pounds per cubic meter or higher. Total production of 1500 to 2000 pounds per acre of pond may be possible. However, a great deal of the final production depends upon the species grown, the diligence of the producer, and the size of the pond. The use of aeration and/or water circulation devices may be very beneficial to the farmer when growing fish in cages and is strongly recommended.

Cage production of fish is possible for producers who are interested in utilizing ponds that may be unsuitable for typical pond aquaculture; however, extreme care and hard work is required to produce fish in cages. County agents and appropriate extension personnel should offer all the assistance that the producer may require to ensure a successful harvest.

(See appendix for recommended readings on Cage Production)

Raceway and Flow-through Fish Production Systems

In Kentucky, year round commercial trout culture occurs in steel-reinforced, concrete raceways. Raceways have a length to width ratio of approximately 6:1 and hold a water depth of 3 to 4 feet. Typically, raceways are built in pairs and share a common interior wall. Raceways that are 36 feet by 6 feet may have a floor and walls that are 6 inches thick. Larger units may be constructed of poured concrete 8 inches or more in width depending on raceway length and water volume. Trout production is limited by the availability of large freshwater springs which provide gravity-fed water to the raceways in adequate quantity. Large volumes of water must flow via gravity through a series of terraced raceways and are discharged into a receiving stream with little or no wastewater treatment.

Aeration occurs between raceways as the water flows over a screened outfall and pours into the head of the raceway below. Water volume is exchanged approximately every hour. The cost of pumping such large volumes of water (400-4,000 gallons per minute) would be prohibitive in most cases. Nitrogenous wastes are removed from the raceways by flushing or dilution before toxic levels of ammonia gas can concentrate in the water. Alkalinity (greater than 100 milligrams per liter) and pH (7.5) generally limit the serial reuse of Kentucky's well buffered limestone spring water to 6 to 8 raceway passes. The water flow rate, water chemistry, temperature, size of fish, and the rate of feeding determines the volume of fish which can be produced in a particular raceway system. Generally, rainbow trout can be grown at a rate of 25-50 pounds annually per gallon per minute of water flow.

Flow-through, or single use raceways and circular tanks, are often used for hatchery rearing of fry and juvenile warm-water fish such as largemouth bass, channel catfish, and hybrid striped bass. For short durations, it is economically feasible to pump relatively little water into a raceway or tank given the small volume of fish that are consuming small quantities of feed. Normally, after these fish are feed trained or have reached a certain length or weight, they are stocked into earthen ponds. Potentially, larger warm-water fish could be grown in flow-through raceways which were supplied with a free or inexpensive water source. However, such situations are not common.

Raceways and tanks are commonly used for temporarily holding bait minnows and all sizes and species of fish. Rectangular raceways or holding tanks fit well in buildings and provide easy access to the fish for the purposes of size grading and harvesting. However, raceways are expensive to construct, require maintenance, and must be dredged periodically to remove sludge. Circular or square tanks are made of a variety of materials and can be less expensive than concrete raceways or holding tanks. Circular tanks with conical floors and centrally located stand-pipes (equipped with venturi sleeves) tend to do a better job of removing sludge. However, circular tanks require more space in rectangular buildings than raceways and are more difficult to grade or harvest from.

Recirculating Production Systems

A recirculating system is the most intensive system of fish production. This system through water treatment and water reuse can utilize less than 10 percent of the water required by ponds to produce similar fish yields. Many fish species grown in ponds, raceways and floating pens could be reared in commercial-scale recirculating systems. Therefore, with increasing concern for resource conservation and demand for high quality aquacultured products, there is a great deal of interest in recirculating systems in the United States and other parts of the world. Though there have been a few reports of profitable commercial-scale recirculating systems, economic viability of growing most commonly cultured species in these systems has not been proven. Recirculating systems have generally been expensive to build. These systems will not be used on a wide scale basis until total cost of producing fish is comparable to the cost of production in ponds and other similar systems. The challenge to designers of recirculating systems is to develop systems that maximize production capacity per unit of capital invested but will maintain reliability of the controlled environment. Currently, recirculating systems have a great value in educational and research labs.

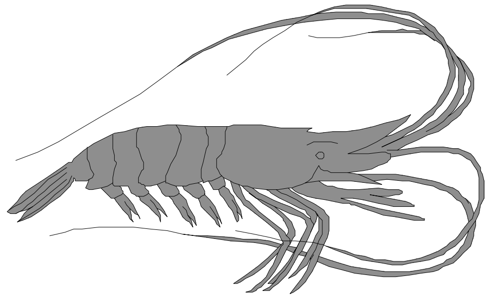
The major advantages in using recirculating aquaculture systems are 1) low water requirements, 2) low land requirements, 3) the ability to control water temperature, 4) the ability to control water quality, and 5) independence from adverse weather conditions. Therefore, the aquaculturist has the ability to measure and control most variables which make up the environment of the recirculating system and maximize fish production per unit.

Good water quality is most important in maximizing fish production in a recirculating system. Critical environmental parameters in the water of the production system include the concentrations of dissolved oxygen, un-ionized ammonia-nitrogen, nitrite-nitrogen, nitrate, carbon dioxide, pH, and alkalinity. By-products of fish metabolism include carbon dioxide, ammonia-nitrogen, particulates, and dissolved fecal solids. In recirculating tank systems, proper water quality is maintained by pumping tank water through specialized filtration and aeration equipment. Water treatment components must be designed to eliminate the effects of these waste products as well as work in conjunction with the total system.

Numerous technologies are available for recirculating systems. However, there are four basic components to these systems: solid waste removal, ammonia- and nitrite-nitrogen control, dissolved gas control, and disinfection. Solid waste includes settleable and suspended solids. Settleable solids sink to the bottom of the tanks and are siphoned and discarded from the system. Suspended solids are removed with screen or sand filters. Ammonia and nitrite-nitrogen control is accomplished with a biofilter that relies on bacteria to remove these nitrogenous waste products. Some of the common biofilters are rotating biological contactor (RBC), expandable media filters, fluidized bed filters, and packed tower filters. Dissolved gas control involves adding dissolved oxygen and removing carbon dioxide. Some common dissolved gas components include diffuser aeration, mechanical aeration, packed column aerators, counter current diffusion column, pressurized spray tower, and pressurized packed column. The last component to be considered for a recirculation system is disinfection of pathogenic organisms which can be accomplished with ozone or ultraviolet irradiation.

Most reports of successful production have been from small (less than 100,000 pounds per year), recirculating systems supplying fish to local niche markets at high prices. These high priced markets are necessary for financial success because of high cost of fish production in recirculating systems. Typically, the fixed cost of developing a recirculating system is higher than that for an equivalent pond production system. Given this fact alone, a producer should not try to compete with pond raised products. Instead, the producer should target high value markets, such as gourmet food, tropical or ornamental fish, or year around supply of fresh product. As with other aquaculture production systems, the size of the recirculating system and decision to become involved should be market driven.

Major Species



Freshwater Prawns

The freshwater shrimp, or more properly freshwater prawn, is a member of a large group of freshwater crustaceans found in many parts of the world. There are several species found native to the U.S., but most aquaculture efforts have concentrated on the Giant Malaysian Prawn (*Macrobrachium rosenbergii*) which is a native of southern Asia. Culture efforts in the U.S. were initiated in Hawaii in 1960s, South Carolina in the 1970s, and Mississippi in the 1980s. Despite these efforts, substantial concentrated production of this species has not developed. Large scale production has been hindered by relatively low production rates, size variability at harvest, and a relatively demanding process for producing seedstock.

Over the past five years interest in production of this animal has again increased due to an increasing demand for shrimp products, reduced supplies of shrimp (especially large sizes) due to serious disease problems in saltwater shrimp production, and increases in production rates for prawns based on new management and production practices. Other factors producing increased interest in production include identified markets for live and fresh prawns in inland locations, the growing trend among consumers wanting to know of how their food was produced, and the discovery that prawns actually grow more rapidly at cooler temperatures.

Chart 6 – U.S. shrimp consumption has steadily increased over the last 18 years.

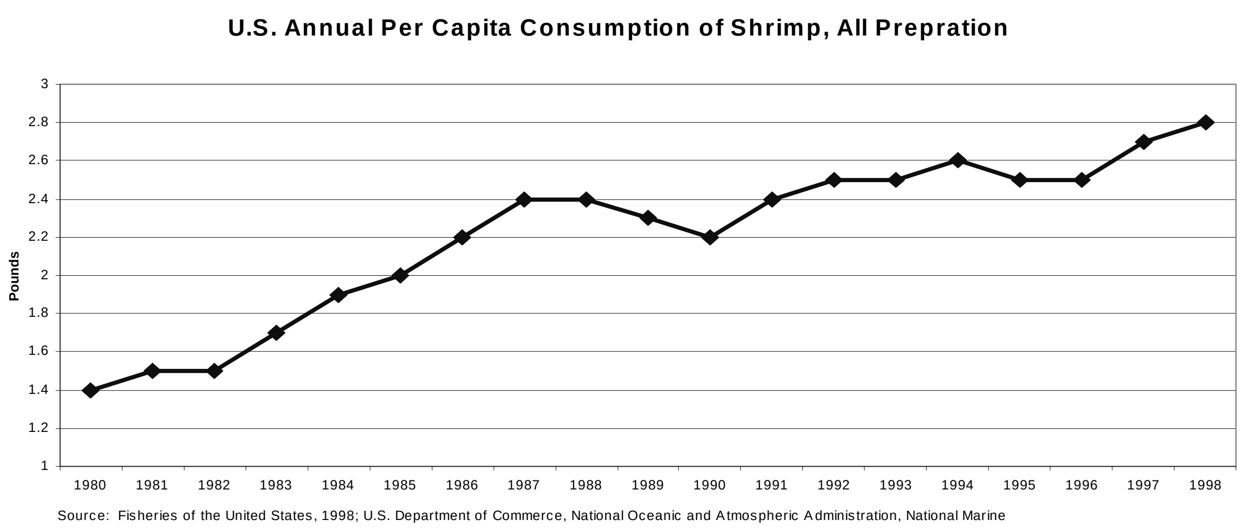
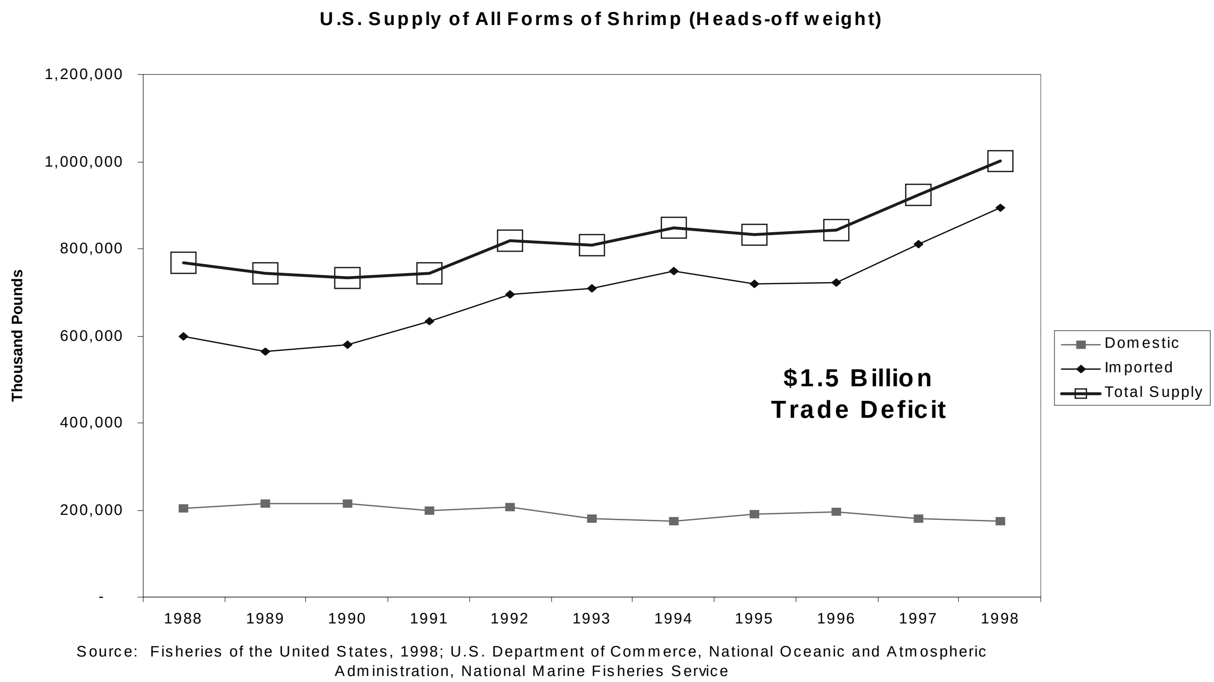


Chart 7 – U.S. domestic supply of shrimp has remained steady while imports have increased to meets needs of increased consumption of shrimp.

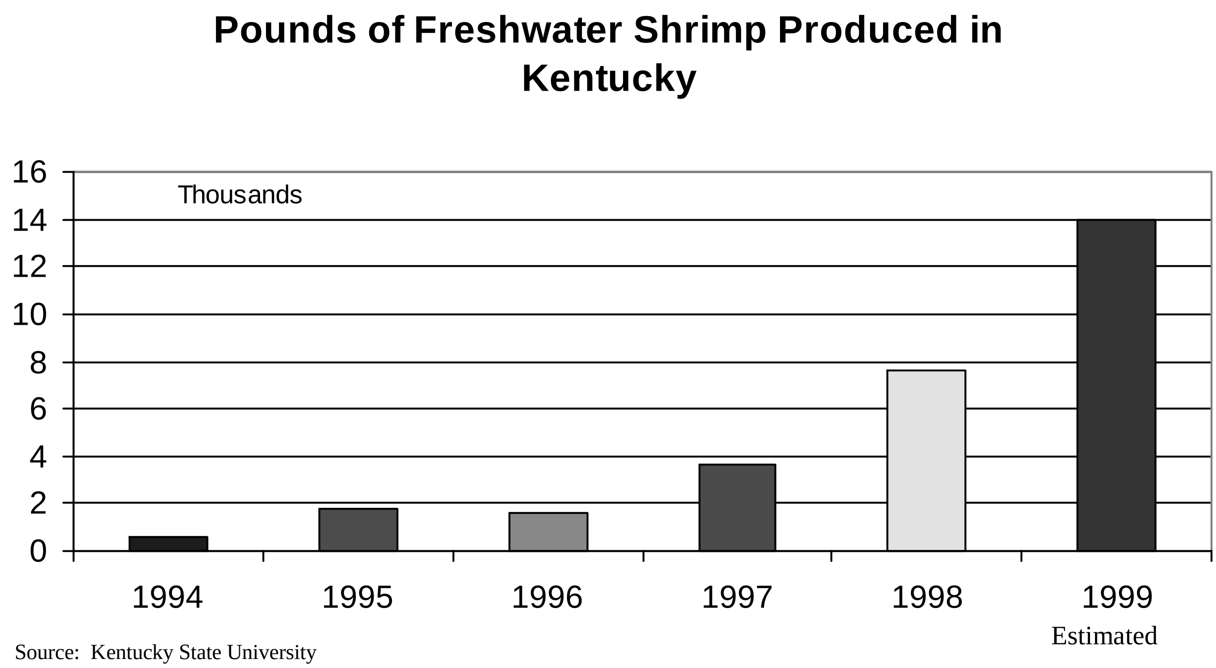


Seedstock production for prawns normally begins with selection of broodstock at the harvest of production ponds in the fall. The number of females is based on anticipated production needs. Broods must be overwintered in tanks at greater than or equal to 70º. Volume and added substrate in holding tanks should allow each brooder approximately two square feet of surface area. Broods should be fed a high quality marine shrimp diet or sinking salmonid pellet. Either should be supplemented with fish flesh and beef liver so that the females can store the proper nutrients in the egg yolks for the larvae to live on after hatching.

In Kentucky, production ponds are stocked in late May-early June with what are known as 60 day nursed juveniles (0.3-0.5 gram average weight). That is they have been grown for 60 days in freshwater after completing 30 days of larval development in brackish (salty) water. This means prawns should be hatched from mid-February to mid-March to allow sufficient nursery time prior to pond stocking.

Nursery tanks are normally much larger than larval tanks as stocking rates are reduced from approximately 200 per gallon in the larval tanks to 20 per gallon in the nursery tanks. These tanks must also be provided with mesh substrate structures sufficient to produce 40 post larvae per square foot density. In the nursery phase, water temperatures are maintained at 78-82ºF and the prawns are fed trout starter feeds at a declining percentage of body weight.

Chart 8 – Freshwater shrimp production has increases in Kentucky.



Production ponds should be properly prepared before juvenile prawns are transferred from the nursery. Most ponds used are 0.5-1.0 acre in size. Proper dimensions are for the pond to be about twice as long as it is wide. The pond bottom should slope to the drain end where a 8-10 inches drain pipe is located in the bottom of a catch basin which runs the width of the pond bottom. This catch basin is 1.5-2.0 feet deeper than the adjoining pond bottom and about 8 feet wide. Ponds are equipped with either paddlewheel or turbo aspirator type aerators which also mix and destratify the pond. Aerators are placed at the center of one of the long levees about six feet out in the water and push water straight toward the center of the opposite levee. Approximately 0.5-1.0 hp of aerator capacity is needed per acre. If ponds have been filled more than two weeks they should be treated to reduce predaceous insects.

Juvenile prawns can be transferred to the ponds in plastic bags filled with oxygen. These bags are floated in the pond 20-30 minutes before opening to allow temperature adjustment. The bags should be transferred in early evening, or protected from the sun if moved during the day. After 20-30 minutes the bags may be opened and pond water added at about a quart every 5 minutes. This will allow the juveniles to adjust to the factors other than temperature (i.e. pH, hardness, etc.). The number of prawns to be stocked depends primarily on marketing considerations. The higher the stocking density the greater the production (pounds per acre) but the smaller the average prawn. The other factor affecting stocking density is whether artificial substrate is added to the pond. To produce very large prawns, stocking densities of 8,000 - 12,000 per acre will produce about 600-700 pounds per acre with an average weight of 40-45 grams (10 prawns per pound). At 16,000 prawns per acre without substrate, about 1,000 pounds per acre of prawns are produced averaging 30-35 grams (12-15 prawns per pound). With artificial substrate added, the density can be increased to 24,000-26,000 per acre with production of

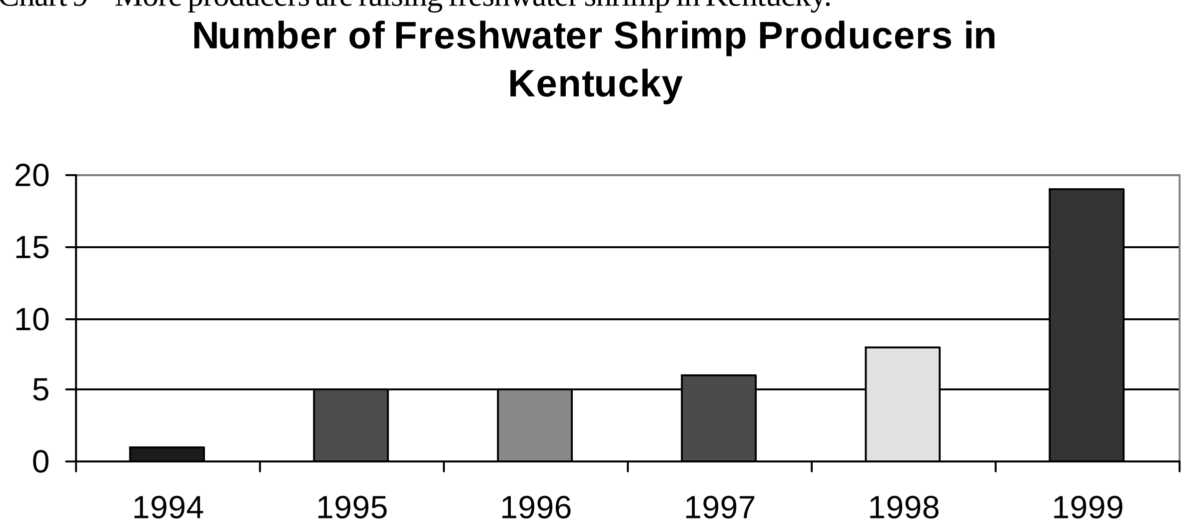
1,500-1,700 pounds per acre at this same average size of 35 grams.

Feeding of prawns should begin within 1-2 days of stocking. For the first month, supplemental feeds such as distillery by-products can be used at 20 pounds per acre per day. During month two, a 32% protein commercial pellet is gradually mixed in with the distiller's grains. During months three and four, a 'high' quality freshwater or marine shrimp pellet is fed based on body weight. From stocking until prawns weigh 5 grams, feed at 25 pounds per acre per day, distributing half in the morning and half in the evening. After prawns reach 5 grams in average size, the feeding rate is based on a percentage of the total estimated weight of prawns in the pond. During the period prawns are 5-15 grams, they are fed 7% of their weight daily, 15-25 grams are fed 5% of prawn weight, and greater than 25 grams are fed 3% of total prawn weight. Survival is assumed to be 100 percent.

To harvest the prawns, the pond is drained down to concentrate prawns in the harvest basin. Adding freshwater or providing aeration in the catch basin during harvest will reduce stress. Prawns are removed from the basin using a small seine then transferred to clean, aerated water (purging tanks) to allow them to remove mud and debris. If prawns are to be marketed live, they can be held in tanks for transport or sold directly to consumers on-farm. Prices of $6.00-$9.00 per pound have been the going prices in-state. If prawns are to be sold on ice or processed, they should be removed from purging tanks and immersed in ice water for 15-30 minutes to rapidly chill the prawns. They can then be held on drained ice until processed or sold. Maximum holding time is approximately five days for whole (head-on) prawns and 8-10 days for tails.

Presently, the only commercial freshwater shrimp hatchery/nursery is in Texas. KSU has purchased post-larval shrimp from this source and nursed them to stocker size for research and on farm demonstrations since 1994. Since beginning research on freshwater shrimp in 1990, KSU has been able to increase yields per acre, define appropriate production techniques, and demonstrate freshwater shrimp production in Kentucky can be viable.

Chart 9 – More producers are raising freshwater shrimp in Kentucky.



Source: Kentucky State University

Beginning in 1998, the KSU Aquaculture Research Center has been able to hatch and nurse freshwater shrimp from breeder stock. This is an important milestone towards developing an in-state freshwater shrimp industry. Another promising development is the addition of substrate into ponds to provide additional habitat for the shrimp. This technique has shown substantial increases in yield. The KDA has provided a grant to KSU for the 1999 and 2000 production season to provide a secure supply of juvenile shrimp for Kentucky producers to stock into grow-out ponds and to provide technical assistance to private producers to start commercial freshwater prawn hatchery nurseries.

(See appendix for recommended publications on Freshwater Prawns)

Freshwater Shrimp

Gross Revenue

	Yield		Selling Price		Gross Revenue	Your Farm
	1000	pounds	$6.75	lb	**$6,750**	
Your Farm						

Variable Operating Costs

	Units	Type	Cost per Unit	Cost		Your Farm
Stocking Costs	16000	prawns	$0.10	1600		
Feed	40	50# bags	$14.50	580		
Hired labor	32	hours	$8.00	256		
Marketing Charge				$405		
Other Operating Costs				486		
Total Variable Costs					**$3,327**	
Interest on Variable Cost	6 months @ 10%				**$146**	
Return Over Variable Costs					**$3,277**	

Fixed Costs	**Total Per Acre**	**Annualized**		
Short Term - 5yrs	$355	$71		
Long Term - 10 yrs	$7,210	$721		
Total Fixed Costs			**$792**	
Return to Land, Capital & Management			**$2,485**	

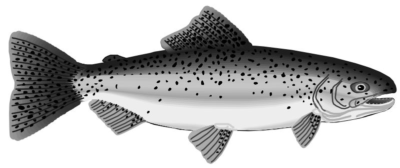
Operator Labor	43 hours	$8.00	$344		
Return to Land & Capital				**$2,141**	

Notes:
Based on per acre production

Additional References

Woods, Timothy, James Murdock, and Seth Riggins, Freshwater Shrimp Enterprise Cost and Return Estimates for Kentucky, Dept Ag Econ, UK, Ag Econ Extension Publication 98-05, December 1998

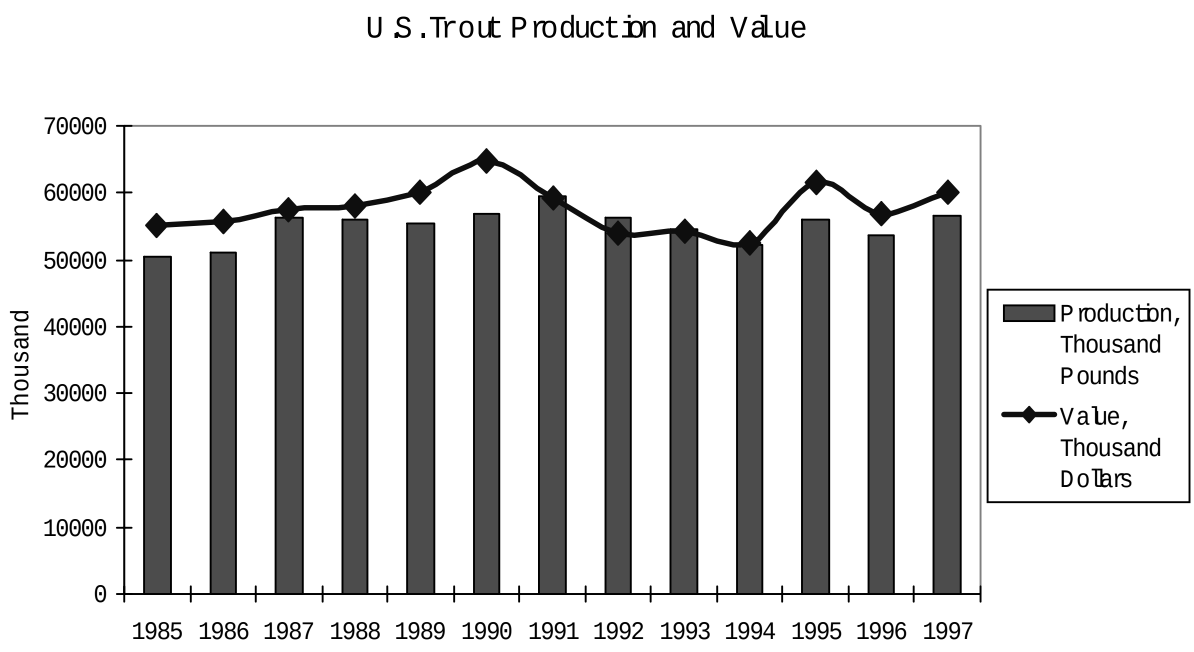
Montanez, J.L., James Dillard, and Marty Fuller, Economic Analysis of Production of Freshwater Shrimp, Mississippi State Experiment Station Bulletin 985, October 1992



Trout

Rainbow trout (*Onchorynchus mykiss*) are native to western North America and have been cultured for over 100 years. Over the last several years, the U.S. trout industry has been relatively stable in numbers of operations and value of sales and output. The state of Idaho produces the most trout in the United States (41 million pounds sold in 1998). North Carolina leads trout production (3.5 million pounds sold in 1998) in the southeastern states. Kentucky has a small, but well established commercial rainbow trout industry with seven year-round farms producing approximately 400,000 pounds. The U.S. Fish and Wildlife, Wolfe Creek National Fish Hatchery, located near Jamestown, Kentucky, also annually produces about 1 million trout for stocking as sportfish.

Chart 10 – Trout production in U.S. has been relatively steady over the last 12 years.



Source: Fisheries of the United States, 1998; U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service

Kentucky trout production is limited by the availability of large freshwater springs which provide gravity-fed water in adequate quantity. These springs must have a year round supply of contaminant free water. To insure trout survival, water temperature should rarely exceed 70 degrees F. For a small trout facility to provide supplemental income, flow rates of approximately 350-500 gallons per minute would be required. Small scale, full time trout farming would require flow rates of 1,000-2,000 gallons per minute.

Most Kentucky trout farms are equipped with egg incubation facilities. Eyed eggs are typically purchased from commercial brood fish farms located in the western United States. Trout and trout eggs should be certified to be free of diseases. Commercial culture occurs primarily in concrete raceways. Large volumes of water flow via gravity through a series of 4-8 raceways and is discharged into a receiving stream. Densely stocked fish are supplied with cold water which is rich in dissolved oxygen. The water flow removes wastes from the culture unit and is replenished with oxygen when spilled into the next raceway. The water flow rate, water chemistry, temperature, size of fish, and the rate of feeding determines the volume of fish that can be produced in a particular raceway system. Average values are 20-40 pounds of fish per gallon per minute flow rate per year.

Trout may also be stocked in ponds during late fall (October or November) at a rate of 1000-1200 fish per acre in ponds which allow seining and do not contain largemouth bass. During the winter, trout may also be grown in suspended cages and net pens. Trout, 8-10 inches in length are stocked in ponds, cages or net pens, in order to reach marketable size by spring (March or April). Six fish may be stocked per cubic foot of volume of a cage or net pen.

Currently, production and marketing research is underway to investigate profitable alternative water sources for growing trout. These would include waters associated with coal mining operations in eastern Kentucky. South Eastern Community College in Cumberland, Kentucky has been developing a trout production demonstration site as a result of a KDA Value-added Grant. S. E. Community College estimates there may be as many as 500 suitable trout production sites in Harlan, Bell, and Letcher Counties using water from abandoned deep coal mines. Grow-out culture and test marketing of winter, pond-raised trout is currently being conducted in fallow freshwater shrimp ponds. However, the high cost of stocker trout, feed, and poorly developed markets contribute to uncertain profitability of seasonal trout production. Efforts are underway to provide lower cost, advanced trout fingerlings for winter stocking. The KAA has applied for and been awarded a KDA Value-added Grant to contract with a trout producer to supply a lower cost source of Kentucky raised fingerlings. Cooperative purchase of larger feed shipments will be organized to reduce costs. Test marketing of small volumes of fresh trout is being conducted.

(See appendix for recommended publications on Trout

Trout Production in Concrete Raceways

Gross Revenue

	Yield		Selling Price		Gross Reven	Your Farm
	6250	pounds	$1.25	lb	**$7,813**	
Your Farm						

Variable Operating Costs

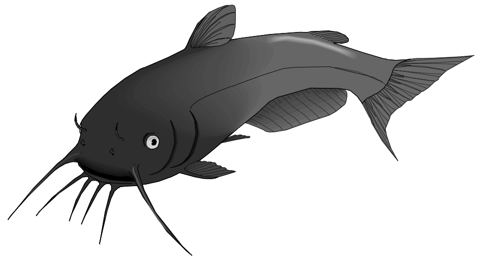
	Units	Type	Cost per U	Cost		Your Farm
Stocking Costs	9412	fish	$0.15	1411.8		
Feed - standard	106.3	cwt.	$23.00	2444.9		
Feed - medicated	11.8	cwt.	$34.00	401.2		
Electricity	12		$11.25	135		
Marketing charge	7500		$0.06	450		
Chemicals				37		
Total Variable Costs					**$4,880**	
Interest on Variable Cost		6 months @ 10%			**$316**	
Return Over Variable Costs					**$2,617**	

Fixed Costs	**Total**	**Annualized**		Your Farm
(2) Concrete Raceways 35' X 6"	$4,494	$300		
Total Fixed Costs			**$300**	
Return to Land, Capital & Management			**$2,317**	

						Your Farm
Operator Labor	165	hours	$8.00	$1,320		
Return to Land & Capital					**$997**	

Notes:

SRAC No. 221, Budgets for Trout Production: Estimated Costs and Returns for Trout Farming in the South, 1990 J.M. Hinshaw, E. Rogers, J.M. Easley.



Catfish

There are presently approximately 50 commercial catfish farms in Kentucky according to a survey done in 1998. The main growth area of catfish farming is in the Purchase Area of the commonwealth. Over a million dollars in total catfish sales by Kentucky catfish farmers were recorded in 1998. In Kentucky, catfish farming almost always involves the culture of channel catfish (*Ictalurus punctatus*).

Catfish spawn in late spring/early summer. Since catfish spawn 3-6 weeks later in Kentucky the transportation of eggs from hatcheries in states further south can functionally increase the growing season and produce larger fingerlings by the end of summer. It takes about 5 to 8 days for hatching and another 4 days for the fry to use up their yolk sac energy supply. The fry become swim-up fry and are fed in tanks approximately every 2 hours for about a week. They are then stocked into fertilized nursery ponds that have an abundant natural food source. (Fry can also be stocked into nursery ponds immediately after becoming swim-up fry). In the pond, the fry are also fed a finely ground, high protein feed such as salmon starter. Fry mature into fingerlings and reach approximately six to nine inches in length by the end of the first growing season when they are stocked at 40,000 per acre. Catfish fingerlings are grown in Kentucky but are often hauled in from other states farther south and stocked into Kentucky ponds.

Catfish fingerlings can be sold to commercial fish growers or to recreational pond owners directly or by way of live haulers. Good business is generated by catfish fingerling producers who haul fingerlings to recreational pond owners. In exchange for hauling small loads to the pond owner and providing technical advice, the hauler can charge more for the fingerlings, thus maximizing his or her profit.

Fingerlings of 6-9 inches are stocked into grow-out ponds at approximately 3,000 per acre if aeration is available; or 1,000 per acre without aeration. Stocking of grow-out ponds can be in the fall of the fingerling year or spring of the grow-out year. The catfish will gain more weight during the fall months when they are stocked at the lower density. In addition, they will be in the pond and ready to start growing at the first sign of warm weather the following spring. Often times growers' plans to stock in April are delayed until they can find an available source of fingerlings. This frequently delays stocking until May, and the valuable early-season growth opportunity is lost.

In grow-out ponds the catfish are fed a 28% to 32% protein feed containing soybean, corn, wheat, vitamin and mineral supplements, and usually fish meal. After they are fed, all the feed will be eaten within 20 minutes. This is approximately 1% to 3% of their body weight depending on water temperature and the size of the fish. Ponds ranging in size from a fraction of an acre to 20 acres or larger are used to grow out catfish. Recent trends in large catfish producing regions in the southeastern United States are for 10 to 15 acre ponds to be used to maximize management efficiency as well as being economical in pond construction costs. Ponds in Kentucky are typically smaller than this; there is a trend for the construction of ponds approximately 5 acres in size in the Purchase region of the commonwealth. Ponds in less flat regions are usually significantly smaller than 5 acres.

Water quality in commercial catfish production ponds must be monitored for water quality to ensure that the fish not only stay healthy, but are able to grow most efficiently. Water quality test kits are recommended for use by fish farmers. Workshops are held by the Cooperative Extension System to teach the proper use of these kits. Ammonia should be monitored at least once a week and nitrite should be checked about 2 to 3 times a week. High nitrite can be neutralized by adding salt (NaCl) to the pond water, and it is highly recommended that catfish farmers maintain a prophylactic level of salt in their ponds in case nitrite concentrations rise unexpectedly. In some parts of the commonwealth, large quantities of agricultural limestone are needed to add hardness and alkalinity (buffering capacity) to the water. This helps to prevent drastic pH fluctuations, which can be stressful to the fish.

In the event that the catfish should get sick during the production phase, there is a fish disease diagnostic laboratory on the main campus at KSU in Frankfort. Accurate diagnoses can be made there as well as appropriate treatment recommendations such as feeding medicated feed or improving water quality. The university laboratory is serviced by an American Fisheries Society Certified Fish Pathologist.

When channel catfish reach market size (about 1.25 pounds) at the end of the second growing season, they can be sold to processing plants or pay lakes either directly or via live haulers. Pay lakes may request that the fish be larger than one pound. About 2 million pounds of catfish are stocked into Kentucky pay lakes each year. Most of this comes from out-of-state sources, but progress has been made during joint KDA-KSU marketing workshops in coordinating business agreements among fish growers, live haulers, and pay lake owners. Other funding from the KDA has helped to establish a harvesting/hauling service for growers needing to have their fish harvested and sold to markets such as pay lakes.

Catfish are typically harvested with polyethylene or coated nylon seine nets that have floats on the top and heavy weights on the bottom. Seines can be pulled by hand by a harvesting crew or can be moved with tractors driving on top of the pond levees. Live cars (or “socks”) of a specified net mesh size can be attached to some seines, and are used to grade the fish in order to retain only the fish large enough for marketing and allow the small fish to escape back into the pond. After the fish are graded, they are dipped out of the live car and weighed before selling to the buyer. This can be done by hand or with the use of a boom and harvesting basket attached to an in-line scale.

Marketing to processing plants is an option for Kentucky catfish farmers. Presently, the only plants available are out-of-state. Kentucky-based fish processing plants operated from the late 1980s to the mid-1990s, but are currently out of business. Now, through a KDA value-added grant, a cooperatively owned processing plant is being organized in western Kentucky.

Expansion of Catfish Production

The KAA and the Purchase Area Aquaculture Cooperative are examples of producers that are organizing to develop catfish production, processing, and marketing. There is a great deal of technical support available to further development the industry, including the KSU Aquaculture Research Center, Cooperative Extension Specialists, and the KDA.

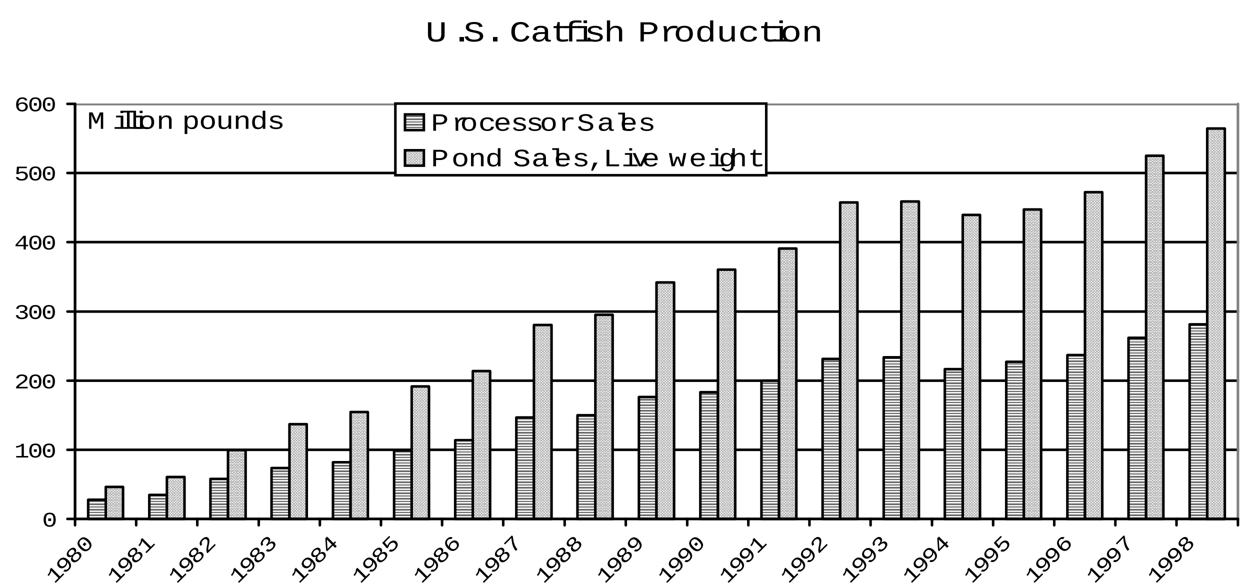
The natural resource base for expanding catfish production in Western Kentucky is excellent for several reasons:

a) There is over 20,000 acres of fairly level (less than 2% slope), poorly drained soils in the purchase area that are better suited for building level type catfish ponds than they are for their present use, row crop production.
b) Western Kentucky has an abundant supply of good quality groundwater at relatively shallow depths. This water supply is essential for good management of catfish ponds.
c) The growing season is adequate to produce 1¼ to 1½ pound fish, ideal for processing. There are fewer days in which water reaches temperatures high enough to severely stress the fish than in states where the growing season is longer.

Markets for processed catfish are expanding nationally and local markets are excellent.

(See appendix for recommended publications on Catfish production)

Chart 11 – Catfish production, pond side and processor sales, has increased.



Source: USDA

Catfish

Gross Revenue

	Yield		Selling Price		Gross Revenue	*Your Farm*
	4000	pounds	$0.80	lb	**$3,200**	
Your Farm						

Variable Operating Costs

	Units	Type	Cost per Unit	Cost		
Stocking Costs	3500	fingerlings	$0.15	$525		
Feed	3	ton	$225.00	$912		
Hired labor - productior	10	hours	$8.00	$80		
Electricity				$375		
Hired labor - harvest	4000	per pound	0.04	$160		
Marekting Costs				$192		
Total Variable Costs					**$2,244**	
Interest on Variable Cost	1 year @ 10%				**$224**	
Return Over Variable Costs					**$732**	

Fixed Costs	**Total Per Acre**	**Annualized**		
Levee Construction	$2,500	$166.67		
Well Construction	$500	$33.33		
Piping	$150	$10.00		
Pick-up Truck	$225	$15.00		
Bulk Feed Storage	$200	$13.33		
Aeration	$200	$13.33		
Feeders	$100	$6.67		
Total Fixed Costs			**$258**	
Return to Land, Capital & Management			**$473**	

Operator Labor	50	hours	$8.00	$400		
Return to Land & Capital					**$73**	

Notes:

Based on per acre production

Live-haul to paylakes also presents an attractive opportunity for some producers. This budget is based on marketing to a processor.

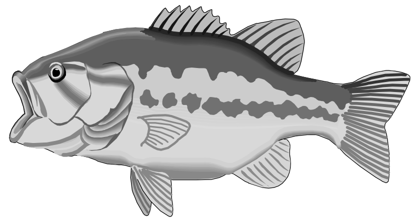
Published yields vary considerably; 3,000-4,500 pounds per acre. Higher yields are accessed through constant aeration.

Production Cost References

Stone, Nathan, Small Scale Catfish Production: Introduction, U Arkkansas CES FactSheet, 1994

Stone, Nathan, Carole Engle, and Robert Rhode, Costs of Small-Scale Catfish Production, U Arkansas CES FactSheet, 1997

Personal interview with Norm Penner



Largemouth Bass

The largemouth bass (*Micropterus salmoides*) is a member of the Sunfish Family (*Centrarchidae*). Members of the genus *(Micropterus)* are known as black bass and share the sunfish family with the bream (*Lepomis spp.*), crappies (*Pomoxis spp.*) and several other genera. The largemouth bass is native to the midwestern and southeastern United States and northeastern Mexico. At present, largemouth bass have been introduced throughout the United States and many other countries worldwide. Interest in the commercial culture of largemouth bass is due to the great demand and a high selling price compared to other cultured species.

The largemouth bass is one of the most popular sport fish in the United States. Although there has been extensive research on largemouth bass for many years, this work has almost exclusively addressed hatchery production and fisheries management. Amazingly little research has been conducted on growth of bass to larger sizes, their nutritional requirements, or suitability as an aquaculture species.

In the 1960s, Dr. Snow at Auburn University conducted a series of studies on raising largemouth to sizes of 6-8 inches on feed as a method of increasing and intensifying hatchery production for sportfish stocking. During the 1980s a number of federal and state hatcheries refined feed training techniques, again to maximize hatchery production. In recent years aquaculturist have become interested in the culture of feed trained largemouth to larger sizes. This interest is based on an increasing demand for large bass for remedial stocking in sportfish ponds, their use in commercial “trophy” lakes, and a demand for live bass as a food fish among ethnic Asians.

The production of largemouth bass fry follows well establish procedures dating back to the 1930s. Largemouth bass are usually pond spawned and do not require hormone or photoperiod manipulations. Broodfish of greater than or equal to 2 years of age and 1.5 pounds in weight are stocked into 0.5-1 acre spawning ponds at 50 brood pair per acre. Ponds must be free of existing fish. Spawning ponds are normally not fertilized so that spawning behavior, eggs, and fry can be observed easily and more easily harvested. Broods may be stocked when temperatures reach 65°F and spawning should begin soon after.

Since spawning ponds are not fertilized a nursery pond should be prepared as soon as spawning begins using organic and inorganic fertilization so as to contain large numbers of food items (zooplankton) for the bass fry. When large numbers of fry can be seen in the spawning pond, fry should be transferred from the spawning to the nursery pond and stocked at 40,000 - 80,000 fry per acre. After 3-4 weeks in a properly prepared nursery pond bass should reach 1.5-2.0 inches in length and be ready for feed training.

To feed train largemouth bass (and several other species) the basic concept is to remove the fish from the natural source of food, crowd them at high densities, and present them with highly palatable prepared foods at frequent and regular intervals. For feed training, fingerlings (1.5-2.0 inch) are seined from the nursery pond, graded to uniform sizes, and stocked in flow through tanks (round or rectangular) at a high density, which is based on water flow. Fish are then offered either freeze dried krill, ground fish flesh, or fish eggs. Freeze dried krill is especially effective, commercially available, and easy to feed and store. These highly palatable products are then gradually mixed in with a high quality salmonid diet. With fish flesh and eggs a semi-moist diet is produced. Over a series of about a week, each day's feed ration should be increasingly comprised of the manufactured feed. By Day 7 the fish should be consuming straight feed. Fish that have trained to take the feed will by this time be thick bodied, with large bellies, and can be removed with graders. The "feed trained" fish should be moved to a separate tank or compartment and maintained on feed for several more days before pond stocking. Fish that haven't obviously trained can be left in the tank and the use of moist training diets or krill may be repeated. After an additional week most of these fish should adapt to the diet. With good results about 80-90% of the fish originally stocked should train to accept artificial diets. Recent studies have shown that offspring from second or third generation feed-trained fish train easier than those from forage fed fish indicating improvements from domestication.

During the training period tanks should be cleaned daily and water quality maintained by suitable flow through. Because of the crowded conditions and large amounts of feed used, external parasites can be a real problem as can Columnaris. Diagnose and treat affected fish quickly and properly. Terramycin has been used effectively to treat Columnaris by inclusion in the feed training diets. A 0.5 or 1.0% salt bath for up to 1 hour is effective in reducing stress when handling and grading and also will reduce the occurrence of infectious disease. Potassium permagenate has been used with mixed results.

After the fish have been feeding actively in tanks for at least 2 weeks, fish can be stocked into ponds at 20,000 - 30,000 per acre and fed 2-3 times per day using a 40-48% protein salmonid diet with 8-10% fat. Feed the fish all they will readily consume at each feeding. Largemouth will feed voraciously on some days and not so actively on others, this is probably associated with temperature, sunlight, and/or water quality changes. A floating diet is desirable as it allows the person feeding to more easily observe the fish feed to satiation . Bass should attain sizes of 6-8 inches (with some larger individuals) by the following fall. This size is well suited for pond stocking and brings approximately $0.75 per fish wholesale and $1.50 per fish retail.

To produce fish of greater than or equal to 1 pound will require at least one additional year of growth. Fish can be thinned to grow-out densities either in the fall or spring, however fish should not be handled when water temperatures are below 55°F due to fungal infections. Some papers have recommended a grow-out density of 2,000 per acre. However, research at KSU found no difference in average weights of fish stocked at 5,000 or 2,500 per acre, while the higher density produced double the amount of fish per unit of pond. Additional research at KSU found production was best in bass stocked at 5,000-6,000 per acre and fed a 46-48% protein diet with 6-8% lipid. Fish were fed once daily to satiation and produced approximately 4,500 pounds per acre of fish which averaged just under (9/10's) a pound. Bass can be harvested by seine similar to catfish. They are actually easier to catch, but will jump over the seine if edges aren't held high.

Water quality tolerances in largemouth bass vary with age and other culture conditions. Data indicate that feed conversion efficiencies are reduced at oxygen concentrations below 4 milligram per l, avoid D.O. levels less than 3 milligram per liter and can tolerate a D.O. of 1.4 milligram per liter at 25°C. Ammonia tolerance is similar to or slightly less than channel catfish with a 24 hour un-ionized ammonia LC_{50} value of 1.69 milligram per liter. However, centrarchids appear to be very tolerant of high nitrite concentrations due to an ability to prevent absorption. The 96 hour LC_{50} for nitrite is 24.8 milligram per liter in channel catfish but 460 milligram per liter in largemouth bass.

Nutritional research on largemouth bass is extremely limited. In the 1960s Snow at Auburn successfully used the Oregon Moist Pellet, formulated for salmonids, to juvenile bass to a size of about 8 inches. In the 1980s requirement studies determined a protein requirement of 41% for age-one fish. Pond studies raising second year fish to approximately 3/4 of a pound demonstrated that diets containing 42-48% protein could be advantageous. Most largemouth bass in commercial production are currently fed high protein (greater than 40%) salmonid diets based primarily on ready availability. However, reported problems concerning pale, fatty livers and mortality have been thought to be nutritionally related. Liver problems may reflect a skewed protein/energy ratio or excess carbohydrates in the diet. Winter mortality in pellet fed fish has also been reported and could be related to nutrition, especially vitamin deficiencies. Additional nutritional research is sorely needed as an essential component to the development of the efficient aquaculture production of this fish.

Largemouth are susceptible to many of the parasites and bacterial disease common to most cultured fishes. Diseases specific to the largemouth bass are not common although there are recent reports of a largemouth bass virus. The best advice to avoid disease problems is to minimize handling during the summer and winter. Like other centrarchids, especially crappies, largemouth are very susceptible to columnaris (saddleback) disease, especially during the training period. Juvenile bass are especially prone to fungal infections (*Saprolegneosis*) when handled at temperatures less than 55°F and mortality can be extremely high.

Asian consumers appear to desire live largemouth bass above all other freshwater fish. They desire fish of 1.5-2.0 pounds which may require third year grow. A study at KSU showed relatively slow third year growth as fish only went from 0.9 pound to 1.2 pounds during the third summer. Interestingly though, fish grew better at high densities. Production methods for sizes greater than 1.0 pound should be investigated further, as demand for fish of this size has been identified in excess of 700,000 pounds per year at over $3.00 per pound live weight.

Processing of largemouth has not been reported. However, the basses tend to have a relatively round body profile, and may become quite thick in body confirmation at large sizes. Preliminary data from KSU indicated dress-out values similar to catfish (60% whole dress, 40% filet), relatively high protein levels, and extremely high levels of omega-3 fatty acids. These are the "heart healthy" fatty acids reported to be so advantageous for human health.

(See appendix for recommended publications on Largemouth Bass)

Largemouth Bass

Gross Revenue

	Yield		Selling Price		Gross Revenue	*Your Farm*
	3500	pounds	$3.00	lb	**$10,500**	
Your Farm						

Variable Operating Costs

	Units	Type	Cost per Unit	Cost		
Stocking Costs	5000	fingerlings	$0.50	$2,500		
Feed	3	ton	$650.00	$1,950		
Hired labor	40	hours	$8.00	$320		
Electricity				$375		
Marketing charge	3500	pounds	$0.10	$350		
Total Variable Costs					**$5,495**	
Interest on Variable Cost	1 year @ 10%				**$550**	
Return Over Variable Costs					**$4,456**	

Fixed Costs	**Total Per Acre**	**Annualized**		
Levee construction	$2,500	$166.67		
Well construction	$500	$33.33		
Piping	$150	$10.00		
Bulk feed storage	$200	$13.33		
Aeration	$200	$20.00		
Feeders	$100	$10.00		
Pickup Truck (1/2)	$200	$20.00		
Total Fixed Costs			**$273**	
Return to Land, Capital & Management			**$4,182**	

Operator Labor	50 hours	$8.00	$400		
Return to Land & Capital				**$3,782**	

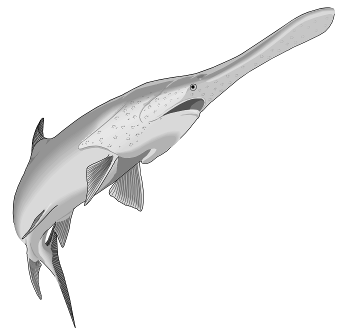
Notes:

Based on per acre production comparable to a 4 5-acre pond catfish production system
Yields range between 4,000-4,500 lbs/acre under experimental conditions
Price is based on live-weight sales. Higher prices may be available selling to sportfish ponds
Higher prices of $3.25-$4.25 have been quoted for live weight
Stocking costs can be reduced to $0.25/fish if purchased in large volume

Production Cost References

Stone, Nathan, Small Scale Catfish Production: Introduction, U Arkansas CES FactSheet, 1994
Stone, Nathan, Carole Engle, and Robert Rhode, Costs of Small-Scale Catfish Production, U Arkansas CES FactSheet, 1997

Pond construction costs reflect helpful input from Mr. Norm Penner
Stocking and yield estimates conservatively reflect those observed at the KY State U Aquaculture Res Ctr



Paddlefish

Paddlefish, spoonfish, spoonbill cat, and *Polyodon spathula* are among several names given to this unique prehistoric fish. The paddlefish is the largest (over 200 pounds, 6-foot long) freshwater fish in the United States and is found in 26 states that have large streams, rivers, and impoundments within the Mississippi River basin and adjacent Gulf Coastal drainages. Paddlefish are highly valued for its black eggs (roe) processed into caviar and its boneless, firm, white meat. However, they are currently available only from the wild populations. Overexploitation and contamination by organochlorine pollutants (i.e. PCB) have required that many state agencies close down this valuable fishery. Commercial paddlefish farming is necessary to meet the market demand for its caviar and meat and alleviate harvest pressure from the wild paddlefish fishery.

Paddlefish have many outstanding characteristics for aquacultural development as a food fish in Kentucky and other states of the United States. Paddlefish filter feed on zooplankton throughout life, are long-lived (greater than 20 years), and grow rapidly (up to 10 pounds per year) reaching sizes up to 200 pounds. They can be harvested by selective gill nets or by seining. Paddlefish can be propagated artificially and fingerlings raised intensively up to 14 inches in ponds, then grown for meat and roe intensively in ponds with catfish or extensively in reservoirs. Paddlefish meat is firm and boneless with a beef or pork-like texture, and it is also similar to sturgeon in taste and texture.

Artificial Propagation

Currently, broodstock are obtained from wild sources. Typically, males are smaller (by one-third to one-half in weight) than females, and have tubercles on their head and opercular flaps that feel like sandpaper. In contrast, mature females have few, to no tubercles, and the abdomen is round and extended during the pre-spawning period.

Broodstock must be held in circular tanks (8 foot) in the hatchery. Water temperature of 60 to 65°F, flow rate of 2 gallon per minute and water saturated with oxygen are optimal conditions. Broodstock should be injected intraperitoneally with hormones to induce spawning. For milt collection, tubing attached to a syringe is inserted into the urogenital pore and collected from the fish. Large volumes of milt can be obtained from one male. Milt from two to three males should be used to fertilize the eggs so as to increase genetic diversity. Milt is checked microscopically and 75-100% of the spermatozoa should be motile.

Milt can be collected several hours before use and stored in sealed containers on wet ice.

For collection of eggs, any one of several methods can be used: hand-stripping, caesarian section, or the Minimally Invasive Surgical Technique, MIST. Hand-stripping is labor intensive and often requires three individuals 8-10 hours at about 30-minute intervals to remove the total volume of eggs. Caesarian section is a relatively quick surgical method (30 minutes) to remove eggs through a 3-4 in abdominal incision; however, suturing is time consuming and muscular stress on the incision usually results in poor retention and less than 25% survival of broodstock. The MIST is minimally invasive and permits quick removal of ovulated eggs and requires much less handling time than the other methods. This method of egg removal involves a small incision in the dorsal area of the oviduct which permits direct stripping of eggs (10 minute) from the body cavity through the gonopore, and bypasses the oviductal funnels. Greater than 90% survival of broodstock is expected.

The eggs should be fertilized using the "wet method". Milt is added to water at a 1:200 ratio (milt to water) and then immediately poured onto the eggs. The fertilized eggs are stirred for one minute then coated with Fuller's earth suspension for 20 minutes. The eggs are then rinsed free of Fuller's earth, volumetrically measured and loaded into McDonald jars at about 70,000 eggs per 2-gallon incubator. Larvae hatch in approximately 6 days when eggs are incubated at 65° F. Larvae must be held for another 5 to 6 days before they will consume food.

Nursery Phase

Larvae can be grown in fertilized earthen ponds or in tanks. In ponds, live food such (*Daphnia spp.*) must be present in order for the paddlefish larvae to have appropriate food until they are large enough to accept extruded pellets. In tank culture, paddlefish larvae can be trained to feed only on prepared diets (i.e. RangenR Trout/Salmon diets).

For pond culture, site preparation should begin about two weeks before spawning. Ponds should be drained and dried. After fish have been spawned, the pond should be flooded with well water or from filtered reservoir water. Rice bran is recommended as the organic fertilizer for paddlefish nursery ponds to promote zooplankton i.e. (*Daphnia*). Once the fish reach about 3.5 inches, they can be trained to eat a 1/16-inch extruded pellet (45% protein). Survival rates can range from about 50 to 80%. It takes approximately 6 weeks for the paddlefish to reach about 5 inches at which time they are able to filter feed. If fish are trained on a prepared diet, they can remain in the ponds and will continue to grow up to 0.5 pounds and 14 inches in about six months.

Production systems

Reservoir ranching and polyculture with catfish are two practical systems to raise paddlefish for caviar and meat. Production of paddlefish in these systems relies on the filter-feeding of naturally produced food organisms; therefore requiring no feed cost and little management. Reservoir ranching is an extensive method for producing paddlefish. Fish are stocked at low densities (10-20 fish per acre) and can reach 10 pounds per fish in about 18 months and can be sold for their meat or permitted to grow until maturity, and then harvested for their roe. Fish are captured with gill nets with nearly 90% efficiency. Survival of greater than 50% is expected in reservoirs. Use of all-female paddlefish for caviar production would be most beneficial in this system.

Polyculture of paddlefish with catfish is a more intensive system than reservoir ranching. Paddlefish stocked at 30-80 fish per acre with catfish stocked at 4, 000 per acre can reach up to 7-10 pounds in about 12 months with survival of greater than 90%. Fish can be harvested by seining and easily sorted by hand from the catfish. This system is best for paddlefish meat production or for grow-out of paddlefish fingerling for ranching. Further investigation of polyculture with catfish is being conducted through a grant funded by Southern region SARE Program 1999-2001.

Currently there are no commercial sources of paddlefish fingerlings available for fish farmers wanting to try paddlefish. Because of the demand for fish farmers wanting to try paddlefish products, both in-state and out-of-state, and the limited supply of wild caught fish, KSU Aquaculture Research Center applied for and received a KDA Value-added Grant to produce paddlefish fingerlings and to teach interested Kentucky fish farmers how to hatch and raise paddlefish fingerlings.

Food Science/Marketing

Paddlefish meat is firm and boneless and is very similar to sturgeon in taste and texture. We have shown that paddlefish meat is well accepted by consumers. Even those who do not eat fish regularly liked paddlefish products. Recently, we have a developed several smoked paddlefish meat products. Several of the products have been well received in white tablecloth restaurants, gourmet shops, as well as, currently being test marketed in a large food chain in Kentucky. Paddlefish meat also has been tested for surimi (imitation crab meat) production with promising results. Further development of value-added paddlefish products is being studied.

Research at the Aquaculture Research Center, KSU, Frankfort has focused on the development of all-female stock (via genetic manipulation) for the caviar industry, commercial production (reservoir ranching and polyculture) for its meat, food science research for value-added products, and marketing. Most of this information is available for (potential) fish farmers to consider raising paddlefish as an alternative food fish; this is essential to the growth of Kentucky aquaculture.

Russia and other states of the former Soviet Union were the main sources of caviar and sturgeon fish products. The collapse of the Soviet economy has severely impacted the supply of caviar and sturgeon from the Caspian Sea. Paddlefish meat and caviar are similar to sturgeon and have demonstrated a following in the marketplace. Because of this, there is interest in Kentucky paddlefish from caviar and value-added fish products wholesalers. The largest caviar in the U.S. has made several trips to Kentucky investigating the potential to purchase and process paddlefish meat and roe. If a volume supply of paddlefish could be produced in Kentucky, the wholesaler has stated they would be willing to establish a processing facility in Kentucky for paddlefish and other Kentucky fish. Because paddlefish can be grown out in large bodies of water with no feed costs, the Aquaculture Task Force recommends the possibility of using specified public bodies of water to reservoir ranch paddlefish. Reservoir ranching of paddlefish could potentially generate significant aquaculture income and create needed processing facilities within the commonwealth.

(See appendix for recommended publications on Paddlefish)

Paddlefish - Polyculture Supplement to Catfish

Gross Revenue

	Yield		Selling Price		Gross Revenue	*Your Farm*
	200	pounds	$5.50	lb	**$1,100**	
Your Farm						

Variable Operating Costs

		Units	Type	Cost per Unit	Cost		
Stocking Costs		50	fingerlings	$2.00	$100		
Feed	n/a		50# bags	$14.50	$0		
Hired labor		1	hours	$8.00	$8		
Marketing Charge					$66		
Total Variable Costs						**$174**	
Interest on Variable Cost		12 months @ 10%				**$17**	
Return Over Variable Costs						**$909**	

Fixed Costs	**Total Per Acre**	**Annualized**		
3% of catfish enterprise	$350	$35		
Total Fixed Costs			**$35**	
Return to Land, Capital & Management			**$874**	
Operator Labor	1 hours	$8 / $8		
Return to Land & Capital			**$866**	

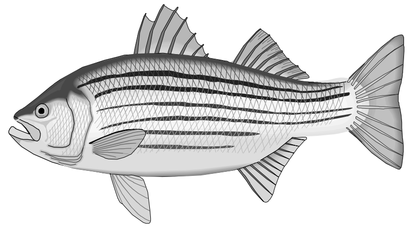
Notes:

Based on per acre production

Assumes growing out paddlefish in an operating catfish enterprise

May see some higher costs assocaited with higher aeration

Additional value-adding opportunities exist with the paddlefish, including processing for fillets, smoking, delivery, etc. While higher revenues may be realized, they also will involve higher production and marketing costs.



Hybrid Striped Bass

Hybrid striped bass (HSTB) are produced by crossing striped bass (*Morone saxatilis*) with white bass (*M. chrysops*). There are two crosses produced: the original cross (also called palmetto bass) is made by using female striped bass and male white bass; the reciprocal cross (also called sunshine bass) is made when female white bass and male striped bass are used. Hybrid striped bass require warm water temperatures (68-86°F) for rapid growth and thus, many pond-based farms have been located in the southern United States. In 1992, approximately 60% of all HSTB production occurred in this region. However, HSTB can be farmed in a wide variety of culture systems, including earthen ponds, raceways, cages, and large cylindrical tanks. In pond systems, ground and surface waters are used and the ambient temperatures control the fish's health and growth rate. In tank or raceway culture systems, heated water can be utilized and recirculated. These recirculating systems are usually indoors and can be developed in areas where pond culture may not be feasible or where natural water temperatures may be too cold to allow for optimal growth rates. Massachusetts, for example, is a leading producer of HSTB, almost exclusively through the use of recirculating systems.

Hybrid striped bass culture can be divided into four phases of production: Phase I culture, the hatchery phase, where the hatched fry are grown for 30-60 days to reach a 1-3 inches fingerling, Phase II culture where phase I fish are grown for between 5 to 9 months to grow to 3 to 10 inch fingerlings, and Phase III culture which is basically a grow-out of fish to market-size (1.5-2.5 pounds) or to adult fish.

For Phase I culture, there are many variables that need to be taken into consideration when growing hatched fry (larvae) to a small fingerling such as pond preparation, water quality management, and handling of fry. All these will differ based on method of production, desired intensity of production, and edaphic conditions of site. In general, 5 to 10 day old fry (post-hatch) are stocked into ponds at rates of 50,000 to 60,000 fry per acre. However, many facilities growing fish for stock enhancement will stock up to 250,000 fry per acre. For commercial food-fish production, a lower stocking rate will allow for more rapid growth. Survival of fry-to-fingerlings can be low (less than 20%), however, values between 25-60% are typical. Fry should be stocked into ponds at night to minimize stress and when water temperatures are 66°F. Oxygen level of the pond should be recorded twice daily (a.m. and p.m.) and ammonia, nitrite, pH, and alkalinity measured twice per week. The ponds are generally fertilized one to two weeks prior to stocking with inorganic or organic fertilizers to aid in the growth of zooplankton which the fry eat. Fry generally will eat the zooplankton in the pond, but supplemental feeding may allow for increased growth and survival of fry. When fish are about 21 days old, a high-protein salmon starter diet is fed 1 to 3 times per day, 7 days per week, at a rate of between 1-5 pounds per acre per day for the first week, and increased up to 10-15 pounds per acre per day, thereafter. It is generally recommended not to exceed 30 pounds acre per day.

When Phase I fingerlings are ready to be grown to larger fish, they are harvested from the nursery ponds and stocked into ponds for Phase II production. Stocking density for phase II production ranges from 4,000 to 100,000 fish per acre based on the required target size for the fingerlings. For commercial food-fish production, values of between 10,000 and 15,000 fish per acre should be used. Diet should be a high protein (35-50%) floating diet with a pellet size that will allow for consumption by the fish. Feeding rates can be as high as 20% of body weight (BW) for the first 30 days after stocking, but decreased monthly until harvest so that fish should be fed 3-4% BW at that time. Farmers should not sample fish, if possible, since that can lead to stress of fish and disease. The average culture period for Phase II fingerlings is the shortest 150 days and should reach a size of 40 grams per fish (12 fish per pound) and be 6 inches in length. However, there have been reports that fish can reach a weight of greater than 90 grams (5 fish per pound) in a growing season.

Production of Phase III fish involves the growing of hybrid striped bass to market-size on to adults that can be used as broodstock. Phase II fingerlings to be stocked for grow-out should weigh 100-250 grams (4.5 to 2 fish per pound) and stocking density should be between 2,000-6,000 fish per acre. A floating diet with between 38-40% protein should be fed, and fish should be all they will eat once or twice daily, 7 days per week. A standing crop of HSTB at harvest ranges between 2,000 and 5,000 pounds per acre with average weights of 1-2 pounds, and feed conversions of 1.5-2.3.

The culture of HSTB in intensive recirculating systems can also be accomplished. Aquaria can be used to grow fry (larvae) for approximately 10 days post-hatch at densities of 4,000 fry per gallon. After this period, fry should be transferred to either circular tanks (preferable) or rectangular per square tanks. Biological and mechanical filtration systems must be used when growing HSTB in an indoor facility. Costs for tank production have not been reported, but it is surmised that it is at least $2.30 per pound depending upon numerous variables. This is as opposed to costs of $1.75 per pound for pond production. However, tank culture is a profitable enterprise if the producer has identified the proper market(s). Cage, raceway, and intensive pond production methods can also be used to produce HSTB, each having their own requirements.

(See appendix for recommended publications on Hybrid Striped Bass)

Hybrid Striped Bass

Gross Revenue

	Yield		Selling Price		Gross Revenue	*Your Farm*
	3500	pounds	$2.50	lb	**$8,750**	
Your Farm						

Variable Operating Costs

	Units	Type	Cost per Unit	Cost		
Stocking Costs	5000	stockers	$0.30	$1,500		
Feed	3	ton	$650.00	$1,950		
Hired labor	40	hours	$8.00	$320		
Electricity				$375		
Marketing charge	3500	pounds	$0.10	$350		
Total Variable Costs					**$4,495**	
Interest on Variable Cost		1 year @ 10%			**$450**	
Return Over Variable Costs					**$3,806**	

Fixed Costs	**Total Per Acre**	**Annualized**		
Levee construction	$2,500	$166.67		
Well construction	$500	$33.33		
Piping	$150	$10.00		
Bulk feed storage	$200	$13.33		
Aeration	$200	$20.00		
Feeders	$100	$10.00		
Pickup Truck (1/2)	$200	$20.00		
Total Fixed Costs			**$273**	
Return to Land, Capital & Management			**$3,532**	

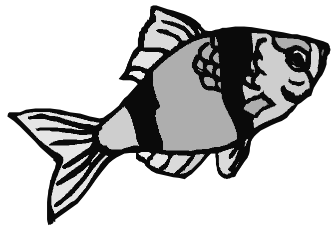
Operator Labor	50	hours	$8.00	$400		
Return to Land & Capital					**$3,132**	

Notes:

Based on per acre production

Yields in a pond system can vary significantly, 2,000-5,000 lbs per acre.

Production and prices are based on targeting fresh product for sale to retail establishments. Higher prices can be obtained in live markets and sales to restaurants, however larger production and marketing costs will be incurred.



Baitfish

Kentucky has several large reservoirs and lakes as well as many smaller lakes, thousands of miles of rivers, and over 135,000 farm ponds. These countless shorelines and waterways offer recreational and sport fishing opportunities for Kentucky residents, and visiting tourists. One thing is certain, when our fishermen sit back and relax to “wet a line,” they need to bait their hooks.

Baitfish are usually purchased at local or area bait shops (retailers). Most of the minnows sold in the United States are raised on fish farms in Arkansas and several other southern states. It is estimated that in 1989, Arkansas had 27,800 acres of ponds dedicated to the production of baitfish or minnows, solely. The income generated from these baitfish was estimated at over $25 million. By 1995, Arkansas baitfish production had increased to 28,900 acres with farm gate sales of over $47 million. Today, baitfish aquaculture ranks fourth with more than 60,000 acres of production in the United States. Annual retail sales of baitfish in Canada and the U.S. have been estimated at $1 billion.

The word “baitfish” is a common term used to describe small fish used as bait for sport fishing. Several species of fish are raised as bait: golden shiners (*Notemigonus crysoleucas*), goldfish (*Carassius auratus*), and fathead minnows (*Pimephales promelas*). Golden shiners are the primary species that is farmed for bait (75% of sales in Arkansas). The techniques used to produce the different types of baitfish are similar.

Golden shiner fry for stocking are produced on the farm in broodfish ponds. Mature adults are stocked into broodfish ponds at approximately 400-500 pound of fish per acre. Spawning mats are placed in shallow water around the pond’s edge at 100 mats per acre when water temperatures have warmed to 65°F. When the mats have been covered with eggs, they are transferred to fry-rearing ponds (50-100 mats per acre) to allow hatching. After the fry have hatched, the mats are removed from ponds, dried and stored.

Commercially prepared feed is offered to golden shiners in rearing ponds at an initial daily rate of 5 pounds per acre. Feeding rates are increased to 35 pounds per acre by the end of the production season. Pond management includes liming and fertilization, and chemical applications to control diseases if they occur. Water losses due to evaporation are replaced by pumping from wells. Baitfish are harvested by seining the entire pond or by seining a small area of the pond where fish have been congregated for feeding. With good management and carefully controlled daily feeding, minnow harvests of 600 to 800 pounds per acres can be achieved.

Baitfish are transferred from seine nets to tanks mounted on trucks, using buckets and dip nets. Fish are stocked into transport tanks at a rate of 1-2 pounds of fish per gallon of water. The fish are then transported to a holding facility where they are placed in concrete tanks. They are held in these tanks for 24 hours to allow acclimation to crowding in a small volume of water. Baitfish are then graded according to size (number of fish per pound) and delivered to wholesalers or retailers. Small minnows or "crappie bait" contain 125 to 333 fish per pound. Estimating an average yield of 400 pounds per acre and a price of $2.75 per pound, annual returns for a 160-acre farm would be approximately $137 per acre with an annual income of $21,920.

While all of the baitfish species mentioned can be farmed in Kentucky, reliable and consistent markets are the most important consideration for baitfish production in Kentucky. Producers must decide whether they will sell to wholesalers, deliver directly to retailers, or raise, haul, and sell their crop personally. Baitfish sales in the United States are characterized by organized marketing which is structured to prevent entry of newcomers into the industry. These large markets are controlled by large producers who have advanced experience and technology. Also, baitfish producers must be aware of oversupply, shortage, changes in weather patterns that affect sport fishing, and the temporary whims of fishermen concerning "the ideal bait."

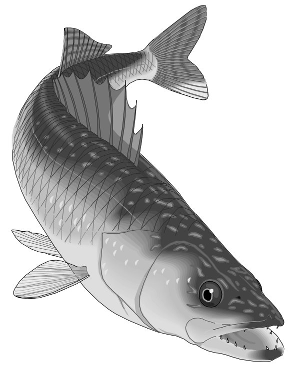
Large producers and wholesalers make weekly deliveries to retail baitfish distributors and bait shops surrounding Kentucky's larger lakes and reservoirs. However, it is impractical for them to make return trips to an individual bait shop that is having a busy weekend and who runs short on bait late on a Saturday afternoon. "Topping off" at these bait shops with sudden and heavy, weekend fishing traffic could provide new markets for small, local baitfish producers. Rather than attempting to supply a bait retailer's weekly minnow needs for an entire season, small farmers could replenish or "top off" weekend shortfalls at several area bait shops (i.e., weekend route sales at multiple locations).

The best markets are located near large urban areas and newly established lakes. However, these two conditions rarely occur together. Isolated fishing areas that are difficult for large producers to access provide market opportunities for small, local baitfish farmers. It is possible that a farm with 60 to 70 acres of ponds could provide a baitfish producer with a reasonable income if the farmer could produce 800 pounds per acre of high quality, small baitfish and sell directly to retailers.

Small-scale, niche marketing appears to be the best opportunity for bait producers in Kentucky. Direct retail sales in remote fishing areas could provide additional market openings throughout the commonwealth. Kentucky minnow farmers should start small and expand their acreage as their markets show stable and steady growth. To become a successful Kentucky baitfish producer, you must establish solid markets and provide a high quality product.

(See appendix for recommended publications on Baitfish)

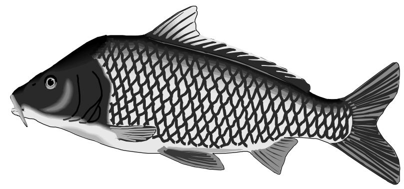
Minor Species



Walleye

The walleye is one of the fish being evaluated at KSU for its potential as an aquaculture species. Walleye is one of the most important commercial and recreational fish species, and a popular food fish in the north-central United States and Canada. The commercial walleye aquaculture industry currently produces fingerlings for stocking public and private lakes, but has potential to eventually supply larger food size fish for retail markets and restaurants. The climate in Kentucky appears to be well suited for pond production of coolwater fish such as walleye. Production of 1.0 pound walleye should take approximately 30 months in ponds in Kentucky according to growth rates found in research at KSU. Walleye appear to require relatively high protein levels so feeds containing, greater than 40% protein and 10% fat diets should be fed. It was observed that walleye appear to be sensitive to temperature fluctuation and high light intensity, as determined by lack of feeding activity with changing weather patterns and bright sunny days. Larger, deeper ponds (greater than 0.5 acres, greater than 5 feet deep) may reduce this effect as temperature would change more slowly and light intensity would be reduced. Also, feeding is best at dawn and dusk. Walleye are amenable to high density culture. However, average size at harvest may be increased at lower stocking densities. Walleye also appear to have slow growth in the third season grow-out as compared to the second. This may indicate that third-year walleye have passed their rapid growth phase and are becoming sexually mature. Refinement of culture methods and domestication would likely reduce the time required (a reasonable goal would be 30 months) to produce harvest size fish.

(See appendix for recommended publications on Walleye)



Common Carp

Common carp is the main aquaculture species in many European and Asian countries. This fish has several advantages that made it so popular for commercial culture: a) very fast growth rate, b) high tolerance and easiness to handle, c) ability to be reared in high density and to give high production per square unit, d) ability to utilize prepared diet with relatively low content of protein, and e) occurrence of highly productive strains and breeds reared during a long-term process of selection and domestication. Most carp is sold on the market as live fish or as whole carcass.

In contrast to many other countries, common carp is not a popular edible in the United States. The main obstacle for acceptance of carp as edible fish in the United States is the presence of many intramuscular bones in the muscles. U.S. consumers do not like to eat fish meat with small bones and prefer boneless fish fillet.

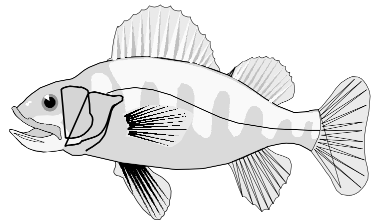
Possibly, a change in consumers' attitudes to carp may be achieved by application new types of carp meat processing. The following is suggested:

a) The using of fillet-machine which cuts the bones. Such machines for producing filets have been constructed recently and now are being used in several European countries.
b) Process carp meat by smoking and retort (canning) using special recipes (using tomato sauce, etc.) as is used in some European countries.

It is possible to initially develop optimal ways of carp meat processing by using fish caught from natural reservoirs and lakes in Kentucky. If market development proved successful, information on commercial rearing of carp in ponds is well developed and could be used immediately.

Forty percent of the world aquaculture production is from carp species. An export market for Kentucky raised carp may be possible.

(See appendix for recommended publication on Common Carp)

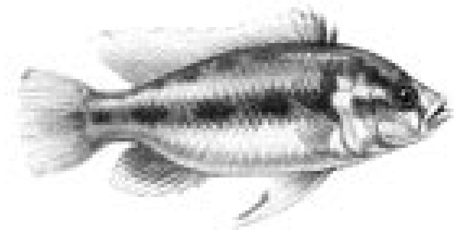


Yellow Perch

The yellow perch is a highly valued food fish in the north-central region of the United States. Commercial harvests of yellow perch from the Great Lakes and Canada have failed to keep pace with market demands. This has resulted in high market value (up to $12 per pound for fillets, retail). Consumer demand for yellow perch has generated interest in the development of economical cultural methods. The yellow perch is considered a coolwater species. A recent study at Kentucky State University demonstrated that the optimum temperature for growth of yellow perch to be 75^{o}F, closely matching summer (June - October) water temperatures in ponds in Kentucky. Previous research at KSU with yellow perch has also indicated that high stocking densities may be advantageous by stimulating feeding activity therefore allowing for maximum growth. Yellow perch may have potential for use under cage culture conditions.

Yellow perch should be fed a high quality floating diet containing approximately 40% protein and 10% fat and should be fed to satiation twice daily. Yellow perch are amenable to pond culture and should be considered as a species having culture potential in Kentucky. Pond production of yellow perch should take approximately 18 months to harvest size (0.25 pound) in Kentucky. Fingerling costs are high when dealing with genetically small fish such as yellow perch; for example yellow perch fingerlings cost $0.25. If four fingerlings are required to produce one pound of fish at harvest, fingerling costs would be $1.00 per pound of yellow perch produced. Processing costs would also be higher. Some obstacles related to the culture potential of yellow perch in Kentucky are that markets within Kentucky are currently limited, mainly due to a lack of consumer awareness. Also, yellow perch are not indigenous to most of Kentucky and the Department of Fish and Wildlife are concerned about the potential of introducing yellow perch in public waters.

(See appendix for recommended publications on Yellow Perch)



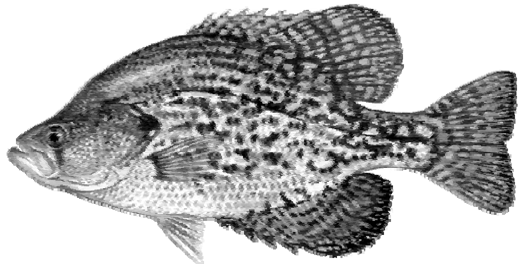
Tilapia

Several species of tilapia and their hybrids are farmed throughout the world. The blue tilapia (*Tilapia aurea*) is a species commonly farmed in the United States. There is evidence to suggest the Egyptians raised tilapia in ponds over 3000 years ago. Tilapia are also called "Saint Peter's Fish" because it has been said that they were the fish Peter caught when Christ told him to cast out his nets in the Sea of Galilee.

Tilapia have several attributes which make them attractive as a culture species: high tolerance of poor water quality and crowding, good performance on commercial catfish feed (32% protein), a high degree of disease resistance, and a mild flavored, white flesh. Because of their tolerance to crowding and poor water quality, tilapia are well suited to cage culture and recirculating systems. Research has also shown that in addition to controlling filamentous algae, tilapia stocked in channel catfish ponds can help control off-flavors by eating blue-green and other large planktonic algae.

Tilapia have a good growth rate. A 2 to 4 ounce tilapia fingerling can reach 3/4 pound. by the end of a temperate growing season. Tilapia performance is best in a temperature range of 72-90ºF. Growth and feeding slow when water temperatures drop below 70ºF. However, tilapia are cold intolerant and die when water temperatures are lower than 45-55ºF. Blue tilapia will survive in lower water temperatures (above 45ºF) than most other species of tilapia. The pond production season in Kentucky would begin in late April and end just before the middle of October. Therefore, tilapia marketing would be seasonal and within a week or two of the same time each year. Indoor culture of tilapia in recirculating systems could extend the growing season.

(See appendix for recommended publications on Tilapia)



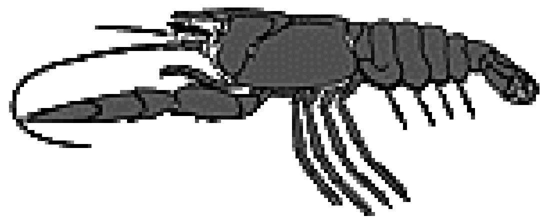
Crappie

Black and white crappie belong to the family of sunfishes. Crappie are popular game fish in many parts of the United States including Kentucky. These fish are being evaluated as candidates for commercial aquaculture due to the following criteria: strong consumer recognition and acceptance (black and white crappie are highly-prized panfish in many states), good growth rate in optimal conditions, trainability to prepared diets, and ease of spawning in captivity.

The principal obstacle to commercial culture of crappie involved their high rate of reproduction which often leads to overcrowding and stunting. Both black and white crappie reach sexual maturity at the age of one year and can spawn repeatedly in production ponds. The presence of large numbers of small fish in ponds decreases the effectiveness of prepared diet utilization, and causes stunting.

To allow successful use of crappie in commercial production, methods for preventing uncontrolled reproduction are being developed. This may be achieved by rearing mono-sex progenies obtained by means of genetic methods (induced gynogenesis and sex reversal). The investigations of this have been initiated recently at the Aquaculture Research Center of KSU.

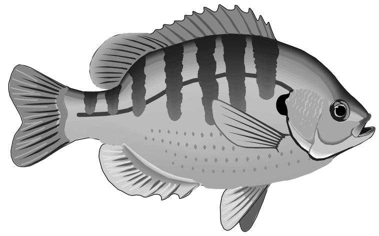
(See appendix for recommended publications on Crappie)



Red Claw Crayfish

Red claw crayfish (Australian crayfish; *Cherax quadricarinatus*) should be very similar in culture methods and economic data to the freshwater shrimp (*Macrobrachium rosenbergii*) that are described in a prior report. However, there are several differences. One difference between the two species is that red claw will, at the present time, cost more for stocking-size individuals, due to the location (Belize) of the hatchery. Individuals in the U.S. who sell red claw generally produce small numbers of individuals (200-1000) and these are not sufficient numbers to stock even a small pond. Another difference is that red claw can spawn in freshwater, not seawater as the freshwater shrimp does. Thirdly, red claw do not undergo larval stages like freshwater shrimp and can eat a pelleted diet after being released from the female. These last two characteristics of red claw make them easier for a producer to establish his/her own hatchery. A drawback to red claw juvenile production is their much lower fecundity rate compared to the freshwater shrimp. Red claw females generally produce from 100 to 1000 juveniles per female; however, survival is high because they do not have larval stages. A fifth difference between the two species is that red claw can be sold to the aquarium industry where they are highly desired because of their colorful shell. Aquarium industry can pay a supplier up to $2 per inch for a small (1-3 inches) red claw to be sold as an aquatic pet. A sixth difference is that red claw can tolerate somewhat cooler water temperatures than the freshwater shrimp so that the growing season could be increased. However, like the freshwater shrimp, red claw die when water temperatures decline to 50°F; therefore, they should not pose a threat to native crayfish species in Kentucky, nor do they burrow. Lastly, red claw can be grown in tanks somewhat more easily than the freshwater shrimp due to its less cannibalistic nature if shelters are provided. Red claw offer another alternative for Kentucky producers who desire to grow them and/or start a hatchery operation.

(See appendix for recommended publications on Red Claw Crayfish)



Hybrid Bluegill

In recent years the interest in culture of bluegill hybrids has increased greatly. Much of the attention has been focused on the hybrid produced when male bluegill (*Lepomis macrochirus*) are crossed with green sunfish (*L. Cyanellus*). This hybrid has been singled out among the many "bream" species based on its' aggressive nature, willingness to accept artificial diets, and skewed sex ratio (greater than or equal to 90% male). This has resulted in substantial production for stocking into recreational ponds. In Kentucky hybrid bluegill have been evaluated, and show promise, for use in pay lakes (fee fishing). In the north central region of the U.S., hybrid bluegill have also been identified as a species of primary interest for food fish production.

Compared to other interspecific hybrids, such as hybrid striped bass, hybrid bluegill are relatively easy to produce. No hormone treatments are required and pond spawning is relatively productive and reliable. One of the most important factors in the production of hybrid bluegill is proper identification of both sexes used in the cross. Improper sexing of even one or two fish can ruin the production of an entire pond.

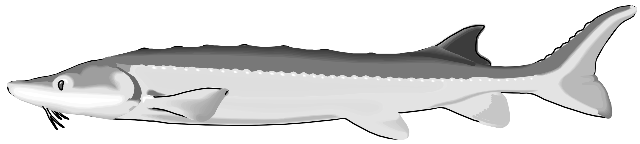
Bluegill males need to be at least two years old and greater than or equal to 1/4 pound in size. Green sunfish females may be much smaller. Broodstock are normally stocked in late winter or early spring at 20-40 pairs per acre. Sex ratios are normally 1:1. Ponds should be filled at least 2-4 weeks before broods are stock. It is essential that no other fish are present in the pond at stocking. The pond should be fertilized to produce a plankton bloom. Providing areas around the edge of the pond with fine gravel, or even gravel in nesting boxes may proved beneficial.

Spawning usually occurs at 78-80°F. Fry should be observable soon after hatching. Broodfish may be selectively removed by using a large mesh seine (based on brood size). A powder trout starter diet should be fed around the edges of the pond. Once feeding is observed particle sizes can be increased accordingly. Approximately 100,000 fry per acre may be produced. Fingerlings can reach a stocker size of 2-3 inches in 60-100 days. Transport of 2-3 inch fish is usually less stressful once temperatures cool in the fall. For pond stocking fish are now ready to sell. Wholesale price for 2-3 inches hybrid bluegill is approximately $0.05 each with retail prices of $0.25-$0.40 each.

For use in pay lakes, or possibly as a food fish, at least a second year of growth is required. Fingerlings are thinned or stocked in the fall or spring at 5,000-10,000 fish per acre. These fish are fed all they will eat of a floating trout or hybrid striped bass diet of 36-42% protein. Based on research at Kentucky State University approximately 3,000 pounds per acre of fish averaging 1/3 pound each can be produced during this second year.

Field trials of this size of fish in pay lakes indicates excellent acceptance by customers and allows the pay lakes to diversify their offerings. One cooperating pay lake operator stated a willingness to pay $2.50 per pound for 1/3 pound hybrid bluegill. Their potential as a food fish has not been well investigated but is being researched in the north central region.

(See appendix for recommended publications on Hybrid Bluegill)



Sturgeon

Sturgeons are found only in the northern hemisphere. Like the paddlefish, sturgeon are without bones and the processed roe (caviar) is highly valued. Of the 26 sturgeon species found in the world, the main sources of caviar for global demand are only from four sturgeon species from the Caspian Sea: beluga (*Huso huso*), Russian sturgeon or osetra (*Acipenser gueldenstaedti*), stellate or sevruga (*A. stellatus*) and ship (*A. nudiventris*). Reports have shown that there is a major decline in sturgeon stocks within the Caspian Sea. Farming technologies have been established for some commercially valuable species. Sevruga and Russia sturgeons are being farm-raised in ponds in Europe. In the United States, white sturgeon have been farmed-raised on one farm in California which has recently begun to market meat and caviar. The farming system uses a recirculating system requiring feeding prepared diets, intensive management, and high capital and operating costs, especially for mature females for production of caviar. Shovelnose sturgeon, found in the Mississippi drainage, have recently drawn much attention as a domestic caviar in the United States. The use of Russian sturgeon that can be farm-raised in ponds and co-exist with other fish species should be evaluated in Kentucky.

(See appendix for recommended publications on Sturgeon)

Aquatic Plants

Aquatic plants are grown commercially for food, aquariums, water gardens, and wastewater management. The largest aquatic plant crop in the world is rice. Watercress is a common species of water plant, native to the United States, which is produced for consumption as food. There are many large Asian communities in the United States which form lucrative specialty markets where such aquatic plants as water chestnut and aquatic spinach are sold.

In 1992, the market for aquarium plants was estimated at $16-$20 million per year. There are several species that are farmed, including elodea and valisineria. However, the market is dominated by national wholesalers. These large wholesalers sell to regional wholesalers, who in turn, sell to local retailers.

A multi-million dollar, nationwide industry which services and supplies water gardens have sprung up in the last decade. Water gardens have become very popular in residential areas where individuals have large discretionary incomes. Combining flowering and exotic aquatic plants with colorful fish (koi and goldfish) creates what Asian civilizations have cultivated as “living art.” Water gardens are popular because they provide the modern urban dweller with a private and relaxing backyard environment for meditation and reflection.

A water garden can be made in a whiskey barrel or a pond as large as the landscaper desires. The cost of an aquatic garden can range from one hundred to several thousand dollars. Many of the more popular water garden plants are species which are native to Kentucky; for example, water lilies and lotuses (which are farmed in ponds) and bog plants.

These new urban and residential markets may offer future opportunities for Kentucky’s water farming entrepreneurs. However, several of the species marketed are exotic plants and/or are considered to be nuisance and weed species in natural waterways, ponds, lakes, and reservoirs. There may be restrictions on the culture of imported aquatic plants and controls must be in place to prevent weed species, native and exotics, from entering public and natural waters.

(See appendix for recommended publications on Aquatic Plants)

Research, Extension, and Education

Introduction

The Research, Extension, and Education Committee of the Kentucky Aquaculture Task Force was assigned the duty of reviewing, evaluating, and making recommendations on the status, future, and coordination of research, extension, and educational activities related to aquaculture within the commonwealth.

The only aquaculture programs in Kentucky are at KSU. A history and status of state programs will focus on that institution.

KSU Aquaculture Program History

Unlike several southern states which have aquaculture initiatives spread over several institutions, almost all aquaculture research, extension, and educational activities in Kentucky are based at KSU. Kentucky State University's interest and efforts in aquaculture date back to the late 1970s when interest in aquaculture among Kentucky citizens began to develop and information requests to the University of Kentucky's (UK) and KSU's Extension Programs increased dramatically. Officials from the commonwealth's two Land-Grant Universities (UK and KSU) met and agreed that KSU should be the school to take further steps in addressing the needs in this area.

In 1981, KSU's Land-Grant administrator and an extension specialist organized a fact-finding trip to allow University personnel and interested Kentucky farmers to gain first-hand knowledge of existing aquaculture programs in the country. Auburn University in Alabama served as host institution and agreed to assist KSU in the development of aquaculture research and extension capabilities.

Later in 1981 and at the request of KSU, Drs. Schmittou and Cremer of Auburn University's Department of Fisheries and Allied Aquacultures initiated an evaluation and feasibility assessment for aquaculture production in different physiographic regions of the commonwealth. As a result of the assessment, they also began plans for the development of an aquaculture extension program at KSU and the development of a research facility.

The resulting plan was approved by the University's Board of Regents in 1981. Design and construction of the Aquaculture Research Center was begun in 1982. Basic construction was completed in 1985. However, because substantial problems existed in the electrical service and integrity of the ponds, the facility did not become fully operational until 1986. In the interim, personnel utilized cooperators' ponds in the Franklin County area to begin research on the culture of catfish and rainbow trout in cages. During this period, Dr. Cremer served a split appointment as Extension Aquaculture Specialist and Principal Investigator. In 1983, Dr. Gary Jensen (now USDA's National Aquaculture Extension Coordinator) was hired as State Aquaculture Specialist and Dr. Cremer's appointment became 100% research. From that time on, Aquaculture Research and Extension Programs became distinct, though tightly connected. In 1999, the Research and Extension Programs and the new Academic Program were merged into a combined administrative unit.

Facilities

Kentucky State University's Aquaculture Research Center is the only such facility located in the commonwealth of Kentucky. Facilities at the Aquaculture Research Center include 35 research ponds and a 2,000 square foot hatchery housing spawning, holding, and experimental tanks. A 4,000 square foot office/laboratory building houses a state-of-the-art histology laboratory, offices, and conference/classroom space. A 3,500 square foot nutrition laboratory contains a wet laboratory for aquarium studies, a feed preparation/water quality laboratory, office/computer space, and an analytical laboratory. A 3,000 square foot greenhouse facility contains temperature control systems capable of evaluating three temperature levels in nine 1,500 gallon tanks, as well as a recirculating shrimp hatchery system. A second 3,000 square foot greenhouse, built in 1998, contains four 10,000 gallon tanks for broodstock holding and conditioning. These facilities may be utilized for student research and teaching.

The program also includes a Fish Disease Diagnostic Laboratory housed on campus in the Cooperative Extension Building. This lab is fully equipped with incubators, microscopes, and video microscopy.

Personnel

James H. Tidwell, Ph.D., Coordinator of Aquaculture Programs (Research, Extension, and Education), also Principal Investigator on freshwater shrimp and largemouth bass projects.
Steven D. Mims, Ph.D., Principal Investigator on paddlefish, sturgeon, and crappie projects.
Carl D. Webster, Ph.D., Principal Investigator on aquaculture nutrition projects.
Robert M. Durborow, Ph.D., State Specialist for Aquaculture, Fish Disease Diagnostic Laboratory.
William A. Wurts, Ph.D., State Specialist for Aquaculture, Western Kentucky.
Forrest S. Wynne, M.S., Area Aquaculture Extension Specialist, Eastern and South Central Kentucky.

The Aquaculture Research Center also has 10 other full-time employees including a Ph.D. level scientist (Dr. Boris Gomelsky) supported by grant funds, two M.S. level research assistants (RA), two B.S. level R.A.s, a B.S. level Facility Manager, and four full-time technical and support personnel.

Research

The goal of the KSU Aquaculture Research Program is to increase the knowledge base in aquaculture and thereby facilitate increases in farm income and the productivity of on-farm water resources. This is to be accomplished by examining and developing production technologies suitable for the climatic and physiographic conditions prevalent in Kentucky. To meet these goals, the KSU Aquaculture Research Program's initial goals have been development and adaptation of pond and cage culture techniques for channel catfish and trout, as they are the principal species of the Kentucky fish farming industry.

Goals

The USDA expects newly developing aquaculture species to experience rapid expansion in the next decade by adapting existing production and processing systems already developed for catfish and trout. Development of these species is expected to occur largely in states which, like Kentucky, do not currently have well established production, processing, or marketing infrastructures for aquaculture. It is the intent of research, extension, and education efforts to assist Kentucky producers to be a part of this future development by investigating alternative aquaculture species that can be produced profitably in Kentucky.

Extension

Research information is of little practical value unless it is communicated to producers in a useful and understandable form. Training and extension programs serve as the primary means of transferring this knowledge from the researchers to the end users. KSU Aquaculture Specialists are integrated into the UK Cooperative Extension System. Specialists are housed in western Kentucky at the UK Princeton Research and Extension Center (Dr. Wurts), central Kentucky at KSU main campus (Dr. Durborow), and in eastern Kentucky at the Rural Development Center in Somerset (Mr. Wynne).

Teaching/Education

Kentucky State University began offering a Minor in Aquaculture in 1992 within the Division of Mathematics and Sciences. Since that time, over 75 students have been involved in the aquaculture courses at KSU. No other university in the commonwealth offers an aquaculture curriculum. In 1998, the Council on Post-secondary Education approved KSU to offer a Master of Science in Aquaculture/Aquatic Science beginning fall semester of 1999. This program has been designated as a Program of Distinction through the Regional University Excellence Trust Fund set up by House Bill 1 in 1998.

Teaching aquaculture and developing experiential learning activities have rapidly developed at the secondary level. Scattered over different regions of the commonwealth, 47 high schools and vo-ag programs currently have aquaculture activities. These efforts are extremely important for increasing awareness of aquaculture among young Kentuckians while their minds are still open to new enterprises.

Long-term Vision

To achieve desired goals, KSU should remain as the lead program in the commonwealth based on expertise and over 70 years of cumulative Kentucky aquaculture experience. State support should be added to federal support to expand services, coverage, and flexibility. This should include augmentation of existing facilities, increased support for personnel and students, and the possibility of adding satellite facilities in different physiographic regions of the commonwealth.

Recommendations

The following recommendations are based on discussion within the Research, Extension, and Education Subcommittee and within the full Task Force. Implementation of many of these recommendations has already begun.

1) The KDA, KSU, and the KAA should hold a joint annual aquaculture conference to promote

industry awareness. The conference should also include a trade show.

2) KSU should develop a master reference book for county extension agents to source aquaculture information to the public.
3) The KSU extension offices should be granted funds to produce needed aquaculture publications of Kentucky-specific species manuals.
4) KSU should be funded according to the same formula as UK in obtaining state funding for extension work.
5) Appropriate funds should be granted to KSU and/or KAA to assist high school vocational agricultural teachers to start aquaculture education programs. This should include support for a KSU position dedicated to assisting high school programs statewide.
6) State funds should be appropriated to KSU researchers, to research and solve local and regional problems and to develop aquaculture opportunities.
7) Support for graduate student assistantships is essential.
8) Additional field assistance is needed.
9) Additional research facilities at KSU are necessary to support rapid development of new species' culture and production methods.
10) Research and demonstration facilities should be established in different regions of the state due to differences in species of interest and production conditions across the commonwealth.

Marketing and Promotion of Kentucky Aquaculture Products

Marketing Strategies

Choosing an appropriate marketing strategy is often the difference between success and failure for most aquaculture ventures. Aquaculture products can be sold by a variety of different methods, each requiring a different level of involvement and investment by the producer. Production levels, cash supply, and the talents of the producer must all be considered when choosing a marketing approach. Examples of some possible marketing strategies are given below with an explanation of the positive and negative points of each.

Direct Sales Advantages

Direct sales to consumers allow the producer to realize a greater profit for the product by taking responsibility for the promotion and distribution, thereby “cutting out the middle man.” Money that would otherwise be paid to a wholesaler or shipper is kept by the producer, thus increasing the profit margin. Direct sales also allow the producer total control of the quality of the product sold. This is especially important if the producer is marketing a product, which is identified by the producer’s name. Selling directly can offer a degree of independence not possible when selling to a wholesaler. The producer has more control over the product’s price and is not at the mercy of one large customer, the wholesaler, who may find another source of fish. The producer is often more enthusiastic about the product than a wholesaler who may be marketing a number of different species and who may not be pushing any one product. Harvest scheduling is controlled by the producer and not the wholesaler, which can have a significant impact on profitability.

Direct Sales Disadvantages

There are a number of problems associated with direct sales. The promotion and distribution done by the producer costs money and may not be as effective as when done by a wholesaler whose entire business is the buying and selling of fish. Most food fish producers raise a single species of fish, which may not be attractive to retailers or consumers looking for variety. Those who are willing to buy a single species are often not interested in buying in large quantities, requiring the producer to establish a number of small accounts to sell the entire product.

Wholesale Sales Advantages

Selling to wholesalers allows the producer to concentrate time, effort, and cash resources on fish production. The wholesaler is responsible for purchasing the expensive refrigerated trucks and storage equipment needed for product distribution, and for paying the maintenance costs, insurance, and taxes involved with such equipment. Wholesalers generally have a broad customer base, which allows them to purchase large amounts of a single species for resale. They are equipped with the office space and sales force required to move large quantities of product.

Wholesale Sales Disadvantages

The main drawback to selling wholesale is the price the producer receives for the product. Wholesalers are in the business of buying fish at low prices and reselling them at higher prices. To do this they must be able to buy fish at prices considerably lower than the selling price to the retailer.

Niche Marketing

Niche marketing is the method by which the producer finds a market that can accept the product and offer a return that provides an acceptable profit. The high rate of return usually achieved in niche marketing provides many small producers with an opportunity to compete. Niche markets are usually limited in size and ability to accept large amounts of product. An example of niche marketing is the sale of unusual fish to an aquarium.

§ **Live Fish Sold for Food -** This market exists primarily in large cities such as New York and Chicago where customers are capable of taking several thousand pounds each delivery. There are opportunities in smaller communities as well. Some supermarkets have live tanks that hold fish and crayfish. Producers may also sell fish directly to consumers at the production facility.

§ **Bait Suppliers and Distributors -** Most of the bait sold to Kentucky anglers is produced out-of-state. Kentucky aquaculturists may be able to break into this lucrative market if they can lower production costs and offer bait dealers fish at prices that are competitive with current suppliers. Baitfish are often a secondary product for game fish producers or fish that are not suitable for the ornamental fish trade, as with the fish culled in goldfish farming. This should not take away from the fact there is a profit to be made by selling to this market.

§ **Pay Fishing Operations -** These operations stock their lakes with large fish then charge a fee for admission and for the weight of fish caught. Many operations also offer processing at an additional cost. In 1998, there were 174 pay lakes in Kentucky, with the majority purchasing their fish from out of state suppliers. Catfish and bass are the species of choice stocked by pay lake operators and anglers. Aquaculturists in Kentucky could produce these species.

§ **Lake and Pond Stocking -** There are thousands of private lakes and ponds in the State of Kentucky, many of which are stocked with bass, bluegill, crappie, and catfish. These are the fish most often used for stocking. Their small size allows for easier delivery. The Kentucky Department of Fish and Wildlife currently operates hatcheries to supply the fish stocked into public bodies of water. There may be opportunities, however, for producers to raise and sell fish for stocking in private lakes and ponds.

§ **Live Hauling -** Live hauling is a vital service required by many fish producers. Kentucky live haulers have been transporting fish produced both in-state and out-of-state for a number of years. Live haulers pick up fish for transportation in trucks with special water tanks and aeration equipment and deliver them to customers for stocking into lakes and ponds, for pay lake operations, and for human consumption. It is possible for a producer to act as a live hauler for other producers as a means of supplementing income or for a hauler to generate enough business to perform this service as a sole means of support.

Value-added Products

Individual producers can work together cooperatively. If given access to planning and financed assistance, producers may be able to develop value-added products for sale. Examples are smoked, canned, or processed fish, fresh and frozen fillets. More producers could retain profits if they could integrate their sales further up the marketing chain.

Conclusion

There are many methods used to market aquaculture products. Some producers find they are better at growing fish than selling fish. In this case it may be wiser to invest time and money into efficiently producing fish, take a lower price and sell to a fish wholesaler. Other producers find the additional money received for their products justifies the effort required for selling direct. Niche marketing may be a viable alternative for small-scale producers.

Aquaculture Marketing in Kentucky

Most industry observers expect the demand for fish to continue to increase due to the aging of the U.S. population and increased emphasis placed on nutritional characteristics and health benefits of eating farm-raised fish. Farm-raised fish have rapidly advanced from being a substitute for ocean-caught products to a highly regarded premium product. Consumers want high quality food products that are readily available. Quality assurance can be provided more effectively and consistently in aquaculture than any other fishery due to the control the farmer has over the production and harvest. Consumers need to be aware of the health benefits of including farm-raised fish and shellfish in their diets.

Promoting Kentucky aquaculture products across the country and world not only will increase sales, but also alleviate competition for local buyers between Kentucky producers. Products should contain "Kentucky-Grown" on labels and the benefits of Kentucky raised products should be advertised at every step of the marketing chain.

Kentucky producers have important marketing advantages when compared to eastern and western counterparts. Kentucky is geographically centered and close to large market areas. This allows delivery of a fresher product to a wider range of buyers, with fewer losses and spoiling attributed to shipping product long distances. These advantages should be exploited whenever possible.

Research into marketing and consumer demand for Kentucky aquaculture products should be encouraged in Kentucky's universities. Their readily available expertise can be of considerable value to increase the profits Kentucky producers receive for their products.

The development and testing of new, valued-added aquaculture products should be expanded. Expertise and technology should be extended to processors and entrepreneurs. Marketing and promotion should be approached as a partnership among industry, government, and extension programs. Kentucky should expand development and testing for value added products with assistance from the Department of

Agriculture and the university research programs.

A full-time Aquaculture Marketing Specialist should be hired by KDA to work with the industry on networking and providing links between buyers and sellers. This would include developing directories and point of purchase materials, organizing buyer tours, manning booths at tradeshows, and making individual contacts with key buyers of aquaculture products.

The KDA should designate an employee to serve as the State Aquaculture Coordinator who will work to enhance communication among government agencies, institutions, industry producers, buyers, and processors. Enhanced communication will lead to improved coordination and competitiveness with suppliers, producers, and markets. The Aquaculture Coordinator also can provide assistance with the permitting or regulatory process, including advocating positive change, if needed.

Aquaculture marketing information should be relayed to potential new producers. Choosing an appropriate marketing strategy can mean the difference between success and failure for most aquaculture ventures. Assistance in making sound choices should be available to each aquaculturist.

Lack of attention given to marketing plans by would-be growers, particularly for small-scale ventures, has been a common problem that should be addressed in continuing market research. Frequently, farmers have entered fish farming without definite plans for marketing the fish. Additional market research, particularly oriented to small operations is important to continued industry development. The importance of marketing should be emphasized as an integral part of an aquaculturist's business plan. Production growth and marketing efforts will require synchronization to minimize costs of either excess supplies or excess capacity in processing.

Key infrastructure components such as hatcheries, processing, feed manufacture, and collection points should be developed. This assistance should include assistance with feasibility studies, the formation of grower owned cooperatives, and grants to provide seed money to leverage public/private investment in aquaculture development. Aquaculture products will play an ever-increasing role in supplying traditional seafood markets, however, better industry infrastructure and marketing channels must be established.

Use of strategically located processors is vital for the continuing development and expansion of aquaculture in Kentucky. Production areas must be concentrated as they develop so that Kentucky's advantage of market location is not lost due to high costs of small-scale processing and inefficient distribution.

Marketing Checklist

Source: 1998 Wisconsin Aquaculture Directory, Wisconsin Department of Agriculture, Trade and Consumer Protection

Fish farming is an ancient practice that can provide many profitable opportunities. Under the appropriate conditions, aquaculture can be a rewarding and an economically feasible business opportunity. Like other forms of farming, fish production involves capital investment and risks. It is important for the potential fish farmer to determine first what aspect of fish farming is of interest and how much it will cost to enter that respective business. Design, investment, and operational requirements differ for each culture system and species grown. The following checklist is designed to be used as a prescreening tool for prospective aquaculturists. It may help you build or expand a business plan. Such planning can be a map to success.

Yes	No	Market
		Can you continually harvest and market your product throughout much or all of the year?
		Is there a market for your fish when you plan to sell them?
		Is there an established market for your fish?
		Are other fish products available at prices lower than your profitable selling price that will out-compete you in the market?
		Have you identified your primary and alternative markets?
		Have you assessed the market size/demand and potential competitors?

Yes	No	Personnel
		Do you or your production manager have the technical training/experience to manage your operation at optimum efficiency?
		Do you have available the resources to make immediate diagnosis and proceed with proper chemical treatment of diseases and parasites for fish stocks and to deal with other biological problems of hatching and rearing?

Yes	No	Capitalization, Production Plant Facilities, Layout, & Equipment
		Do you have land with suitable water supplies and sites for fish farming?
		Are your facilities accessible during prolonged adverse weather?
		Do you have the machinery/equipment needed to raise, process, and market fish?
		Do you have the necessary financial resources?
		Have you developed a realistic business plan?
		Will the expected profit be adequate compensation for your labor, management, and risk?
		Have you accounted for expansion?
		Will investment and operating capital interest rates permit a reasonable profit?
		Can you afford to forego income until you sell your first crop?
		What emergency power unit is available in the event of power loss?
		Are you willing and able to devote the daily time and effort required?

Yes	No	Physical Factors
		Is the proposed culture site an unrestricted area and does the site have natural elevations?
		Is the prospective site located near markets and processing facilities?
		Have core drillings been made to determine impervious qualities of subterranean soils?
		Are adjacent lands subject to aerial crop spraying for insects and weeds?
		Do you have enough water to raise the desired fish?
		Do you have the appropriate water supply?
		Will the soil hold water?
		Is the area protected from flooding?
		Can you build a water retention area to remove fish wastes?
		Can you discharge water from your site?
		Does the land have proper topography for the construction of ponds or race ways?
		Can you economically secure your production facilities from poaching and prevent escape of stock?
		Is the site easily accessible year round for you and transport trucks?

Yes	No	Production Factors
		Are eggs/fingerlings available from local dealers at competitive prices?
		Can you raise your fish from eggs to produce your own fingerlings?
		Are high quality fish feeds readily available at competitive prices?
		Do you have a suitable area to store feeds?
		Do you have a source of the drugs/chemicals needed?
		Are you aware of universities, government agencies or professional fish culturists that can provide you educational and technical services?

Yes	No	Harvesting
		What is the most economical type of harvesting method for your present and future facility?
		How will you construct ponds and other production facilities to provide the most efficient harvesting techniques?
		What special equipment is needed for harvesting?
		Will you need special holding tanks/ponds to keep quantities of fish ready for immediate delivery?

Yes	No	Transporting
		What facilities do you have available for transferring harvested fish to market or to a processing plant?
		What will you use for cooling water during transportation of live fish?
		How will a suitable water exchange for long-distance shipments be made avail able in transit?

Yes	No	Processing
		If you plan to dress/package fish for retail, will you facilities conform with State Sanitation Code?
		Are your production facilities reasonably convenient to a processing plant?
		Is it to your advantage to contract with a processor for your annual production?

Yes	No	Are you equipped to handle these risks?
		Poor water quality
		Fish disease and parasites
		Poachers and vandals
		Potential chemical contamination
		Business management and taxation

These are the essential elements to a successful fish farming enterprise:

- Large volumes of high quality water
- Suitable water quality
- Sufficient financial resources
- Established markets
- Appropriate management skills and time
- Good service and good product quality

A better understanding of the requirements for successful aquaculture should now be gained. The next step is to meet personally with a knowledgeable aquaculture specialist or experienced industry persons to assess your specific situation and explore potential options. Time and work spent on planning can be profitable and the greatest reward may be the decision not to go into fish farming; it definitely is not for everyone.

Regulatory Considerations

In establishing an aquaculture enterprise, there are several regulatory considerations. There are different permit requirements depending on the type of enterprise. A directory with each agency's phone numbers and contacts is included in the appendix.

Pond Construction Permits

- § May require local zoning and business permits
- § Check with NRCS to determine whether land is classified as wetlands.
  - § If land is a wetland, contact the U.S. Army Corps of Engineers for a wetland construction permit.
- § Pond construction permit is needed if pond is in a flood plain. Contact NRCS for a permit application.
- § If more than five acres are disturbed for pond construction, a stormwater permit for construction activity is required during construction. Contact Division of Water, Natural Resources & Environmental Protection Cabinet.

Water Withdrawal

- § No permit is required for agriculture use (KRS 151.140).

Aquaculture Production

- § Contact Department of Fish and Wildlife Resources, Division of Fisheries.
- § Commercial Propagation Permit is required. This permit covers production, selling and transporting of all endemic species (natural to Kentucky) fish, frogs, crayfish, and other aquatic organisms. Seines larger than 10 feet are covered under this permit.
- § Most exotic species are not permitted for commercial production, and no fish or other aquatic organism may be raised in public waters
- § Non-native species such as grass carp and aquarium species other than those listed in 301 KAR 1:130 Section 3 may not be imported, possessed, and sold unless approved by the Department of Fish and Wildlife Resources, Division of Fisheries.

Water Discharge Permit

Contact Natural Resources & Environmental Protection Cabinet, Division of Waste Management

- § 401 KAR 5:60(11) requires a **discharge permit** for aquaculture water if more than 5,000 pounds a month of feed is used, or if more than 100,000 pounds of animals are raised. This affects only concentrated aquatic animal production facilities.
- § If a pond is to be drained for harvest, **a one-time discharge permit** will be issued by the Division of Water's regional office.

Pay Lake

- § Contact Department of Fish and Wildlife Resources, Division of Water. A pay lake operation license is required if:
  - § The pond is stocked at least twice annually with at least 500 pounds of adult fish per surface acre, and

    - The pay lake issues fishing permits to patrons.
- If the lake does not distribute fishing permits to patrons, each person must a have Kentucky fishing license.
- Retail operations may fall under other business licensing requirements. Contact the Business Information Clearinghouse for more information.

Live Hauler

- Contact Department of Fish and Wildlife Resources. A transportation permit is required to haul any live aquatic organism. A permit for the species being hauled is issued.
- Retail operations may fall under other business licensing requirements. Contact the Business Information Clearinghouse for more information.

Bait Shop

- Contact Department or Fish and Wildlife Resources for a live fish and bait dealers license, if selling live fish retail or wholesale.
- Retail operations you may fall under other business licensing requirements. Contact the Business Information Clearinghouse for more information.

Processing

- A producer can sell **live** or **whole fish on ice** without falling under processing requirements.
- Product sold in any other form is considered processing. Processing of seafood requires special permits, facilities, and considerations. Contact local health department for more information.

Finance and Business

In order for the aquaculture industry in Kentucky to expand, existing and new producers will need access to business planing and financial services. Careful start-up planning can mean the difference between success and failure in a capital-intensive business such as aquaculture. Kentucky has a number of agencies and organizations that can provide financial or business planning assistance to aquaculture producers. Refer to the appendix starting on page 58 for a listing of sources of business planning and financial assistance within the commonwealth.

Aquaculture Task Force Recommendations

General

I. The commonwealth should promote additional research into aquaculture marketing, consumer demand, and value-added product development through **funding for Kentucky Department of Agriculture aquaculture marketing programs and the Kentucky State University aquaculture research programs. Recommended funding of $100,000 per organization per year**.

II. The Kentucky Department of Agriculture should hire a full-time Aquaculture Marketing Specialist to work with the industry on development, marketing, and promotional efforts.

III. Kentucky Department of Agriculture should continue to assist the aquaculture industry within the commonwealth to develop key infrastructure components such as hatcheries, processing, feed manufacture, marketing associations, collection points, and harvesting capabilities. This can be accomplished with information gathering and dissemination, marketing assistance, promotions, and grants.

IV. Kentucky Department of Agriculture, Kentucky State University, and the Cooperative Extension Service should assure the provision of aquaculture marketing and production information to potential new producers within the commonwealth.

V. The Kentucky Aquaculture Association is an effective farmer organization working to promote and develop the aquaculture industry in Kentucky. Kentucky Aquaculture Association should receive support funds to expand its efforts and hire an executive director.

VI. The Kentucky Department of Fish and Wildlife Resources should amend its regulations to allow holders of valid aquaculture propagation permits to possess, use, and transport seines of any size for use in the permit holder's aquaculture business.

VII. Freshwater Shrimp (Prawns) (*Macrobrachium rosenbergii),* are being raised in Kentucky by an increasing number of farmers. Freshwater shrimp has been demonstrated not be a threat to native species, as they cannot reproduce in freshwater. Because there is no danger of freshwater shrimp reproducing in the wild in Kentucky, it is recommended the Department of Fish and Wildlife Resources not require a special non-native species exemption for producers of freshwater shrimp.

Legislative

I. In order to assist the development of local markets for agriculture products, **legislation should be passed which favors the purchase of Kentucky grown products (including aquaculture products), when available, by all state funded projects, agencies, and institutions.**

II. In order to support and expand the aquaculture extension assistance offered to Kentucky farmers, **the Kentucky State University Cooperative Extension Program should be funded proportionately, according to the same formula as the University of Kentucky Cooperative Extension Program in obtaining state funds for cooperative extension work.**

III. Paddlefish is a valuable native species that is non-competitive with sport fish in the commonwealth's public waters. Reservoir ranching could potentially generate significant aquaculture income and create needed processing facilities in Kentucky. **The commonwealth should support efforts to develop controlled reservoir ranching of paddlefish in designated public bodies of water.**

Budgetary

I. In order to diversify Kentucky Agriculture and foster the growth of aquaculture production in the commonwealth, **a 50 percent cost-share fund for the construction of aquaculture production ponds should be established and funded at a rate of $500,000 in year one and $750,000 for year two and beyond. Cost share fund should be administered by the Kentucky Department of Agriculture.**

II. Aquaculture in Kentucky is a not a traditional agriculture enterprise. In order to provide aquaculture producers and entrepreneurs with access to funds to develop aquaculture enterprises, **the Legislature should establish a low-interest revolving loan fund specifically for aquaculture production in Kentucky and fund it at a rate of $500,000 annually.**

III. In order to continue to develop key infrastructure components such as hatcheries, processing facilities, feed manufacture, value-added product development, collection points, and harvesting resources, **a 50 percent cost-share grant program should be established and funded at $500,000 per year. Cost share fund should be administered by the Kentucky Department of Agriculture.**

IV. To date, the Kentucky State University aquaculture program has been funded almost entirely from federal funds. As a result, the research conducted has focused on issues of interest nationally. In order to direct the research focus on problems and opportunities within the commonwealth, **reoccurring state funds should be allocated Kentucky State University to address local and regional aquaculture opportunities and problems. Research should be funded at a rate of $250,000 per year**.

V. In order to support the rapid development of new aquaculture enterprises and production techniques, **state funding in the amount of $500,000 per year for two years should be provided to Kentucky State University for additional research facilities**.

Appendix A Finance and Business

Business Planning Help

Kentucky Farm Business Management Program
http://www.uky.edu/Agriculture/AgriculturalEconomics/farmmgmt.html
University Of Kentucky
Department of Agricultural Economics
431 Agricultural Engineering Building #2
Lexington, KY 40546-0276
(606) 257-5762

The Kentucky Farm Business Management Program (KFBM) program helps farmers maintain financial performance, determine the profitability of individual enterprises, improve management practices, complete tax returns, establish financial and production goals, and make sound farming decisions. The program is financed by the UK College of Agriculture, Department of Agricultural Economics, which provides nine program specialists spread across six areas of Kentucky, and farmers' fees range from $450 to $1200 annually. In return, the specialists provide automated record keeping, one-on-one counseling, prepared financial statement, tax records, and comparison crop and livestock analyses. Workshops on the following farm management topics are offered: goal setting, decision-making, record keeping, balance sheet, income statement, cash flow, enterprise budget, and farm planning.

Kentucky Small Business Development Centers
http://gatton.gws.uky.edu/KentuckyBusiness/ksbds/ksbdc1.htm
State SBDC Office
Kentucky Small Business Development Center
225 C.M. Gatton Business & Economics Building
Lexington, KY 40506-0034
(606) 257-7668

SBDC provides training, counseling and educational materials to those needing assistance in developing their small business, including agricultural businesses. The state office is located in Lexington. Offices in Elizabethtown, Lexington, Hopkinsville, Bowling Green, Ashland, Owensboro, Murray, Pikeville, and at Bellarmine College, University of Louisville, Morehead University, Northern Kentucky University, Southeast Community College, and the Center for Rural Development in Somerset make-up the network in 18 locations. Workshops are offered on such topics as bookkeeping, cash-flow systems, tax set-up processes, and how to write a business plan.

Kentucky Cabinet for Economic Development
http://edcweb/kyedc/startup.html
Business and Entrepreneurship Development Division
Business Information Clearinghouse
2200 Capital Plaza Tower
500 Mero Street
Frankfort, KY 40601
(800) 626-2250

Sources of Finance for Aquaculture Operations

Community Farm Alliance Loan Fund
http://www.communityfarmalliance.com
624 Shelby Street
Frankfort, KY 40601
(502) 223-3655

A loan program operated by Community Farm Alliance offering loans from $1,000 to $15,000, depending on the amount of money in the Fund. The Fund was started in 1991 and makes operating, equipment and livestock loans to farmers unable to obtain financing from other sources. Interest rates range from 9% and 11% with loan fees the responsibility of the farmer. Collateral is required equal to the loan value with flexible terms of 1 to 3 years repayment.

Community Ventures
1450 N. Broadway
Lexington, KY
(606) 231-0054

This micro-loan program offers SBA guaranteed loans, which may be available to farm-based businesses, not necessarily agriculture.

Kentucky Cabinet for Economic Development
http://edcweb/kyedc/kedfa.html
Kentucky Economic Development Finance Authority
24th Floor, Capital Plaza Tower
Frankfort, KY 40601
(502) 564-4554

§ **Kentucky Economic Development Finance Authority (KEFDA) Direct Loan Program** – Available for agribusiness ventures, but not retail projects and the amount of the loan awarded is directly related to the number of jobs created. KEFDA may loan up to 45% of total project but the applicant must have 10% already invested. Minimum loan amount is $25,000 and maximum is $500,000 with a fixed interest rate from one to five percent (1%-5%) depending on the term of the loan. Loans are only for land, buildings or equipment, not for operating expenses. An applicant should contact a local bank to discuss KEFDA eligibility and a $500 fee must be submitted with the application.

Kentucky Highlands Investment Corporation (funded under SBA)
http://www.ezec.gov/homepages/rural/Kentucky/khci.html
(606) 864-5175

Lending programs offered by KHIC are targeted to selected counties in southeastern Kentucky.

§ **Micro-Enterprise Loan Fund** – Available to individual or cooperative applicants in the KHIC service area of Bell, Clay, Clinton, Harlan, Jackson, Knox, Laurel, McCreary, Pulaski, Rockcastle, Wayne and Whitley Counties. The funds are available for applicants unable to obtain bank credit, who meet SBA's standards of small businesses. For example, value-added processing of farm products would be eligible, but on-farm processing would not. The maximum loan amount is $25,000 and the term is a maximum of six years. Interest rate is 10-12% and all financial records, test marketing and a business plan need to be in order.

§ **Appalachian Capital Corporation Loan Fund** – Available to businesses located in the KHIC service area of Bell, Clay, Clinton, Harlan, Jackson, Knox, Laurel, McCreary, Pulaski, Rockcastle, Wayne and Whitley Counties. Agricultural projects are not eligible, but processing of value-added farm products would qualify. Loan amounts are $150,000 or 75% of the project cost, whichever is less, and can be used for purchase of fixed assets and/or working capital. A $500.00 processing fee is charged at the time of application and the interest rate is negotiable.

Sustainable Agriculture Research and Education (SARE)
http://www.sare.org/san/htdocs/sare/about.html
Southern Region SARE
1109 Experiment Station, Room 205
Griffin, GA 30223-1797
(770) 229-3350

Administered through the Southern region host institutions, SARE offers competitive producer grants funded through USDA. Grants are for up to three years for a total of $10,000 and cover costs associated with testing or demonstrating a new idea, crop, system or technique. Applicants are expected to match requested funds. Applicants to diversify, start or expand a farm business are not funded.

Tobacco Communities Reinvestment Fund
Commodity Growers Cooperative Assoc.
620 S. Broadway, Suite 206
Lexington, KY 40508
(606) 233-7845

Funded by the Kentucky Office of Attorney General, and administered through Commodity Growers Cooperative, mini grants and micro-loans are available to farmers and farm groups seeking to diversify their farm operations. Strong consideration is given to tobacco farmers, small farmers, and farm applicants residing in the fifteen (15) county identified by the Kentucky Long-Term Policy Research Center as the most highly tobacco-income dependent counties in Kentucky and U.S., and groups of farmers working in cooperation. Grants range from $500 up to $10,000. Micro-loans are also available.

Kentucky Department of Agriculture

http://www.kyagr.com
500 Mero Street
7th Floor
Frankfort, KY 40601
(502) 564-4696

- **Linked Deposit Program –** The Linked Deposit Program provides funds to qualified Kentucky financial institutions through the Abandoned Properties Account. These funds are then offered to eligible borrowers at a reduced interest rate. The program funds can be used for diversification, land acquisition, expansion of facilities or buildings, as well as the purchase of livestock, poultry, seeds, fertilizers, machinery, equipment, and the export of agricultural products. The maximum amount available to an individual borrower is $100,000, and at least half of annual gross income must come from farming in order to qualify.
- **Value-Added Grants Program –** Grants are awarded to non-profit organizations on behalf of Kentucky agriculture producers. The purpose of the program is to enhance marketing opportunities that increase the value of agricultural products through production and/or marketing-based practices. A 30 percent match of funds is required from the applicant. Grants have been awarded for cooperative marketing and processing ventures, livestock sales and handling equipment, value-added product research, forage improvement programs, shared equipment, and other projects that benefit multiple farms.

Kentucky Farm Bureau

- **Farm Income Improvement Foundation (FIIF) –** The FIIF was established to provide assistance to agriculture producers in Kentucky, Tennessee, Virginia, North Carolina, Indiana, Ohio, and Missouri. The foundation is directed by a 16-member board, the president of the Kentucky Farm Bureau serves as president of the foundation. Funds for FIIF come from different sources. Grant criteria is written for each program to comply with requirements of the various funding sources.

Federal Agencies

Farm Services Agency Farm Loan Programs
http://www.fsa.usda.gov/dafl/flphome.html
Kentucky State FSA Office
771 Corporate Drive
Suite 100
Lexington, KY 40503-5478
(606) 224-7601

Farm Services Agency offers direct and guaranteed farm ownership and operating loan programs to farmers who are temporarily unable to obtain private, commercial credit. Often, these are beginning farmers who can not qualify for conventional loans because they have insufficient financial resources. The Agency also helps established farmers who have suffered financial setbacks from natural disasters, or whose resources are too limited to maintain profitable farming operations. Applicants unable to qualify for a guaranteed loan may be eligible for a direct loan from FSA.

- **Farm Ownership Loan –** May be used to purchase farms, construct farm dwellings or service buildings and/or develop land and water resources. Limitation is $200,000 for direct loans and $700,000 for guaranteed loans. These may be scheduled for a period of up to 40 years. Interest rate is a fixed rate established at time of loan approval.
- **Farm Ownership Joint Financing Plan –** May be used to assist beginning farmers and ranchers entering agriculture to purchase a farm or ranch. FSA will lend up to 50% of the purchase price at a fixed interest rate of 5% and the applicant obtains the other 50% from another lender.
- **Farm Operating Loan –** May be used for the purchase of livestock and equipment, for annual operating and family living expenses, and for refinancing debts related to the operation of the farm. Limitation is $200,000 and may be scheduled for a period of up to 7 years (except for annual operating and living expenses, which must be paid back in one year). Interest rate is a fixed rate established at time of loan approval.
- **Beginning Farmer and Rancher Farm Ownership Loans –** May be used to purchase farms, construct farm dwellings or service buildings and/or develop land and water resources. Limitation is $200,000 and may be scheduled for a period of up to 40 years. Beginning farmer or rancher must have operated a farm or ranch for at least 3 years, but not more than 10 years. Beginner does not own farm property totaling more than 25% of the average county farm acreage. If applicant is a business entity, all members must be related by blood or marriage.
- **Beginning Farmer and Rancher Farm Operating Loan –** May be used for the purchase of livestock and equipment, for annual operating and family living expenses, and for refinancing debts related to the operation of the farm. Limitation is $200,000 and may be scheduled for a period of up to 7 years (except for annual operating and living expenses, which must be paid back in one year). Interest rate is a fixed rate established at time of loan approval. Beginning farmer or rancher must have operated a farm or ranch for 5 years or less. If applicant is a business entity, all members must be related by blood or marriage.
- **Beginning Farmer and Rancher Downpayment Farm Ownership Loan Program –** May

be used to assist beginning farmers and ranchers entering agriculture to purchase a farm or ranch. Also provides a means for retiring farmers to transfer their land to a future generation of farmers and ranchers. Applicant makes cash downpayment of at least 10% of purchase price. FSA provides a maximum of 30% of purchase price (or appraised value, whichever is less) for 10 years at fixed 4% interest rate. The remaining 60% of purchase price can be obtained from private lender (FSA will guarantee 95% if from an eligible commercial lender). Purchase price or appraised value, whichever is lower, may not exceed $250,000. Beginning farmers and ranchers are given first priority to purchase FSA acquired properties at appraised market value for the first 75 days after acquisition.

§ **Emergency Loan –** May be used for either operating or real estate purposes if the county in which the applicant operates is declared a disaster area. A production loss loan applicant must have incurred a 30% loss in any one commodity. Physical losses are primarily damage to equipment, livestock, buildings or land itself. Terms of loan are from one to 40 years and based on actual dollar loss due to disaster. Cumulative emergency loan limit is $500,000 per borrower and the interest rate is 3.75%.

§ **Youth Project Loans**

USDA Rural Development Office
771 Corporate Drive
Suite 200
Lexington, KY 40503
(606) 224-7435

A branch of USDA that mainly offers grants and loans for large endeavors (community development block grant, business and industrial loan program).

§ **Business and Industry Direct Loan –** Available in rural areas, this includes all areas other than cities or unincorporated areas of more then 50,000 people and their immediately adjacent urban or urbanizing areas. The maximum aggregate B&I Direct Loan amount to any one borrower is $10 million. It provides loans to public entities and private parties who can not obtain credit from other sources.

§ **Business and Industrial Guaranteed Loan Program –** Available in populations of less than 50,000 people for applicants that are not eligible for FSA programs. Agriculture requirements include loan amounts not more than $1 million with 80% guarantee, and there is no minimum loan amount. Ten percent must be down on an existing business and 20% down on a new business. Terms are 30 years for land and building, 15 years for equipment and 7 years for capital. Past history of agriculture related loans have been to vertically integrated farm projects.

§ **Intermediary Relending Program Loans –** Loan funds available to nonprofit agencies or public government to finance business facilities and community development projects in rural areas

§ **Rural Business Enterprise Grants –** Grant funds available to nonprofit agencies or public government to finance revolving loan programs or develop infrastructure for rural areas.

§ **Rural Business Opportunity Grants –** Funds provide for technical assistance, training, and planning activities that improve economic conditions in rural areas. Applicants must be lo cated in rural areas, which includes all areas other than cities of more than 10,000 people. Non-profit corporations and public bodies are eligible for a maximum of $1.5 million per grant authorized by the legislation.

- **Rural Economic Development Loans and Grants –** Loan and grant funds available to Rural Utilities Service electric and telephone borrowers who use the funds to provide financing for business and community development projects.

Small Business Administration
http://www.sba.gov
SBA – District Office
600 Dr. M.L. King Jr. Place
Room 188
Louisville, KY 40202
(502) 582-5971

Available through commercial lenders, the U.S. Small Business Administration guarantees long-term loans made available to start to expand a business. Although not highly publicized, SBA likes farmer applicants, as they have had a high success rate in the past. If the applicant is an agricultural enterprise (business engaged in the cultivation of soil, producing crops, and raising livestock), then the applicant should first apply for USDA administered loans, and if denied or ineligible, then apply through SBA. If the applicant is a farm-related business that supplies goods or services primarily used in connection with farming, SBA will take applications directly.

- **7(a) Loan Program –** Guarantee to lender is 80% of amount up to $100,000 and 75% of $100,000 through $750,000 maximum guarantee. Interest rate cannot exceed 2.75 over prime, although loans under $50,000 have higher interest rates. Terms are up to 25 years for land, 15 years for equipment, 7 years for furniture and fixtures and 5-10 years for working capital. Farmer eligibility includes: less than $500,000 annual income with livestock and crops, less than $9 million with poultry, and less than $5 million with other experiences.
- **Specialized 7(a):SBALowDoc –** Designed to increase the availability of funds under $150,000 and streamline/expedite the loan review process.
- **Specialized 7(a):SBAExpress –** Designed to increase the capital available to businesses seeking loans up to $150,000, but is currently offered as a pilot with a limited number of lenders.
- **Specialized 7(a):CAPLines –** An umbrella program to help small businesses meet their short-term and cyclical working-capital needs with five separate programs.
- **Specialized 7(a):International Trade –** If your business is preparing to engage in or is already engaged in international trade, or is adversely affected by competition from imports, the International Trade Loan Program is designed for you. Taylor Co., Kentucky is eligible.
- **Specialized 7(a):Export Working Capital –** Designed to provide short-term working capital to exporters in a combined effort of the SBA and the Export-Import Bank.
- **Specialized 7(a):Pollution Control –** Designed to provide loan guarantees to eligible small business for the financing of the planning, design, or installation of a pollution control facility.
- **Specialized 7(a): Qualified Employee Trust –** Designed to provide financial assistance to Employee Stock Ownership Plans.

- § **Certified Development Company (504 Loan) Program –** This program, commonly referred to as the 504 program, makes long-term loans available for purchasing land, buildings, machinery and equipment, and for building, modernizing or renovating existing facilities and sites.
- § **Specialized 7(a):Women's Prequalification Loan Program –** An applicant's business must be 51% owned, operated and managed by women and a maximum loan amount is $250,000. Loans are 7(a) and SBA will guarantee up to 75% of the loan, 80% on loans of $100,000 or less. An applicant must work with a non-profit professional organization in preparing a business plan and completing the loan application. Terms are up to 25 years for land, 10 years for machinery and equipment, and between 5 and 10 years for working capital.
- § **Specialized 7(a):Minority Prequalification Loan Program –** Similar to Women's PreQual Loan Program, although for-profit organizations may be involved as the intermediary. An applicant must be 51% owned, operated and managed by people of ethnic or racial minority.
- § **7(m) MicroLoan Program –** A SBA program that makes funds available to non-profit intermediaries which in turn offer $100 to $25,000 micro loans. Average loan size is $10,000. In Kentucky, the Kentucky Highlands Investment Corporation and Community Ventures offer loans under this SBA program.

Appendix B Regulatory Agency Contacts

U.S. Army Corps of Engineers

Tennessee & Cumberland Rivers Drainage
Nashville, TN
615-736-5181
Mississippi River Drainage
Memphis, TN
901-544-3471
Kentucky River Drainage
Louisville, KY
502-582-5452
Eastern Kentucky
Huntington, WV
304-529-5210

Natural Resources & Environmental Protection Cabinet

Kentucky Dept for Environmental Protection
Division of Water, Floodplain Management Section, KPDES Branch
18 Reilly Road, Frankfort, KY 40601
502-564-3410

Department of Fish and Wildlife Resources, Division of Fisheries

Arnold L. Mitchell Building
#1 Game Farm Road, Frankfort, KY 40601
502-564-3596

Kentucky Cabinet for Health Services

Dept for Public Health
Division of Public Health Protection & Safety
275 East Main Street HS2 E-C, Health Services Building
Frankfort, KY 40601
502-564-7181

Appendix C Recommended Publications for Further Information

Freshwater Prawns

D'Abramo, L.R., W.H. Daniels, M.W. Fondren and M.W. Brunson. 1995. Management practices for culture of freshwater shrimp (*Macrobrachium rosenbergii*) in temperate climates. Bulletin 1030. Mississippi Agricultural Forestry Experimental Station. Mississippi State University, Mississippi, USA.

Tidwell, J.H., L.R. D'Abramo, C.D. Webster, S.D. Coyle, and W.H. Daniels. 1996. A standardized comparison of semi-intensive pond culture of freshwater prawns (*Macrobrachium rosenbergii)* at different latitudes: Production increases associated with lower water temperatures. Aquaculture. 141:145-148.

New, M.B. 1995. Status of freshwater prawn farming: A review. Aquaculture Research 26:1-54.

New, M.B. and W.C. Valenti. In press. Freshwater prawn farming. The farming of (*Macrobrachium rosenbergii)*. Fishing News Books. University Press. Cambridge.

Trout

Southern Regional Aquaculture Committee Publications:

SRAC No. 224, Rainbow Trout, 1995 K.F. Ladewig and Morat.

SRAC No. 220, Trout Production: Handling Eggs and Fry, 1990. J.M. Hinshaw.

SRAC No. 222, Trout Farming: A Guide to Production and Inventory Management, 1990. J.M. Hinshaw.

SRAC No. 223, Trout Production: Feeds and Feeding Methods, 1990. J.M. Hinshaw.

SRAC No. 221, Budgets for Trout Production: Estimated Costs and Returns for Trout Farming in the South, 1990 J.M. Hinshaw, E. Rogers, J.M. Easley.

Winter Culture of Caged Rainbow Trout in the South, 1992 F.S. Wynne Kentucky State University Cooperative Extension Program, 2292 S. Hwy 27, Suite 200 Somerset, KY 42501.

Culture of Salmonid Fishes. 1991 R.R. Stickney. CRC Press 2000 Corporate Blvd., N.W. Boca Raton, Florida 33431.

Catfish

Avault, J.W., Jr. 1996. Fundamentals of Aquaculture. AVA Publishing Company, Inc., Baton Rouge, Louisiana. 889 p.

Boyd C.E. 1990. Water Quality in Ponds for Aquaculture. Alabama Agricultural Experiment Station, Auburn University. Birmingham Publishing Company, Birmingham, Alabama. 482 p.

Durborow, R.M. Catfish Farming In Kentucky. Kentucky State University, National Oceanic and Atmospheric Administration, and U.S. Fish and Wildlife Service. 37 p. (In Preparation).

Durborow, R.M. Channel Catfish Fingerling Production In Kentucky. Kentucky State University, National Oceanic and Atmospheric Administration, and U.S. Fish and Wildlife Service. 31 p. (In Preparation).

Huner, J.V. and H.K. Dupree. 1984 Methods and economics of channel catfish production, and Techniques for the culture of flathead catfish and other catfishes. From the Third Report to the Fish Farmers. U.S. Department of the Interior, Fish and Wildlife Service. Pp. 44-82.

Piper, R.G., I.B. McElwin, L.E. Orme, J.P McCraren, L.G. Fowler, and J.R. Leonard. 1989. Fish Hatchery Management. United States Department of the Interior, Fish and Wildlife Service, Washington, D.C. 517 p.

Tucker, C.S. and E. H. Robinson. 1990. Channel Catfish Farming Handbook. Van Nostrand Reinhold, New York, New York. 454 p.

Schmittou, H.R. 1970. The culture of channel catfish, *Ictalurus punctatus*, in cages suspended in ponds. Proceedings of the Annual Conference Southeastern Association of Game and Fish Commissioners 23(1969):226-244.

Largemouth Bass

Tidwell, J.H., Webster, C.D. and Coyle, S.D. 1996. Effects of dietary protein level on second year growth and water quality for largemouth bass (*Micropterus salmoides*) raise in ponds. Aquaculture 145:213-223.

Kubitz, F. and L.L. Lovshin. 1997. Pond production of pellet-fed advanced juvenile and food-size largemouth bass. Aquaculture 149:253-262.

Tidwell, J.H., C.D. Webster, S.D. Coyle, and G. Schulmeister. 1998. Effect of stocking density on growth and water quality for largemouth bass (*Micropterus salmoides*) grow-out in ponds. Journal of the World Aquaculture Society. 29:79-83.

Hybrid Striped Bass

Culture and Propagation of Striped Bass and Its Hybrids. 1992. American Fisheries Society, Bethesda, MD.

Nutrition and Feeding of Fish, 2nd Edition, edited by R.T. Lovell, pages 199-214: Feeding hybrid striped bass. Kluwer Academic Publishers, Boston, MA.

Paddlefish

Mims, S.D. 1997. Propagation and culture of the American paddlefish, *Polyodon spathula*. 40-minute video. Kentucky State University Land Grant Program, Frankfort, KY.

Mims, S.D. and W.L. Shelton. 1998. Monosex culture of paddlefish and shovelnose sturgeon. Pages 67-76 in Symposium on the Harvest, Trade and Conservation of North American Paddlefish and Sturgeon. Traffic North America/World Wildlife Fund Washington, D.C., USA.

Baitfish

Stone, N., Park, E., Dorman, L.W., Thormforde, H. Baitfish production in Arkansas: golden shiners, goldfish and fathead minnows. Cooperative Extension Program, University of Arkansas at Pine Bluff, MP 386.

Giudice, J.J., Gray, D.L., Martin, J.M. Manual for baitfish culture in the south. U.S. Fish and Wildlife Service and the University of Arkansas Cooperative Extension Service, EC 550.

Pounds, G.L., Dorman, L.W., Engle, C.R., 1991. An economic analysis of baitfish production in Arkansas. Arkansas Agricultural Experiment Station, University of Arkansas, Report Series 321.

Dorman, L.W. and Gray, D.L. Spawning baitfishes. Cooperative Extension Service, University of Arkansas. Fact sheet 9003.

Common Carp

Carp in North America. E.L. Cooper, ed. American Fisheries Society, 1987.

The Carp. Special Issue. Aquaculture, Vol. (129). 1995.

Crappie

Martin, M. 1988. Black and Hybrid Crappie Culture and Crappie Management. Aquaculture Magazine 14(3):35-41.

Hybrid Bluegill

Tidwell, J.H., C.D., Webster, J.A. Clark, and M.W. Brunson. 1994. Pond culture of female green sunfish (*Lepomis cyanellus*) x male bluegill (*L. machrochirus*) hybrids stocked at two sizes and two densities. Aquaculture 126:305-313.

Red Claw Crayfish

Rouse, D.B. and Masser, M.P. 1993. Production of Australian Red Claw. Circular ANR-769, Alabama Cooperative Extension Service, Auburn University, Auburn, AL.

Sturgeon

Dettlaff, T.A., A.S. Ginsburg, and O.I. Schmalhansen. Sturgeon Fishes. Springer-Verlag, New York, New York, 300 pp.

Sternin, V. and I. Dore. Caviar: The Resource Book Moscow, Russia, 256 pp.

Tilapia

Torrans, L. Blue tilapia culture in Arkansas. Cooperative Extension Program, University of Arkansas at Pine Bluff. EC 560.

Southern Regional Aquaculture Center. Tilapia series. Publication Numbers 280-283.

Stickney, R.R. 1988. Tilapia: In, Culture of nonsalmonid freshwater fishes. Chapter 4. CRC Press, Inc.

Walleye

W.M. Koenst. 1986. Revised estimates of growth requirements and lethal temperature limits of juvenile walleyes. Progressive Fish-Culturist 4890-94.

Yellow Perch

Heidinger, R.C. and T.B. Kayes. 1986. Yellow Perch. Pages 104-113 in R.R. Stickney ed. Culture of Nonsalmonid Freshwater Fishes, CRC Press, Inc. Boca Raton, Florida.

Malison, J.A. 1997. Factors promoting and constraining the commercial culture of Yellow Perch, (*Perca flavescens)*. World Aquaculture '97 Book of Abstracts.

Tidwell, J.H., S.D. Coyle, J.E. Evans, C. Weibel, J. McKinney, K. Dodson, and H. Jones. 1999. Effect of culture temperature on growth, survival, and biochemical composition of Yellow Perch (*Perca flavescens*). Journal of the World Aquaculture Society Vol. 30(3)324-330.

Aquatic Plants

Bird, K. 1992. Aquatic plants, new profits for aquaculturists. Aquaculture Magazine, 18(1), pp. 30-40.

Lilyponds Water Gardens. Commercial/promotion information and literature. Internet web-site, www.lilypons.com

Masser, M.P. Ornamental garden pools. Alabama Cooperative Extension Service, Auburn University. Circular ANR-789.

Cage Production

Masser, M.P. 1988. What is cage culture? SRAC Publication 160.

Masser, M.P. 1997. Cage culture: site selection and water quality. SRAC Publ. 161.

Masser, M.P. 1997. Cage culture: cage construction, placement, and aeration. SRAC Publ. 162

Masser, M.P. 1997. Species suitable for cage culture. SRAC Publ. 163.

Masser, M.P. 1988. Cage culture: cage culture problems. SRAC Publ. 165.

Masser, M.P. 1988. Cage culture: harvesting and economics. SRAC Publ. 166.

Webster, C.D., Tidwell, J.H., Tiu, L.G., and Yancey, D.H. 1996. Culture, nutrition, and feeding of fish in cages. Aquaculture Magazine 22(5): 30-39.

Wynne, F. 1992. Winter Culture of Caged Rainbow Trout in the South. Kentucky Fish Farming Newsletter Vol. 5(1) pg. 1-4.

Web-sites to Reference for Additional Information

Kentucky Aquaculture Association – http://web.qx.net/bubbasue/

Kentucky Department of Agriculture – http://www.kyagr.com

Aquaculture Network Information Center – http://ag.ansc.purdue.edu/aquanic/
Southern Regional Aquaculture Publications

AquaNIC – http://aquanic.org

Kentucky State University – http://www.kysu.edu

United States Department of Agriculture - http://www.usda.gov

National Marine Fisheries Service, Fisheries Statistics and Economics Division - http://www.st.nmfs.gov/st1/index.html

Food and Agriculture Organization Fisheries Department - http://www.fao.org/fi/default.asp

Appendix D Acknowledgements

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