



Cooperative
Extension
Program

University of Arkansas at Pine Bluff

Aquaculture Alternatives in Arkansas

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Aquaculture has become a popular form of agriculture. Many people are looking at various aquaculture enterprises as a way to start a new business. Arkansas is a prime location for the development of aquaculture farms. Industry infrastructure, such as feed mills, aquaculture supply houses, financial institutions and equipment manufacturers, is readily available and supports existing producers. In considering an aquaculture business venture, there are a number of important decisions to be made. This fact sheet is intended to assist potential producers by outlining critical questions, briefly describing alternatives and referencing available Extension publications.

In addition to commercial operations, small-scale aquaculture can produce food for family and friends. A pond, a few cages or an indoor system can be managed to provide a supply of fresh fish for the table. The Cooperative Extension Service can supply information on a wide range of options. Official standards for organic fish have yet to be finalized, but there is clearly an unmet demand for organic fish. Many fish feeds are grain-based (e.g., catfish feed), and fish feeds without fishmeal are commercially available.

The vast majority of fish farms in Arkansas are small family businesses. Fish farming requires a high level of dedication, hard work and near-constant attention during the growing season. Prior to entering commercial farming, consider if you have the

temperament, skills, management ability, financial resources and time required to run a fish farm. If you are not interested or suited to the task and still wish to pursue fish farming, you will have to pay to hire a manager.

The Southern Regional Aquaculture Center (<http://srac.tamu.edu/>) provides online access to a series of helpful fact sheets, including SRAC 441, *Aquaculture: Realities and Potentials When Getting Started*. This fact sheet is an excellent resource for people thinking of beginning an aquaculture business. It points out the potential for catastrophic disasters such as oxygen depletions and disease, emphasizes the importance of marketing and discusses the risks and benefits of fish farming. As one ex-farmer put it, the hours are long and the work is hard, but at least the profit margin is microscopic!

It is critical to develop a business plan before beginning an aquaculture operation. A business plan includes both a marketing plan and a financial analysis of the proposed operation (see SRAC Fact Sheet 381, *Developing Business Proposals for Aquaculture Loans*). Marketing is the key to a successful aquaculture business. You may need to contact lenders and investors to acquire the necessary capital. Fish farming requires large amounts of capital for pond construction and equipment, and it is not always easy to sell or lease the business if you decide to exit. Your plan should indicate potential profits.

Will the profit make your efforts worthwhile? Visits to commercial farms and with Extension personnel can help you set goals for your aquaculture operation and assist with developing budgets.

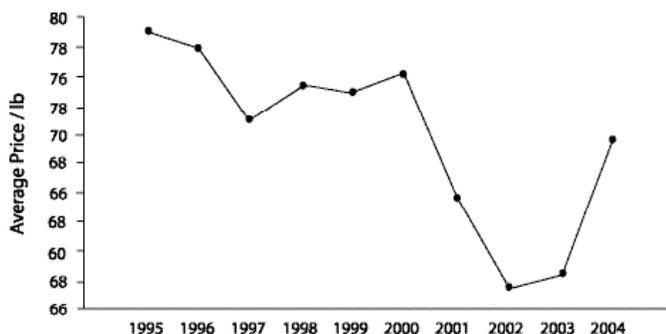
Deciding which aquaculture species to produce is an important step. Each species has its own potential and constraints – biological and economic. The principal question is, can this species be raised and sold for a profit in Arkansas? In selecting a species, it is critical to study not only the production methods but also markets available and accessible to your proposed operation, as well as anticipated costs, market price and expected profits.

Sources of Information

The Aquaculture/Fisheries Center of the University of Arkansas at Pine Bluff (<http://www.uaex.edu/aqfi>) and the University of Arkansas Division of Agriculture, Cooperative Extension Service (<http://www.uaex.edu>) work cooperatively to provide research-based information for people interested in aquaculture. Information on fish production can be obtained from any county Cooperative Extension Service office in Arkansas. Your county Extension agent can provide valuable information on local conditions. Extension materials are designed to provide an objective overview of the requirements and rewards involved. Ultimately, the decision to enter fish farming rests with the individual. Informed individuals make better decisions, reducing the chances of failures that hurt everyone in the business.

Use reasonable caution when obtaining information from the Internet. While many commercial sites provide useful information and links, the potential exists for information to be biased towards a particular company's product or service. Even government or educational sites may be unintentionally misleading. For example, it is possible to access publications developed for one region of the country that offer recommendations unsuited to other locations. Reliable, research-based information can be

Figure 1. Average price per pound (cents) for live catfish delivered to the processor (NASS, USDA)



obtained from the University of Arkansas Cooperative Extension Service web site.

Aquaculture Species

A large variety of different aquaculture species are cultured in Arkansas. The major species raised are the channel catfish and baitfish (golden shiners, fathead minnows and goldfish). Information on culture methods for these crops is readily available from the Cooperative Extension Service. Additional species raised in Arkansas include hybrid striped bass, grass carp, bighead carp, largemouth bass (foodfish), fancy goldfish, koi carp, common carp, ornamental fish, crawfish, trout, black carp, tilapia, freshwater prawns, marine shrimp and turtles. Sportfish, fish for stocking recreational ponds, such as largemouth bass, bluegill, black crappie, hybrid bream and redear sunfish, are also farmed. However, there is limited available information on the production and/or marketing of many of these species. Existing producers have spent much time and effort developing their own production methods and markets. A potential producer should gain experience before attempting to produce these species commercially and must expect to devote a large portion of his or her time to marketing efforts.

Catfish – Arkansas is second only to Mississippi in channel catfish production, with approximately 34,000 acres of ponds. Catfish production is capital-intensive, with investment costs of approximately \$4,000 per acre. It is also a demanding business that requires hard work and skilled management. There are economies of scale in catfish farming, meaning that production costs are lower for larger farms up to at least 320 acres or more. Large farms typically sell fish to processors, while farms of less than 20 acres should consider marketing fish locally through direct sales or fee-fishing operations. Catfish is a high-quality, desirable product, but sales have been hurt by imports of competing fish species from countries with few environmental and regulatory controls [Figures 1 and 2].

Figure 2. Catfish is a high-quality and desirable product.



Catfish can be raised in farm ponds on a part-time basis, primarily as a hobby or for home food production. At this level of production, profits from the sale of fish are not enough to pay for the construction of new ponds. Harvesting existing farm ponds can be a major problem if they are deep, without drains or filled with stumps and other debris.

Baitfish – Arkansas leads the nation in the production of fish for bait and as feeders (live food for ornamental fish and invertebrates). Approximately 24,000 acres of ponds are used to raise over six billion baitfish each year. The main species raised are the golden shiner, fathead minnow and goldfish [Figure 3]. While there have been improvements in hatchery and production methods in recent years, marketing remains the most difficult part of the baitfish business. Baitfish species are not particularly difficult to culture, but it is a risky business, as the retail demand for baitfish is highly variable. Newcomers are unlikely to capture a significant share of the market without developing a thorough understanding of baitfish marketing.

Figure 3. The golden shiner is a common farm-raised baitfish.



Crawfish – Capital requirements and operating expenses for crawfish culture are less than for catfish production because only low (3 foot) levees are needed and forage is used instead of feed. However, harvesting crawfish by trapping requires considerable labor in the spring, when row crop farmers are busy planting. Production of quality crawfish (cleaned and purged) is one way to promote sales of Arkansas pond-raised crawfish and to differentiate the farmed product from the wild catch [Figure 4]. Local markets are willing to pay a higher price for crawfish.

Figure 4. Cleaned and purged crawfish are a popular product.



Sportfish – Sportfish are fish produced for stocking recreational ponds. These include bluegill, black crappie, hybrid bream (bluegill x green sunfish cross is common) and redear sunfish [Figure 5]. The successful producer should be able to offer a variety of healthy, quality fish species to give the customer “one-stop shopping” for their pond stocking needs. Sportfish suppliers may also offer other products to their customers for their ponds, such as feed, aerators and chemicals.

Figure 5. Hybrid bream are popular for fishing ponds and show potential as a food fish.



Tilapia – A hardy tropical fish that is widely cultured around the world, tilapia can be raised in indoor systems or outdoors during the summer months in Arkansas [Figure 6]. Tilapia are particularly suited to culture in recirculating systems, since they tolerate high stocking densities and poor water quality. High overwintering costs and the fact

that market-sized fish would be available for only a short time in the fall limit the potential for pond culture of this species. Production costs in indoor tank systems are relatively high. While there has been a growing market for tilapia fillets, foreign farms are able to produce, process and ship fish to the United States at a lower cost than can be achieved by domestic tilapia producers. Producers in the U.S. are limited primarily to supplying live tilapia to niche markets, such as ethnic grocery stores. The tilapia is an excellent fish for hobby or home food production and is widely used in high school aquaculture programs.

Figure 6. Tilapia are a popular culture species, but they are tropical animals.



Trout – Requirements for trout culture are well established. Trout are typically grown in raceways and require large amounts of clean, cold water (less than 70 degrees Fahrenheit). Winter culture of trout in ponds is possible, but its feasibility has not been established and markets would have to be developed. It would require a relatively large fish to start with, as the growing season is short. Trout are raised in government hatcheries within Arkansas, but at present there are no commercial operations.

Other Food Fish Species – Hybrid striped bass are excellent food fish and are raised in several other states and countries for the food fish market. Arkansas is a leader in the production of hybrid striped bass fingerlings, but there is very limited production of hybrid striped bass as a food fish in the state. Information is available on culture methods, but marketing is likely to be a challenge. Typically, hybrid striped bass are sold whole on ice to restaurants. No processing is available, and this limits production.

Small largemouth bass fingerlings can be brought into tanks and trained to eat pelleted feeds. This is a demanding process, but once the fish learn to accept feed pellets, they can be raised for the live food fish market [Figure 7]. Largemouth bass diets are different from those for catfish, and in general,

Figure 7. Largemouth bass are the most sought-after sportfish in America.



culture methods are relatively demanding. Hybrid bream are also a potential food fish species, grow relatively slowly compared to catfish and will likely require at least two growing seasons to reach a minimally acceptable market size. Currently, there are no commercial hybrid bream food fish producers in Arkansas, and the economics and marketing have not been studied. Crappie (black or white or the hybrid) are another species that has been proposed as a potential food fish, primarily because they are considered “good eating.” While there has been some research on crappie culture, much remains to be learned before commercial culture of this relatively delicate and demanding species becomes a reality.

Paddlefish, buffalo, bighead carp and grass carp are examples of species which can be polycultured with catfish or in extensive culture (fertile reservoirs) [Figure 8].

Figure 8. Paddlefish are not a common culture species, but they can be raised at low densities in reservoirs.



Ornamentals – Some producers raise fish that are strictly ornamental. These include fancy goldfish, koi carp and tropical fish species such as angelfish. Ornamental fish can be sold directly to retail customers or wholesale to dealers. The producer receives a higher price per fish for ornamental species, but a great deal of effort must be exerted to produce quality fish with the body conformation, fins

and colors that the customer demands. As an example, if a producer has high-quality brood fish and has the ability to select out valuable fingerlings from ordinary ones, the results could be rare koi carp with color patterns that are worth several thousands of dollars. However, without the investment and acquired knowledge from years of fish breeding, it is likely that the fish produced will be worth just pennies.

Marine Shrimp –

Marine shrimp, typically the Pacific white shrimp (*Litopenaeus vannamei*), can be raised in low-salinity inland waters during the summer in the southern United States, and there are several farms in Arkansas [Figure 9]. Once past the larval stages, marine shrimp can tolerate water with low salt levels. Shrimp are tropical animals, and they cannot survive the winters in Arkansas. Young shrimp (post-larvae) are stocked in late May, and the resulting product must be harvested by fall (early October) before the onset of cold weather (water temperatures below 59 degrees Fahrenheit). Because of competition from wild-caught and imported shrimp and the seasonal production, marketing is a major concern for inland shrimp farmers. It is essential that the post-larval shrimp be obtained from a reputable hatchery and that they be Specific Pathogen-Free (SPF) and inspected for viral diseases. While post-larval shrimp are widely available, there is limited availability of quality product.



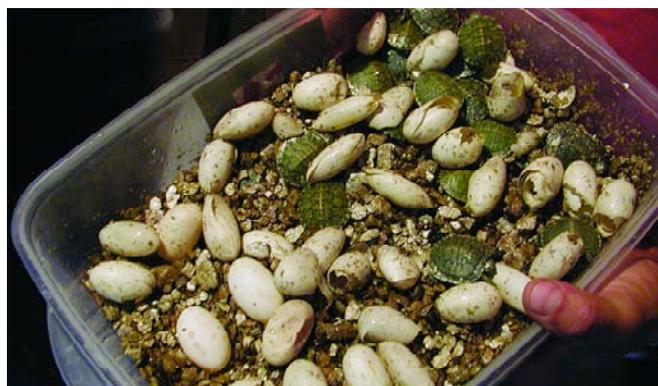
Figure 9. Marine shrimp raised in freshwater ponds, Pine Bluff, Arkansas

Freshwater Prawns – The scientific name for the freshwater prawn (also called freshwater shrimp) is *Macrobrachium rosenbergii*, and it is a tropical species native to Asia. In Arkansas, freshwater prawns are an approved aquaculture species. The stocks must be certified disease-free, and the certificate posted on-site. Prawns can be raised during the summer months only, as they die when the temperature drops below 59 degrees Fahrenheit. Prawns are raised in small ponds, one-half to four acres in size, which are specially constructed for prawn culture. Since prawns live on the bottom, deep ponds are not recommended because the bottom waters often have little oxygen in the summer months. The growing season in Arkansas is limited to 110-130 days, from mid- to late May through the first week of October. For this reason, producers must stock a relatively large “baby” prawn, called a juvenile, which is already about 90 days old. Juvenile prawns are stocked at 16,000 to 20,000 per acre.

The current price is 8 cents per juvenile, so the seed stock alone costs over \$1,280 per acre, excluding delivery. Producers all over the south follow a similar stocking and harvest schedule, resulting in all production being marketed during a two- to four-week period in early fall. This seasonal abundance in supply will become an increasingly important factor as the quantity of prawns produced increases. Processed freshwater shrimp can be imported into the U.S. for a fraction of what it costs to produce shrimp here, so it is unlikely that American producers will be able to expand beyond existing live and fresh niche markets. In general, freshwater shrimp production is an expensive business. Potential producers need to carefully consider the costs and risks involved.

Turtles – Several species of aquatic turtles are also produced in Arkansas. Only a limited amount of research has been done on turtle culture, and current operations have developed many of their own techniques [Figure 10]. Small hatchlings and all turtles smaller than four inches are sold as pets or stocked for grow out, but due to U.S. regulations and health concerns, these must all be sold to overseas customers, typically in China. Turtles weighing one pound and larger are sold as food, domestically and overseas. Anyone considering turtle culture should check with the Arkansas Game and Fish Commission to obtain current regulatory information.

Figure 10. Arkansas has several turtle farms, but little research-based information is available on culture and marketing.



Other Species – A large variety of other aquaculture species currently have limited potential in Arkansas. This list includes animals such as bullfrogs, salamanders, eels, redfish (red drum), bigmouth or smallmouth buffalo, various algae and alligators. The technology to rear these species may exist, but the demonstrated economic feasibility is lacking. For example, alligators survive year-round in the southern portions of the state, so alligator farming for the meat and skin trade is biologically possible. However, the market for these products is comparatively small and is presently supplied by wild

harvest and the few existing farms. Similarly, there is a market for frog legs, but culture of frogs is labor intensive and relatively expensive. Competition from imported frog legs (wild-caught frogs from foreign countries) has made domestic frog culture uneconomical. Buffalo (fish) were cultured and sold in the past, but do these markets still exist? Again, these other species may have potential, but a great deal is unknown.

Every year a number of people “discover” new aquaculture species that are not being raised in Arkansas and see great profit potential in these new ideas. If a species is not presently cultured, usually it means that there are technical problems in its culture or that it cannot be raised profitably.

Aquaculture Species Regulations

A Fish Farming Permit from the Arkansas Game and Fish Commission (AGFC) is required to commercially culture fish or other aquatic animals in Arkansas. To buy or sell paddlefish or sturgeon, a Roe Taker/Seller Permit is required. Fish farmers also must supply a bill of sale or lading when they sell fish (see Section 42 of the AGFC code of regulations for details). The AGFC also maintains a list of approved aquaculture species, those species that can be legally cultured in Arkansas without a special permit. A number of additional species can be raised if a farm meets AGFC requirements and obtains a “restricted species possession permit.” Species that are not on either the approved or restricted list cannot be legally cultured. However, the AGFC does have a process where producers may apply for permission to culture certain species under an “unlisted aquaculture species permit.” For example, marine shrimp culture requires this permit. It is essential not to introduce new species into Arkansas unless and until AGFC approval has been obtained. Exotic species can cause tremendous economic and ecological damage to the state and the region as well as to the state’s aquaculture industry.

Culture Systems

Various systems are used in raising aquaculture crops. The vast majority of species are best grown outdoors in earthen ponds. Cage culture provides a means to raise fish in ponds from which fish cannot be easily harvested. Indoor recirculating tank systems have experienced a high failure rate among commercial operations but are well suited to home use or select niche markets. Raceway culture requires a reliable supply of flowing water, and while feasible in select locations, design and management measures are necessary to minimize the environmental impact from the constant effluent stream they produce.

Ponds – Pond culture is a known and proven technology. Ponds naturally process fish waste products, and successive crops of fish can be raised in the same water without draining or exchanging water. Compared to other culture systems, fish densities are relatively low. Worldwide and in the U.S., most of the fish and shrimp produced through aquaculture are cultured in ponds [Figure 11]. Arkansas has large areas of flat land with soils suitable for levee ponds. For information on commercial levee pond site selection and construction, see SRAC Fact Sheets 100 and 101.

Figure 11. Earthen ponds are the most common culture system.



Groundwater is the best source of water for levee pond fish farming. While groundwater remains abundant in some areas of the Delta, there are regions where groundwater levels are becoming critically low. Prospective producers should consult with well drilling companies or the Arkansas Natural Resources Conservation Commission (formerly the Soil and Water Conservation Commission) to determine local conditions. Proper pond construction and management can limit water use in fish culture to 15 to 24 inches per year after the initial pond filling.

Fish can also be raised in watershed ponds that are supplied with water by rain and associated runoff. Management of watershed ponds is more difficult than levee ponds, and these ponds are susceptible to drought. Nevertheless, watershed ponds are used successfully for fish culture in other areas of the south. Information on site selection and construction of watershed ponds is available in SRAC Fact Sheet 102. Arkansas also has thousands of farm ponds. Many were built for cattle watering or recreational fishing, but they are also used for food fish production. A typical farm pond supports 100 to 400 pounds of fish per acre.

Recirculating Systems – Indoor recirculating aquaculture systems seemingly provide a great many advantages. Fish can be grown year-round in virtually any location with a modest water supply.

Raising fish in indoor tanks facilitates stocking, feeding and harvesting. In some cases, water from fish culture units is used for hydroponic systems which grow vegetables or herbs. Relatively simple, low technology units are widely used for small-scale production and for educational purposes. Dozens of high schools in Arkansas and hundreds of schools across the nation maintain recirculating aquaculture systems to provide “hands-on” experience to students and to demonstrate the real life importance of mathematics, chemistry and other subjects.

A recirculating system typically consists of a culture tank, where the organisms are held and fed; a solids collection device; and a biofilter, where a film of bacteria grows on a substrate (selected for its large surface area to volume ratio) and breaks down toxic nitrogenous wastes into relatively non-toxic forms [Figure 12]. A small pump is used to circulate water through the various components, and an air blower is used to add oxygen to the water. The simplest form of a recirculating system is the home aquarium; the under-gravel filter serves as a biofilter. Commercial recirculating systems are more intensive and produce a greater weight of fish per unit volume than ponds. Additional components such as protein skimmers, micro-screens (to remove small particles) and liquid oxygen systems may be used to increase fish production.

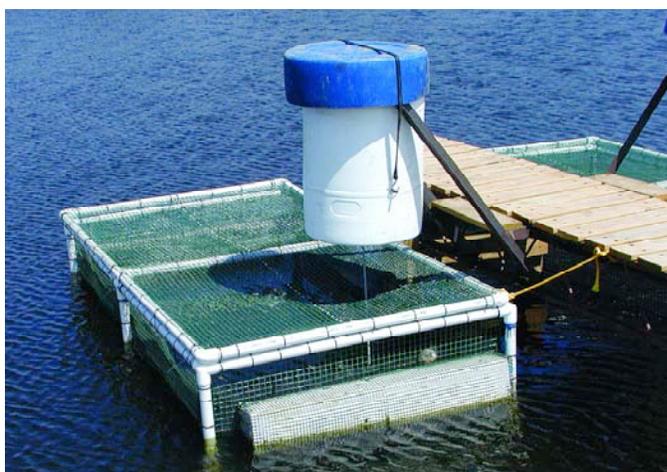


Figure 12. Recirculating systems require careful attention.

Unfortunately, there are a number of disadvantages to using recirculating systems as culture units. Commercial systems are capital and energy intensive and require skilled labor and management. In general, costs of production are higher in recirculating tanks than in other culture systems. Commercial systems require alarm systems and automatic dialers, emergency back-up generators and duplication of important mechanical components, such as pumps. Fish are typically crowded at high densities, and diseases can be problematic. There have been many financial failures of recirculating aquaculture businesses. While many of these failures were due to factors other than the culture system itself, it is important for the potential commercial producer to examine carefully and thoroughly all aspects of the proposed operation. Information on various aspects of recirculating systems is available in SRAC Fact Sheets 451 to 456.

Cages – Cage culture is an option where existing ponds have irregular bottoms and stumps or trees that prevent harvesting fish with a seine, as is done in commercial ponds [Figure 13]. In general, costs of production (per pound) are higher for raising fish in cages than in open ponds. However, cages provide an excellent way to raise small quantities of fish and to keep them readily accessible for harvest – in fact, perhaps too accessible in some cases. Poaching is a major problem in cage culture. SRAC Fact Sheets 160 to 170 provide detailed information on various aspects of cage culture, including suitable species, cage design and construction, siting, management and problems.

Figure 13. Cages are a great way to raise fish for home consumption.



Raceways – Raceways consist of concrete, plastic or earthen channels with constantly flowing water and are typically used to culture coldwater species such as trout. Most existing operations are federal or state hatcheries which produce fish for stocking public waters. Outdoor raceways require a constant flow of good quality water. Suitable water sources are few and are often located in pristine and ecologically sensitive ecoregions. Nutrients added to these waters through fish wastes and excess feed may be considered especially damaging. SRAC Fact Sheets 220 to 224 provide information on trout culture in raceways.

Summary

Investigate carefully the production, economics and marketing potential of a species and culture system before investing. Information on production methods and markets for many aquaculture species is limited. Existing producers have spent much time and effort developing markets and perfecting culture techniques. While many opportunities are available, aquaculture ventures can also be very risky.

<h2 style="text-align: center;">Links</h2>	<p>Economic information on catfish production and processing is also available through the Economic Research Service Aquaculture Outlook. http://usda.mannlib.cornell.edu/reports/erssor/livestock/ldp-aqs/</p>
<p>Fish disease diagnosis and pond water quality analysis services are provided by the Aquaculture/Fisheries Center of the University of Arkansas at Pine Bluff. http://www.uaex.edu/aqfi/extension/fishhealth/</p>	<p>The Arkansas Small Business Development Center provides a wealth of information to individuals thinking of starting their own business. http://asbdc.ualr.edu</p>
<p>Farm pond management information is available online through the Aquaculture/Fisheries Center site at: http://www.uaex.edu/aqfi/extension/farmponds/</p>	<p>The Arkansas Farm Bureau Federation provides representation for fish farmers on issues affecting their livelihood. http://www.arfb.com/</p>
<p>Over 150 online fact sheets on aquaculture crops and topics appropriate for the south are available through the Southern Regional Aquaculture Center. These fact sheets were developed at land-grant universities to provide a source of research-based information. http://srac.tamu.edu/</p>	<p>Statewide producer organizations include the Catfish Farmers of Arkansas and the Arkansas Bait and Ornamental Fish Growers Association. www.cfarkansas.com</p>
<p>Aquatic vegetation can be a problem in ponds. The Texas Cooperative Extension Service web site <i>Aquaplant</i> provides online information on aquatic plant identification and control. http://aquaplant.tamu.edu/ The University of Florida Center for Aquatic and Invasive Plants maintains a premier aquatic plant web site at: http://aquat1.ifas.ufl.edu/welcome.html</p>	<p>There are a several national associations that represent aquaculture producers: The National Aquaculture Association. http://www.nationalaquaculture.org/ Catfish Farmers of America. http://www.catfishfarmersamerica.org/ United States Trout Farmers Association. http://www.ustfa.org/</p>
<p>The State Aquaculture Coordinator (vice president agri/aqua) and assistant Aquaculture coordinator, Arkansas Development Finance Authority, provide overall coordination of assistance to Arkansas aquaculture producers and information on financial programs. http://www.state.ar.us/adfa/</p>	<p>The Catfish Institute provides catfish recipes, nutritional information and other news about catfish production and processing. http://www.catfishinstitute.com/</p>
<p>To obtain a Fish Farming Permit and information on permissible aquaculture species in Arkansas, contact the Arkansas Game and Fish Commission. http://www.agfc.com/</p>	<p>Are birds a problem on your fish farm? USDA APHIS Wildlife Services provides assistance to producers with bird depredation problems. http://www.aphis.usda.gov/ws/statereports/arkansas.html</p>
<p>The Natural Resources Conservation Service provides information on soils, watersheds and wetlands, as well as pond construction information and specifications. http://www.nrcs.usda.gov/</p>	<p>For assistance with fish kills suspected to be caused by pesticides, fish processor bond information, approved special needs aquatic pesticides and fish feed analysis, contact the Arkansas State Plant Board. http://www.plantboard.org/</p>
<p>Considering culturing fish in cages, a recirculating system or a raceway? Large facilities may need to obtain a National Pollutant Discharge Elimination System (NPDES) permit. For more information, see the U.S. Environmental Protection Agency web site on aquatic animal production industry effluent guidelines at http://epa.gov/guide/aquaculture/index.html, and contact the Arkansas Department of Environmental Quality at http://www.adeq.state.ar.us/</p>	<p>The USDA Southern Regional Aquaculture Center (SRAC) is one of five regional aquaculture centers established by Congress. SRAC coordinates regional research and Extension programs. For information on projects within the southern region, visit the SRAC web page. http://www.msstate.edu/dept/srac/</p>
<p>For aquaculture information on a national and international level, the Aquaculture Network Information Center (AquaNic) provides a gateway to the world's aquaculture resources. http://www.aquanic.org/</p>	<p>The USDA Agricultural Research Service Aquaculture Systems Research Unit conducts research on catfish production methods and is co-located with the Aquaculture/Fisheries Center of Excellence. http://ars.usda.gov/spa/asru</p>
<p>The Arkansas Agricultural Statistics Service provides information on aquacultural crops in Arkansas. http://www.nass.usda.gov/ar/</p>	<p>The USDA Agricultural Research Service Harry K. Dupree Stuttgart National Aquaculture Research Center conducts research to address the highest priority needs of the U.S. aquaculture industry. http://ars.usda.gov/spa/snarc</p>

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