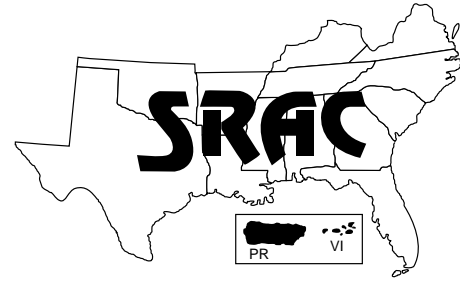


Southern Regional Aquaculture Center



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Channel Catfish Broodfish Management

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Broodfish management is an important aspect of channel catfish culture because having a reliable source of fingerlings is essential to making a profit. Successful management of broodfish includes selecting for the genetic qualities desired by the culturist and processor and then producing high quality fry. The type of breeding program chosen by the fingerling producer determines the population(s) from which the broodstocks are obtained. Broodfish must be selected and then managed for maximum reproductive output. The potential of fish with desirable genetic background is inconsequential if spawning success is poor.

Selection

Broodfish should be selected for the visible characteristics and genetic traits that are desirable to the producer. Visually inspecting the fish is important whether you are obtaining fish from within an operation or purchasing from other producers. If broodfish are selected from within an operation, remember that male channel cat-

fish grow faster than females so that keeping only the largest fish may result in a disproportionate number of males. Also, avoid using large fish that are in foodfish ponds when drained. These fish are not necessarily fast growers, but may just be adept at avoiding the seine.

Broodfish purchased from other producers should be obtained during the late summer to early winter of the year before the spawning season when they will be used. This allows time for stocking at desirable densities and for recovery from the stress of seining, handling and transporting. Proper feed, feeding schedules and water quality will ensure maximum gonadal development before the spawning season. Though it is difficult to inspect individual broodfish on large farms, every effort should be made to select only healthy broodfish of the proper size with well-developed secondary sexual characteristics. Check the fish for suitable body conformation and freedom from sores or hemorrhages on the skin. Although channel catfish can mature sexually at 2 years of age, fish should be at least 3 years old and weigh at

least 3 pounds for reliable spawning. Channel catfish 4 to 6 years old and weighing 4 to 8 pounds are prime spawners. Older and larger fish produce fewer eggs per pound of body weight, are more difficult to handle, and may have difficulty entering certain spawning containers. Cull fish that weigh more than 10 pounds and replace them with younger, smaller fish.

Some traits particularly useful to channel catfish producers are not visible. These include disease resistance, fast growth, good feed conversion and high dress-out weight. These traits can be obtained only by selectively breeding for them. Breeding programs for channel catfish are not advanced, but some selective breeding has been done by individuals and research institutions. Several strains of channel catfish are available throughout the United States. A strain is usually named for the water body the fish were obtained from or the farm they inhabit. For example, the Rio Grande strain originated from the Rio Grande River in Texas. Strains differ in their growth rate; resistance to viral, bacterial and parasitic infections; dress-out percent-

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age; ability to escape seining; and time of spawning. In 1984, Auburn University published a circular entitled *Ancestry and Breeding of Catfish in the United States*. This circular lists more than 300 strains of channel, blue, white and flathead catfish, as well as bullheads. Many of the strains listed were not selected by the breeders for specific traits, but rather were subjected to random mating. A few strains have been selected for desirable traits. These include, but are not limited to, Harvest Select (formally Gold Kist), NWAC 103, Kansas and Rio Grande. This fact sheet does not recommend one strain over another, but describes the characteristics of some of the strains available. This list is far from comprehensive, but includes some strains for which research results have been published.

NWAC 103

The newest line of catfish to be introduced is the USDA 103 (renamed NWAC 103 after public release in 2001). This strain was originally obtained from the U.S. Fish and Wildlife Service. These fish were selected for growth rate. Studies have demonstrated that the NWAC strain grows faster than the other channel catfish strains to which it has been compared. This strain also consumes more feed than the other strains, which may explain the rapid growth. NWAC 103 catfish are susceptible to ESC infection, but whether they are less susceptible than other strains still needs to be explored.

Harvest Select

Since 1991, Harvest Select (formally Gold Kist) has been selecting catfish for improved feed conversion, processing yields, reproductive success and fingerling survival. This breeding program pairs males and females from different strains with individual

characteristics to achieve superior offspring. They are testing for strains that are resistant to ESC and *Columnaris* diseases.

Kansas

The Kansas strain is perhaps the oldest domestic strain of catfish. It was bred for increased growth and disease resistance. However, this strain of fish is not sexually mature until 4 years of age, 1 to 2 years later than other strains. Although this fish does grow rapidly, it is difficult to spawn.

Rio Grande

The Rio Grande strain demonstrates excellent dress-out percentages. These fish spawn later than other strains, but are sexually mature at 2 years of age. They also have poor growth and are susceptible to channel catfish virus, *Ichthyophthirius* and *Columnaris*.

Auburn

The Auburn strain of channel catfish demonstrates moderate growth rates, but female produce fast-growing progeny when cross-bred with other strains. Albinism is common in this strain. These fish are difficult to seine and have excellent dress-out percentages.

Norris

The Norris strain of channel catfish is known for its fast growth rate. Hybrids between the Norris and the blue catfish are fairly resistant to ESC, compared to other strains. Most of the USDA-103 comparison trials have been conducted with the Norris strain.

Breeding programs

Some more progressive catfish farmers have established breeding programs. They realize that breeding programs are necessary to improve production and increase profit margins. Production efficiency cannot be optimized unless the biological potential of the fish

is optimized. Some types of breeding programs are discussed below.

Inbreeding

Inbreeding is defined as the mating of related individuals. Very few studies have been done on inbreeding in channel catfish. However, these studies consistently demonstrated that inbreeding reduces growth, reproductive performance and survival, and increases the incidence of deformities.

Inbreeding does not always result in undesirable characteristics. Selection programs are mild forms of inbreeding. Inbreeding and its less desirable effects can be avoided by ensuring that broodfish replacements come from at least 50 random matings. Inbreeding may also be counteracted through crossbreeding.

Mass selection and family selection

Selection occurs on a farm every time the catfish reproduce. Domestication is a form of selection. It is widely known that domesticated strains of channel catfish grow faster than wild catfish—an average of 3 percent. Selection programs are successful only if the genetic component responsible for the improvement is passed from parent to offspring.

There are two types of selection programs—mass selection and family selection. Mass selection evaluates the performance of all individuals regardless of parentage. Family selection evaluates the performance of families, and whole families are selected or culled. With family selection, specific pairs of broodfish are mated and the progeny are reared separately.

Crossbreeding

Crossbreeding can be used to increase productivity. For a cross-

breeding program, two strains with good qualities are identified and the females from one strain are mated with the males from the other strain. The object is to obtain offspring with the desirable qualities of both parental strains. This method does not guarantee that the offspring will possess all of the qualities desired; some crosses will produce superior hybrids, while others will not. Crossbreeding can increase disease resistance, cause earlier spawning in crossbred adults, and increase spawning rates (more females spawning) and fecundity (more eggs per female). However, the positive aspects of crossbreeding decrease with age. To date, the USDA 103 strain has not been crossbred with other channel catfish strains.

Hybridization

Crossing two different species, for example the channel catfish with the blue catfish, is called hybridization. Approximately 30 hybrid crosses, using seven species of catfish, have been evaluated. Many of these hybrid crosses were difficult to produce, or the crosses resulted in high proportions of abnormal fry. One hybrid cross is promising—the channel catfish female and the blue catfish male. These hybrids grow faster than either parental line, are more disease resistant, more uniform in size, more tolerant of low dissolved oxygen and easier to capture by seining. The major obstacle to hybrid production is that sufficient numbers of fingerlings cannot be produced for commercial application. Researchers are studying ways to improve the number of fingerlings produced. One drawback to the hybrid is the small head size. Many farmers complain that the head of the hybrid is so small the fish get caught in the seine and must be freed manually. This could be remedied by using smaller mesh seines when harvesting hybrids.

Comparisons of Breeding Programs

The three breeding programs discussed differ in their effectiveness. Crossbreeding frequently improves performance. Hybridization has produced only one promising hybrid from 30 different crosses. The easiest and most effective breeding program is mass selection, which improved performance in all strains tested. The actual performance or value of the fish from a selection program is not known unless controlled experiments are conducted.

Guidelines for an On-Farm Breeding Program

Selection for certain traits such as growth, color, or age at reproductive maturity occurs whenever broodstock are chosen from a population. If the choice of stock is made according to a plan, progress can be made in improving the performance of future generations. If little thought is given to the choice of broodstock, the culturist may unintentionally select for undesirable traits. Farmers unwilling to develop even a simple breeding program should realize that imprudent selection of broodstock could decrease productivity and profits. A little extra effort and common sense can help prevent this. The minimum guidelines for a catfish breeding program are:

1. Choose broodstock from domesticated strains. Wild fish are unreliable spawners in captivity and the fingerlings may be susceptible to disease or grow slowly under culture conditions.
2. Select broodfish from stocks that are known to perform well under commercial culture conditions. This will be difficult as few field trials have been done.
3. Do not mistake large fish for fast growing fish, as large fish may be the fish capable of escaping the seine. Try to select broodfish from fish of known

age, but be aware that large fish selected from a pond containing a single year class could result in the selection of mostly siblings.

4. Prevent inbreeding by obtaining broodfish from as many different spawns as possible. Initial stocks should be obtained from several different ponds or, ideally, from unrelated stocks in different locations.
5. If replacement broodstock comes from fingerlings produced on the farm, they should come from at least 50 random matings. If this is not possible because the breeding population is too small (less than 75 to 100 breeding pairs), enrich bloodlines by adding unrelated stock as part of the broodfish replacement program.
6. Keep accurate records of spawning output, egg hatchability, fry survival, and growth rates of fingerlings and food-sized fish. If performance decreases over time it may be because of inbreeding or other problems associated with imprudent selection.

Gender determination

Sex of broodfish should be determined so that females and males can be stocked into brood ponds at the desired ratios. The sex of sexually mature channel catfish in good condition is relatively easy to determine. The urogenital area is located ventrally, posterior to the anus and anterior to the anal fin (Fig. 1). The male releases sperm through an opening called the urogenital pore, a small, fleshy nipple on the genital papilla posterior to the anus. The female has two separate openings—an anterior genital pore for expulsion of eggs and a posterior urinary pore for release of urinary products. The two openings are located in a groove with surrounding tissue forming a distinguishable slit just below the anus.



Figure 1. The genital papilla region of the female (left) and the male (right) channel catfish. The female's region is slit shaped compared to the fleshy nipple appearance of the male.

Mature fish have secondary sexual characteristics that are also useful for selection. These characteristics are most evident near spawning time. The male has a broad, muscular head wider than the body, thickened lips, and often a grayish mottling on the underside of the jaw and abdomen (Fig. 2). The female's head is narrower than the body and she usually lacks the muscularization and pigmentation common in males. During the spawning season, a sexually mature female will have a well-rounded abdomen that

extends past the pelvic fin region into the genital area. If the abdomen is hard to the touch, it is probably filled with feed, whereas a soft, palpable abdomen indicates that the ovaries are well developed. Broodfish usually eat much less during the spawning season. Therefore, it is not difficult to tell if a female has well developed ovaries or a belly full of food.

Care

A common management practice among many fingerling producers is to have separate ponds for

holding and spawning. Stocking densities in holding ponds are usually 2,000 to 3,000 lbs./acre. Spawning ponds need to be new ponds, newly renovated ponds, or former fingerling ponds that have been thoroughly dried out and exposed to air for several months after the sale of fingerlings in the winter and spring. Once the spawning ponds are refilled with water, broodfish from the holding pond are examined and introduced into the newly filled ponds. Several producers have noticed that when older ponds are used, spawning containers in those ponds may be left unattended by the males or spawns may consist of poor quality eggs. This phenomenon has been attributed to poor water quality and other unknown factors.

Stocking density in spawning ponds is usually 800 to 1,200 lbs./acre. Male-to-female sex ratio should be approximately 2:3. Broodfish are kept in the spawning pond until spawning ceases and then removed with a large-mesh seine and returned to holding ponds. Near the end of the spawning season, some producers add fry to spawning ponds containing broodfish to use the available space. Broodfish not captured during seining do not appear to cannibalize the stocked fry. Once the spawning season has ended, broodfish are routinely moved from spawning ponds into holding ponds.

Water quality management

Water quality in the broodfish ponds must be maintained to ensure the survival of the broodfish and the production of large numbers of good quality eggs. Excess nutrients from feed is the main reason for a decline in water quality. Poor quality water (which contains low dissolved oxygen levels and high levels of ammonia, nitrites and carbon dioxide) stresses the fish, making them more vulnerable to diseases and parasites.

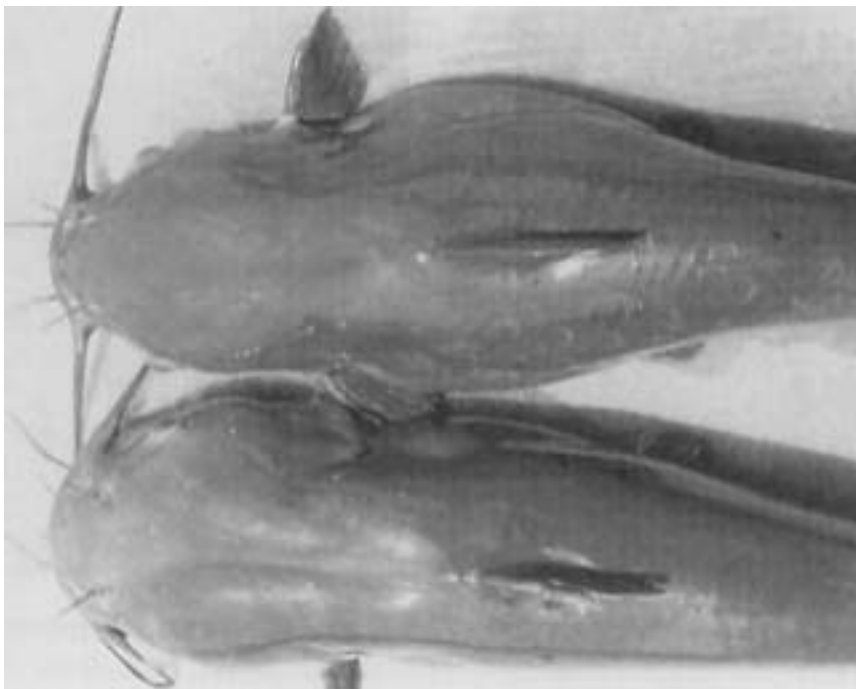


Figure 2. The male catfish (bottom) has a muscular head and the female (top) has a smaller, less muscular head.

Adding feed to the water also adds nitrogen and phosphate, nutrients that can increase phytoplankton production. The phytoplankton use oxygen at night, creating an even greater oxygen demand than a pond with fish alone.

Poor water quality should be corrected before the fish become diseased and die. Options include temporarily reducing feeding to limit the nutrients in the water, aerating to increase the amount of oxygen in the water, and flushing the pond with water from a well or reservoir.

Producers should have emergency aeration equipment available. Dissolved oxygen levels can decrease rapidly when large phytoplankton die-offs occur or when decaying feed and organic matter cause an excessive biological oxygen demand. Large, paddlewheel aerators are the most popular emergency aeration devices in channel catfish farming, although fountain aerators are also used. Flushing the pond with well water, which is often void of oxygen, requires that emergency aeration be used as well. Generally, the first sign of poor water quality is that the fish stop feeding or reduce the amount of feed they consume.

Nutrition

Reproductive performance in broodfish is much more important than growth rate. Nonetheless, fish must have adequate food throughout the year, particularly during the period of egg formation and development. Underfed catfish have low reproductive success and poor egg quality. When both sexes are held in the same pond, an insufficient food supply can result in poor quality female broodfish because the larger, more aggressive males consume most of the limited ration. Broodfish are usually fed the same feed used for food fish grow out. Some catfish producers use a sinking feed because broodfish are more hesitant to feed at the surface. However, because brood-

fish feed slowly, sinking pellets may disintegrate before they can be consumed. When the water temperature is above 70 °F, a nutritionally complete feed of at least 32 percent crude protein is fed at about 2 percent of body weight daily. At water temperatures of 55 to 70 °F, a ration consisting of about 1 percent of the body weight is fed on alternate days. At water temperatures below 55 °F, about 0.5 percent of the body weight is fed once a week.

Forage fish are often stocked into broodfish ponds as a simple way of ensuring that ample food is consistently available during the egg production period. Mature fathead minnows, the most commonly used forage fish, are stocked in the late winter or early spring at 5 to 10 pounds per acre (1,000 to 2,000 fish/acre). Some structure, such as wooden pallets, may be added to the ponds to enhance minnow reproduction.

Estimating the number of broodfish

Production goals determine the number of broodfish required to produce the desired number of fingerlings. If the fingerlings will be used on the farm the producer needs only enough to replace fish that will be harvested and sold in the following year. However, if the fingerlings will be sold to other producers, the annual production goal is based on the number of fingerlings needed to achieve a certain income. Produc-

tion, however, may be limited by the available pond space.

The number of pounds of female broodfish required to produce a specific number of fingerlings can be estimated based on assumptions of egg production, survival of eggs to fry in the hatchery, and survival of fry to fingerlings in the nursery.

Broodfish ponds ranging from 5 to 30 acres are commonly used in the southeastern U.S., with more manageable ponds ranging from 5 to 10 acres. While all the broodfish in the previous example could be stocked into one pond, that would be extremely risky. All of the broodfish and subsequent progeny could be lost if water quality deteriorates or a disease outbreak occurs. Stocking broodfish into several ponds is recommended.

Spawning in ponds

Seasonal changes in water temperature control the reproductive cycle in channel catfish. Exposure to water temperatures below 50 °F for a month or more over the winter stimulates egg production. The subsequent slow rise in the average water temperature to 68 to 77 °F initiates spawning in the spring. The vast majority of channel catfish are spawned using the open pond method: Broodfish are held in ponds with spawning containers (such as milk or cream cans, metal barrels, nail kegs, tile, ammunition cans, plastic buckets or plastic containers, Fig. 3) and allowed to select their mates and spawn naturally. Most spawning

To produce 1,000,000 (million) fingerlings:

If 70 percent of swim-up fry stocked in ponds survive to become fingerlings, then $1,000,000/0.70 = 1,429,000$ swim-up fry are needed.

To produce this number of swim-up fry, if survival in the hatchery from egg to swim-up fry is 80 percent, then $1,429,000/0.8 = 1,786,000$ eggs are required.

If 3,000 eggs are produced per pound of body weight, then $1,786,000/3,000 = 596$ pounds of female broodfish are needed.

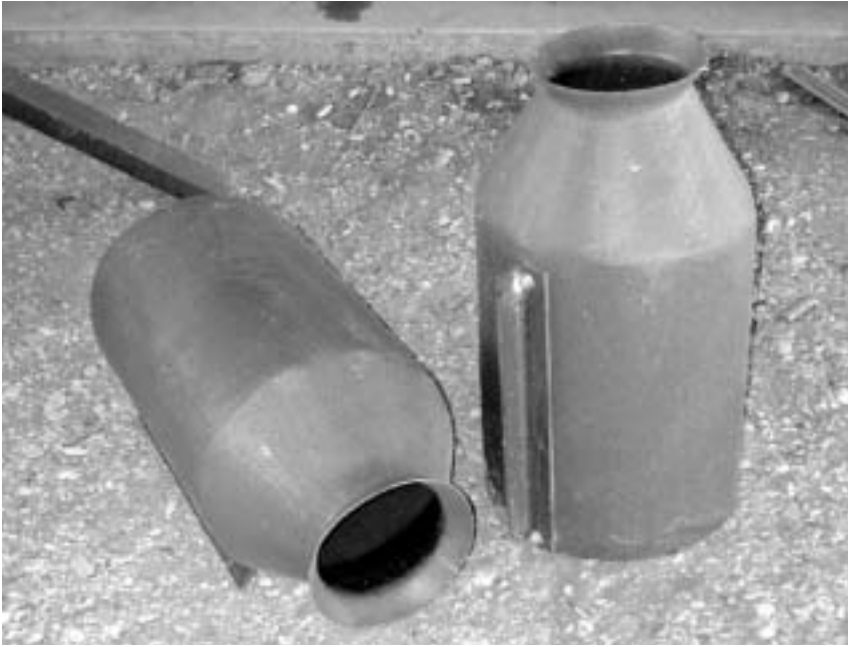


Figure 3. These plastic spawning cans, shaped like milk cans, are used in channel catfish culture.

containers have an internal volume of 20 gallons and an opening of 6 to 9 inches across. Spawning containers are not placed in the pond until the water temperature reaches 75 °F. The channel catfish spawning season in the U.S. can begin in early April and last until mid-July. The length of the season and the start of the season depend on water temperature. Once water temperature has reached 70 °F and remains at that temperature for at least 3 consecutive days, spawning begins. In the southern U.S. spawning season usually begins in late April; in the northern U.S. it does not begin until mid-May.

Spawning containers are placed in the ponds several days before the beginning of spawning season is anticipated. This gives the males time to clean and prepare them. Containers are placed along the pond bank in 2 to 3 feet of water at 10- to 30-foot intervals with the open end of the container toward the center of the pond. Containers are marked with a stake or float for convenient location when there is a need to check for egg masses.

Not all fish spawn at the same time so it is not necessary to have a spawning container for every pair of fish. The number of containers needed depends on whether the egg mass will remain in the pond and receive paternal care or will be removed to the hatchery. If egg masses are not immediately removed to the hatchery, more containers will be needed because each container will be occupied longer. Various ratios of containers to stocked broodfish pairs have been used, but 1:4 and 1:5 are common. Spawning may cease if water quality deteriorates or weather turns unseasonably warm. Spawning may resume if water temperature drops within 10 to 25 days of the onset of warm weather. Draining and replacing one-fourth to one-half of the pond water with cool, high quality well water may also cause spawning to resume.

Once spawning begins, containers should be inspected during the late morning of every third or fourth day to determine if eggs are present. If little or no spawning activity occurs, broodstock should be checked for parasites or dis-

ease. Feeding should always be continued. If the lack of spawning cannot be attributed to poor water quality or disease, then producers should consider moving the fish. Moving reluctant, healthy spawners into newly filled ponds or into existing brood ponds where spawning has been successful and is nearly complete can cause the transferred fish to resume spawning.

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