North Central Regional
Aquaculture Center

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Pond Culture of Channel Catfish in the North Central Region

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Background

The channel catfish, *Ictalurus punctatus*, is the principal warm water species grown in the southeastern United States. In 1991 there were 390 million lb. of channel catfish (live weight) produced in this country, with the majority produced in Mississippi. The price of channel catfish decreased in 1991 compared to 1990 when the production was 30 million lb. less. In December 1991 the price of channel catfish delivered to processing plants was $0.53/lb. compared to $0.72/lb. in December 1990 (live weight). In wholesale terms, dressed whole fish were $1.23/lb. in 1991 and $1.61/lb. in 1990 for the same time period. At the 1991 prices many of the aquaculturists were either losing money or just breaking even. However, both prices and production increased by December 1992. For fish delivered to processing plants, the price increased to $0.63/lb. with 457 million lb. processed (live weight).

Channel catfish is one of 37 different species in the catfish family Ictaluridae. Closely related species are blue catfish, *Ictalurus furcatus;* black bullhead, *I. melas*; brown bullhead, *I. nebulosus*; and yellow bullhead, *I. natalis*. This publication will concentrate on the culture of the channel catfish in this region.

Physical Characteristics

As characteristic of the catfish family (Ictaluridae), the channel catfish has a scaleless, cylindrical body, sharp spines and mouth barbels (thread-like growths). It is the only spotted North American catfish with a deeply forked tail. Young channel catfish have irregularly shaped spots on their sides, which are lost as the catfish ages.

Since the channel catfish is a warm water species, optimal growth occurs when water temperatures approach 80°-85°F. Growth is limited when water temperature is less than 45°F or greater than 95°F. The warm water temperature preferred by the channel catfish is the primary reason why their culture in the North Central Region is limited.

This difference in the regions' growing season is exemplified by the corresponding different air temperatures. In southern Arkansas, there are 185-205 days where air temperature is 65°F or higher while there are only 120-140 of these days in the North Central Region. It is estimated that about 3-6 months of additional time (in consideration of seasonal differences) is required to produce a market-sized fish in the North Central Region than in southern states such as Mississippi. Also, within the North Central Region, channel catfish growth rates would differ in Missouri versus Wisconsin.

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Channel catfish are known for their ability to withstand lower water quality conditions, but limits do exist. These fish require dissolved oxygen of at least 4 parts per million (ppm) or mg/l for routine maintenance, become stressed at 3 ppm and will die at 1-2 ppm. Chronic low levels of ammonia will adversely affect their health and growth. Additional water chemistry restraints are noted in Table 1.

Culture Practices

Source of Brood Stock

It may be possible to obtain brood stock from established producers in your area or other regions in the country. Channel catfish that have been domesticated through several generations are preferable to wild stocks. Domesticated brood

Table 1. Suggested safe limits of water quality variables for channel catfish culture. (Source: *Commercial Production of Farm-raised Catfish*, Louisiana State University Agriculture Center)

Variable	Recommended Range or Value
Total Alkalinity	20-400 ppm
Total Hardness	20-400 ppm
Ponds	20-400 ppm
Hatcheries	above 10-20 ppm
pH	6-9
Un-ionized Ammonia	less than 0.05 ppm
Nitrite	
Minimum Chloride:Nitrite Ratio	minimum 5:1
Hydrogen Sulfide	0
Carbon Dioxide	
Depends on Oxygen Level	less than 20 ppm
Dissolved Oxygen	4 ppm or above

stock will readily spawn, accept artificial diets, and exhibit increased growth rates.

Brood Stock Conditioning

General layout of channel catfish culture is shown in Figure 1. Obtain brood stock either in the fall prior to or at least two months before the onset of the spring spawning season. Brood stock should have robust bodies, be free of wounds and diseases, and not be larger than 6-8 lb. While it is true that the larger the fish, the greater the quantity of gametes (eggs and sperm), it is also true that older, larger fish have gametes of varying quality. The size of the spawn (number of eggs) varies with the health and condition of the female. Females weighing 3-4 lb. will produce approximately 4,000 eggs/lb.of body weight. Females weighing more than 4 lb. will produce approximately 3,000 eggs/lb. of body weight. You should strive to have good quality fish that will reproduce on time during the spawning season.

During the winter months, prior to the spawning season, brood stock should be fed on sunny days when air temperature is above 32°F. Since food consumption is limited by temperature, you should feed between ½ and 1 percent of the pond's total fish weight (biomass), 2-3 times a week as conditions allow. The purpose of this winter feeding regime is to maintain a fish's weight, **not** increase it. Some aquaculturists will try to 'condition' their brood stock during the winter months using food ingredients such as fresh liver or live bait fish. However, this conditioning process is of questionable value.

Spawning Season

At least 6-8 weeks prior to the onset of the spawning season, brood stock should be collected from their wintering ponds and brought to a common facility. At that time the fish should be sexed and grouped for pairings. The ratio of male to females may be 1:1, 1:2 or 1:3 without significant impact upon the success of the fingerling production.

The sex of a channel catfish is generally determined first by observation of the secondary sexual characteristics such as the broad, dark muscular head of the males and the pot belly of the female (Figure 2). Additional sex determination can be done by turning the fish onto its back and inserting a straw into the urogenital opening. A male will often have a papilla at the posterior of the opening while the female region will be slit-like (Figure 3).

The brood stock are then either placed into ponds for free spawning or into pens for controlled spawning. Twenty pairs of fish per surface acre are used for the pond spawning method; do not exceed 1200 lb./surface acre of brood stock. Pen spawning is used in situations where specific pairing of brood fish are used for spawning. Pens should be about 10 feet long and 5 feet wide; construction may be either fencing and wood or cement blocks, with a water depth of 2-3 feet. Since the principal method employed by most aquaculturists is the pond method, further discussion will be based on this method.

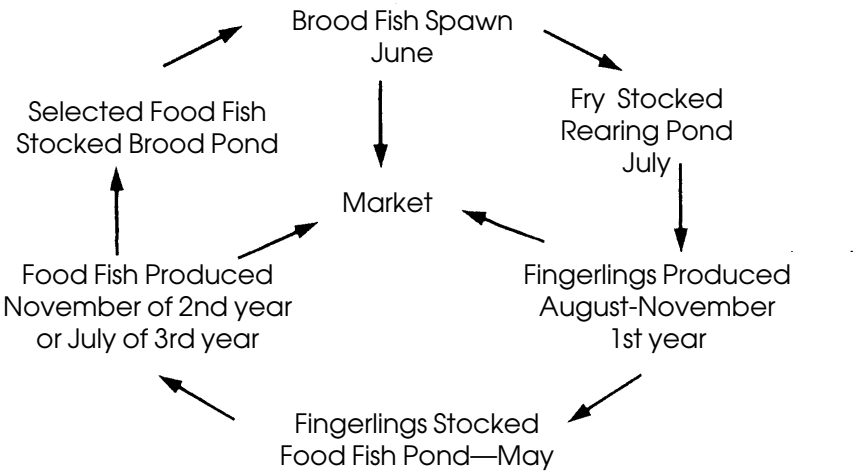

Figure 1. Example of catfish production cycle and market products

Channel catfish spawn in cavities. Either prior to or after the brood stock are stocked into the pond, 2-3 spawning cans for each four pairs of fish should be placed into the pond. These cans may be of variable construction (steel, aluminum, or plastic) but should all have only one opening and be about 10 gallons in capacity. Cans with small holes in the bottom are easier to lift since the water will drain out. The cans should be placed into 2-4 feet deep water with the openings facing the middle of the pond. Floats attached to cans aid in locating cans.

Spawning will begin when water temperature is 75°-85°F; in this region this will be early to middle June. Females will spawn once per year. As the water temperature approaches the optimal spawning temperature, males will move into the cans to clean them and attract the females to their specific can. Cans should be inspected every 2-3 days for egg masses. You should be aware that male catfish will try to protect the nest; thus, be sure that the can is free of brood stock before placing your hand into it.

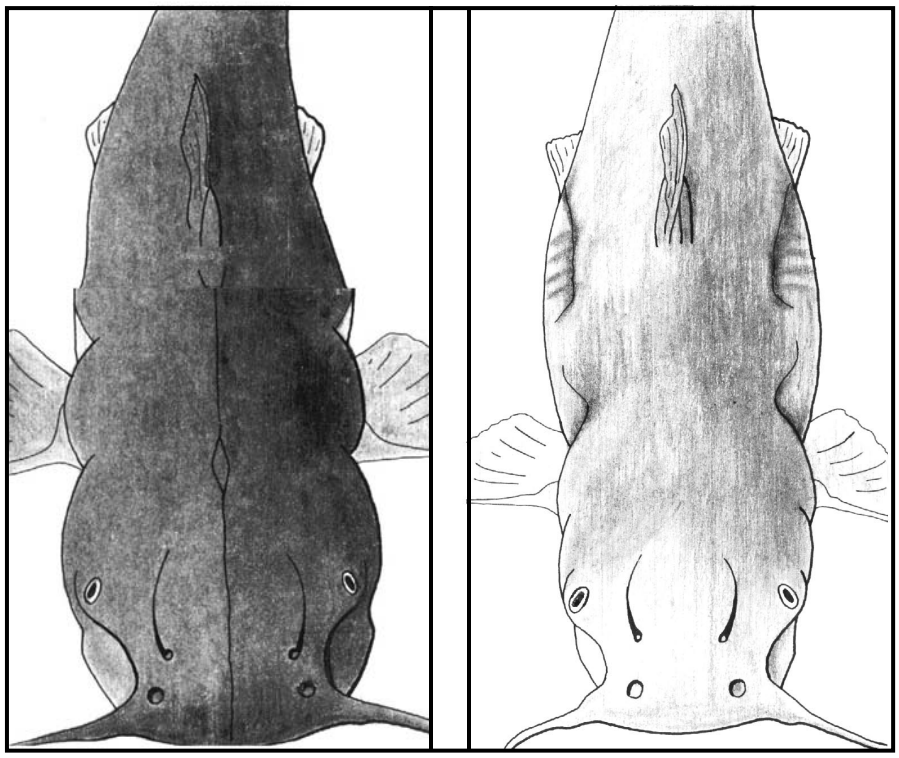

Figure 2. Secondary sexual characteristics of male and female channel catfish brood stock.

At the first appearance of eggs (a solid gelatinous mass) the aquaculturist must then decide to either leave the eggs for parental hatching or remove them for hatching in a hatchery. Parental (male) hatching of the eggs is initially cheaper but the number of fry (fish less than 1-inch long) successfully hatched is not immediately known. Also, the brood stock will later have to be separated from these fry. The hatchery method offers the advantages of numeration of fry and separation of larvae and brood stock, but at an added cost in terms of time, money, and management skills.

Survival of eggs to hatching is approximately 75 percent. The most common hatchery method is to place the eggs in hatching troughs with good water agitation and adequate quality. The preferred water temperature for hatching channel catfish is 75°-85°F. Channel catfish eggs will hatch in 5-7 days depending on water temperature. Closer to the hatching period, the egg masses will take on a deep red color. Newly hatched fry are often called sac-fry because during the first 4-5 days after hatching they have a yolk sac that is used for nutrition.

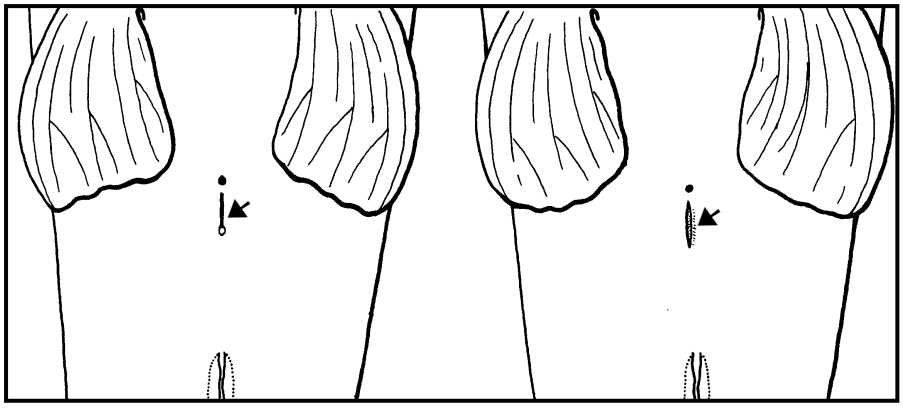

Figure 3. Urogenital openings of male and female channel catfish brood stock.

The fry are then placed into rearing troughs. You should begin feeding fry when they first swim up to the surface with their mouths open and their heads moving back and forth, looking for food. 'Swim-up' usually occurs about 4-5 days after hatching. Channel catfish fry will become dark black the closer the animals get to the swim-up stage. A high-protein feed (45-50 percent crude protein) should be used at this time; typically, trout or salmon diets have been used with

Table 2. Length-weight relationship for channel catfish fingerlings and food fish. (Source: *Commercial Production of Farm-raised Catfish,* Louisiana State University)

Length (inches)	Average Wt. Per Thousand (Pounds)	No. of Fish Per Pound	Avg. Wt. Per Finger. (Pounds)
1	1.3	767.7	0.0013
2	3.5	285.7	0.0035
3	10.0	100.0	0.0100
4	20.0	50.0	0.0200
5	32.0	31.1	0.0321
6	60.0	17.0	0.0588
7	93.0	10.8	0.0926
8	112.0	9.0	0.1111
9	180.0	5.5	0.1818
10	328.0	3.1	0.3280
11	395.0	2.5	0.3950
12	509.0	1.9	0.5090
13	656.0	1.5	0.6560
14	850.0	1.1	0.8500
15	1090.0	0.92	1.0900
16	1290.0	0.82	1.2900
17	1432.0	0.69	1.4320
18	1750.0	0.57	1.7500

some success, size 00 or 0. You should feed fry at least six times a day. However, be sure not to cause poor water quality conditions, e.g., low-dissolved oxygen levels or fungal growth, by over feeding. Spoiled feed must be siphoned off on a daily basis.

Hatchery operations are too detailed to describe further in this publication. Manuals concerning hatchery operations are available from several sources.

Fingerling Production

Channel catfish fry are often placed into culture ponds that have been fertilized and filled 2-3 weeks prior to being stocked. Ponds may be stocked with a variety of organic fertilizers such as alfalfa meal and hay. It is not possible to state specific fertilization regimes since all ponds and locations differ. The 2-3 week time period before stocking the ponds is needed to establish an adequate forage base of zooplankton (small animals) for the young channel catfish.

The fry stocking density will determine the size of fingerlings (fish larger than 1-inch long) obtained in the autumn. For instance, in southern climates the aquaculturist will obtain 8-inch fish in 120 days by stocking fry at 10,000 fish/acre, while only 2-inch fish will be obtained if 138,000 fry/acre are stocked. Considering the cooler climate in this region, you should stock fry at lower stocking rates, such as 10,000-20,000 fry/acre to allow for the greatest amount of growth possible. In the North Central Region, it may be possible to obtain 7-inch fingerlings in autumn by stocking fry at 25,000 per surface acre.

Within days after being stocked, initial daily feeding of fry should begin. The initial feeding rates are 10-12 lb. of size 0 or 1 feed per surface acre of water. The fish should be seined after the initial 1-2 weeks to determine survival and average size. As the fish grow, the aquaculturist needs to feed 4-5 percent body weight daily and adjust the pellet size accordingly; biweekly sampling with a 30-foot seine allows you to obtain the average size of fish present. If you know that the average size of the fingerling is 3 inches, then by using Table 2, you know that 30,000 fingerlings will weigh about 300 lb. Three hundred lb. of fish would require approximately 12 lb. of food daily (four percent body weight fed). Fish larger than three inches should be able to consume 3/16-inch pellets containing 32-36 percent protein.

Channel catfish are noted for their high-feed conversion with fry and fingerlings converting 0.9 to 1.0 lb. of feed for each pound of flesh gained. The ratio during the second year of growth approaches 1.5 to 2.0 lb. of feed per pound gained.

Fingerling Harvest

Seines are used to harvest fingerlings in the months following the initial stocking. Common mesh sizes for harvesting fingerlings are 1/4- to 1/2-inch square meshes. Seine length varies, but generally it should be 1 1/2 times as long and

Table 3. Recommended loading densities for hauling channel catfish. Densities are for water temperature at 65 °F and under ideal aeration; reduce numbers by 25 percent for each 10 °F rise in water temperature. (Source: *Catfish Farming in Florida,* University of Florida.)

Number of Fish per pound	Load Density (pounds fish/gallon water)		
	Transport Time (Hours)		
	8 hrs	12 hrs	16 hrs
1	6.3	5.6	4.8
2	5.9	4.8	3.5
4	5.0	4.1	3.0
50	3.5	2.5	2.1
125	3.0	2.2	1.8
250	2.2	1.8	1.5
500	1.8	1.7	1.3
1,000	1.3	1.0	0.7
10,000	0.2	0.2	0.2

deep as the width and depth of the pond. Seines should also have a float line and a mud line.

Prior to the harvest, fish should not be fed for at least 24 hours in order to decrease stress and fouling of tanks. Hauling tank capacities are listed in table 3. These capacities are affected by water chemistry, water temperature, amount of agitation (air input), and the size and condition of the fish.

Harvest also should take place on cool mornings to decrease stress from extreme temperatures. Once the fish are taken to the holding vats, they are graded into different size classes and sold to other producers or landowners, or used on site for stocking of food fish ponds. Sorting of these fish are most often done with floating graders of varying dimensions. Table 4 lists these dimensions and the subsequent fish size.

Food Fish Production

A second year of production (if not more) is needed to produce food fish in this region. To compensate for the shorter length of the growing season in this region, you should start in the spring with advanced fingerlings of 8 inches or greater. Because of their limited availability, these fish may be expensive to obtain. Fingerlings are often sold as number of fish per pound or average weight per thousand fish (Table 2).

Table 4. Grader sizes for Channel Catfish Fingerlings. (Source: *Catfish Farming in Florida*, University of Florida.)

Distance between Grader Bars (inches)	Average Size of Fingerlings Retained (inches)
27/64	3
32/64	4
40/64	5
48/64	7
1	10

Food fish operations are classified as either extensive or intensive on the basis of pond yield and the level of management required. Extensive culture usually produces less than 1,500 lb. per surface acre while intensive culture produces between 1,500 and 5,000 lb. per surface acre. Extensive culture is generally used where hobby farming or supplemental farming is being used. Intensive culture is aimed at producing primary income.

Since fish are harvested when they reach 1 to 1.5 lb., the stocking rates are directly related to the level of culture being used and the management ability of the aquaculturist. Fish are fed daily a high-quality, complete 32-36 percent protein catfish feed. Fish larger than 3 inches can be fed a 3/16-inch pellet; fish are usually fed out on a 1/4-, 5/16-, or 3/4-inch pellet once they reach 1/2 pound weight. Fish are fed 3 percent of their body weight as water temperature allows (>70°F). Fish should be sampled every two weeks to obtain average weight. In situations where cloudy weather has existed for 2-3 days, it is best not to feed (dissolved oxygen becomes limiting due to plant and animal respiration). When water temperature exceeds 95°F, it is best to not feed every 3 days as fish at these temperatures are often stressed to the point that feed is not being well utilized. Feeding less than 35 pounds of feed per surface acre of pond per day will minimize low oxygen problems caused by high fish stocking rates and associated feeding rates. During the summer, feed should not be stored longer than 30-45 days. Fresh feed assures both quality and paletability.

Table 5. Net Mesh Sizes for Grading and Harvesting. (Source: *Commercial Production of Farm-raised Catfish*. Louisiana State University Agricultural Center)

Square Mesh (inches)	Holds Fish Larger (or equal to)
2	2 lb.
1 3/4	1 1/2 lb.
1 5/8	1 lb.
1 3/8	3/4 lb.
1	1/2 lb. (8-10 in.)
3/4	0.1 lb. (7-8 in.)
1/2	4-5 in.
3/8	3-4 in.
1/4	1-2 in.

Food Fish Harvest and Processing

Once channel catfish have reached harvest size (1 to 1½ lb.), large seines are used to harvest the fish. As with fingerlings, seine length is similarly determined by pond dimensions; however, mesh size can be used to determine size of fish being harvested (Table 5). Fish are transported to the processing points using live-haul trucks with clean, fresh water. Capacities of these tanks should be noted using table 3. As with the fingerlings, fish should be harvested on cool days and not be fed at least 24 hours prior to harvesting to reduce their stress and decrease hauling tank fouling.

Catfish may be either skinned or filleted. Fish that have been skinned, head and entrails removed will usually dress out at 55 to 60 percent. If the fish are filleted, the dress-out weight will be 40 to 45 percent. The fish flesh is then rinsed off and packaged for sale as fresh or frozen fish.

Other Considerations

Disease is a common problem in aquaculture; the wide variety of diseases prevents a detailed discussion here. The best advice to help prevent disease out-breaks is to minimize stress associated with poor handling or water quality conditions. When buying fish from another producer, an aquaculturist should look for robust fish relatively free of wounds.

Marketing is another topic that should be considered by the aquaculturist **prior** to raising fish. Potential markets should be assessed and high-quality standards maintained in order to compete against larger, more established businesses. Creative marketing such as fee fishing and niche marketing should be investigated.

Suggested Readings

Ammerman, G. R. 1989. *Processing channel catfish.* Southern Regional Aquaculture Center Publication 183. 4 pp.

Boyd, C. E. 1990. *Water Quality in Ponds for Aquaculture.* Alabama Agricultural Experiment Station, Auburn University, Alabama. 482 pp.

Gilbert, R. J. 1989. *Small-Scale Marketing of Aquaculture Products.* Southern Regional Aquaculture Center Publication 350. 4 pp.

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. Pages 44-82 in *Third Report to the Fish Farmers: The Status of Warmwater Fish Farming and Progress in Fish Farming Research.* 1984. H. K. Dupree and J. V. Huner (editors). U.S. Fish and Wildlife Service, Washington, D.C.

Lee, J. S. 1991. *Commercial Catfish Farming.* Interstate Publishers, Danville, IL.

Jensen, G. L. 1988. *Commercial Production of Farm-raised Catfish.* Louisiana State University Agriculture Center Publication. Baton Rouge, LA. 67 pp.

McGilbery, J. H., V. Culver, G. Brooks, K. Hood, S. Dean and D. LaBruyere. 1989. *Processed catfish: product forms, packaging, yields and product mix.* Southern Regional Aquaculture Center Publication 184. 4 pp.

McGilbery, J. H., V. Culver, G. Brooks, K. Hood, S. Dean and D. LaBruyere. 1989. *Processed catfish.* Southern Regional Aquaculture Center Publication 185. 4 pp.

Morris, J.E. *Managing Iowa Fisheries: Water Quality.* Iowa State University Extension Service Publication Pm-1352a. 8 pp.

Masser, M., J. Jensen and J. Crews. 1991. *Channel Catfish Production in Ponds.* Alabama Cooperative Extension Publication Circular ANR-195, Auburn University, Alabama. 22 pp.

Wellborn, T. A. 1988. *Channel catfish: life history and biology.* Southern Regional Aquaculture Center Publication 180. 4 pp.

Wellborn, T. A. 1989. *Feeding intensively cultured catfish in levee-type ponds.* Southern Regional Aquaculture Center Publication 181. 4 pp.

Magazines

Aquaculture Magazine
P.O. Box 239
Asheville, NC 28802

The Aquaculture News
P.O. Box 416
Jonesville, LA 71343

Water Farming Journal
3400 Neyrey Drive
Metairie, LA 70002

The Catfish Journal
P.O. Box 55648
Jackson, MS 39296

Contact your state extension specialist(s) for the above information sources and other pertinent information regarding channel catfish culture.

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