SRAC Publication No. 723

Southern Regional Aquaculture Center

June 2000

Species Profile
Bigmouth Buffalo

Conrad W. Kleinholz[1]

Bigmouth buffalo are a popular foodfish and support a large commercial fishery throughout the lower Mississippi River valley. Most "cultured" buffalo are caught by commercial fishermen and held in ponds until harvested and sold. Producing buffalo in catfish ponds may now be economically feasible, because market demand is increasing while commercial harvest is declining. Several live haulers transport buffalo from the Mississippi and Arkansas Rivers to markets in Chicago, New York, Seattle, Toronto and Montreal, and more of their customers are requesting cultured fish. The reported 1998 harvest of buffalo was 22 million pounds, and 94 percent of the harvest was by gill nets and trammel nets. Eighty-three percent of the 1998 harvest was sold to African-Americans. Six percent of the harvest was from seining or culture and was sold to Asians or central Europeans. The growing market for buffalo may indicate increased per capita consumption or the fact that in the last decade the Asian population in the U.S. has grown more than 125 percent and the African-American population 13 percent.

Buffalo are excellent polyculture candidates. By harvesting plankton and detritus, bigmouth buffalo can maximize feed efficiency in intensively managed culture ponds. Disadvantages include the difficulty of sorting them at harvest and the increased labor required in processing a scaled fish.

Life history and environmental requirements

The bigmouth buffalo, *Ictiobus cyprinellus*, has a maximum size of about 80 pounds (36 kg). It has a terminal, oblique mouth with thin lips. There are more than 60 gill rakers (average of 72) on the first gill arch, and a single row of weakly developed pharyngeal teeth. Bigmouth buffalo occur most frequently in slow-moving backwaters or oxbows in rivers, often in flooded or vegetated areas. Bigmouth buffalo are also common in large reservoirs throughout the Mississippi River drainage. Their range extends from Manitoba and Saskatchewan in Canada, and from Montana to Ohio, south to Alabama and west to Texas. The bigmouth mostly eats zooplankton, but also benthic insect larvae, crustaceans and detritus. Cladocerans and copepods are the preferred zooplankton forage, and small zooplankters are eaten more often than large prey such as adult calanoid copepods.

There are three species of buffalo, but only the bigmouth eats plankton. Producers should be able to identify and avoid smallmouth and black buffalo, which do not perform as well as bigmouth buffalo. All three species are common to the Mississippi River drainage system and occur in both rivers and reservoirs.

The smallmouth buffalo, *I. bubalus*, has a small, ventral mouth. Its predominant diet is benthic macroinvertebrates and some plant material. Smallmouth buffalo are most often found in deep, clear pools in river systems. The maximum recorded size is 15 pounds (13.5 kg).

[1]Langston University, Langston, Oklahoma.

The black buffalo, *I. niger*, also prefers riverine habitats and its diet is similar to that of the smallmouth buffalo. Black buffalo have a ventral, slightly oblique mouth with thick, fleshy lips. The black buffalo is found in steeper gradient streams than either smallmouth or bigmouth buffalo. Maximum weight of black buffalo is about 35 pounds (16 kg).

Spawning techniques

There are two types of reproduction—traditional pond spawning and hatchery production. Pond spawning is easy and requires no hatchery facilities, but the number of fry is unknown until fingerlings are sampled or sorted for restocking in growout ponds. Hatchery production requires more facilities, but fry production can be carefully controlled. When fish numbers are known rather than estimated, ponds can be managed so the resulting fingerlings are the desired size for growout during the next season. Broodfish can be maintained with other fish during most of the year, rather than kept in a separate brood pond. The broodfish will do very well in a polyculture pond at rates up to 200 per acre (500/ha), and will probably need no supplemental feeding. If buffalo broodfish are kept in a separate pond, plankton populations can be maintained at desired levels by occasional fertilization with inorganic fertilizers or low quality, rotting hay. Broodfish also can be fed slow-sink catfish pellets at 1 to 2 percent of their body weight.

Pond spawning

Bigmouth buffalo spawn at water temperatures of 65 to 75º F (18 to 24º C). Pond spawning is most successful if spawning/nursery ponds are prepared ahead of time. Annual rye, wheat or rice can be planted during the winter on the interior levees and bottoms of dry ponds. The plants will serve as spawning substrate and green fertilizer when the ponds are filled. Small ponds (0.1 to 1.0 acre; 0.04 to 0.4 ha) are easier to manage than production ponds. As the ponds are filled, add lime (if necessary) to obtain an alkalinity above 50 ppm, and fertilize with 10 to 15 pounds per acre (13 to 17 kg/ha) of 18-46-0 or similar inorganic fertilizer. If surface water is used to fill the pond, it should be filtered through 125-micrometer screening to eliminate predaceous zooplankton. Spawning ponds should contain water only a short time (usually 2 to 3 days) before spawning to reduce insect predators and maximize zooplankton production. See SRAC publication 700, “Zooplankton Succession and Larval Fish Culture in Freshwater Ponds,” for details. Stock broodfish in the spawning pond while it is filling. Stock 15 to 18 fish per acre (37 to 44/ha), with a ratio of two males per female. Broodfish should be at least 2 years old and weigh more than 3 pounds (1.4 kg). The sexes are readily distinguished because males develop breeding tubercles over most of the body surface and usually produce milt when the abdomen is gently squeezed. Females have no tubercles; they have thicker bodies than males and an enlarged, usually inflamed, vent during prespawning and reproductive periods. Egg production is approximately 100,000 per pound (250,000/kg) of body weight. Eggs are approximately 1/16 inch (1.5 mm) in diameter. Buffalo are group spawners; the adhesive, sinking eggs are scattered among flooded vegetation in water 1.5 to 4 feet (0.5 to 1.2 m) deep. Water depth at spawning should be 3 to 6 feet (0.9 to 1.8 m).

Adults can be induced to spawn by quickly increasing water level in a brood pond. If there is no vegetation in the pond, add spawning mats or scatter a coarse hay, such as Johnson grass, at the edge of the pond. Coarse hay does not decay as quickly as grass hay or wheat or rice straw, so it does not reduce the dissolved oxygen in the vicinity of developing embryos or newly hatched fry. Fertilize the brood pond with inorganic fertilizer as for spawning ponds. Move broodfish to another pond when schools of fry are observed along the shoreline. If broodfish are not removed, they will compete directly with fry and fingerlings for zooplankton forage.

Hatchery production

Select broodstock and move them to holding facilities in the hatchery. Sperm should flow freely from males when the abdomen is gently squeezed. Separate the sexes in the holding facilities to control spawning. Inject females with carp pituitary (4 to 8 mg/kg) or a mixture of pituitary and HCG (Human Chorionic Gonadotropin, 2.5 to 5.0 mg/kg + 60 to 750 IU/kg, respectively) to induce final maturation, as mentioned in SRAC publication 425, “Hormone Preparation, Dosage Calculation, and Injection Techniques.” One formulation of HCG is now approved for use with all finfish, but must be obtained by prescription from a veterinarian. The injections are given in two doses—an initial dose of 10 to 33 percent of the total, and a final injection within 6 to 8 hours. Buffalo will usually ripen within 24 to 36 hours of the initial injection. Dry strip the adults and fertilize the eggs in a plastic tub, then add water to the tub and allow eggs to harden for 2 hours. Maintain at least 4 mg/L dissolved oxygen in the water during hardening. After hardening, separate the eggs by simply rolling them gently between the fingers. Then incubate them in hatching jars. Other methods of separating the eggs begin 1 to 5 minutes after the eggs are fertilized. One method uses a saturated suspension of Fuller’s Earth, commonly sold as cat litter. Be sure to use a brand without additives or perfumes. Combine 2 to 4 parts by volume of the suspension per part of eggs. Aerate the mixture with an airstone, and replace the suspension every 10 minutes until the eggs are no longer sticky (probably at least 20 minutes). Then flush the suspension and hatch the eggs in hatching jars. The Fuller’s Earth method is most effective when the total alkalinity is less than 250 ppm. Other methods use salt and urea, followed by tannic acid, or tannic acid alone. For details, refer to SRAC publication 426, "Techniques for Taking and Fertilizing the Spawn of Fish." Eggs hatch within 5 days at 65º F (18.5º C), and within 3 days at 75º F (24º C). Transfer fry to fertilized nursery ponds as soon as they become free-swimming.

Hatching and fry rearing

Fry begin feeding on small zooplankton 3 to 5 days after hatching. A good bloom of rotifers, copepod nauplii, and early instars of cladocerans is necessary for first feeding and growth of fry. Consult SRAC publication 700, "Zooplankton Succession and Larval Fish Culture in Freshwater Ponds," for details on zooplankton succession, and SRAC publication 469, "Fertilization for Fish Fry Ponds," for pond fertilization details and schedules. A zooplankton bloom with appropriate sizes of zooplankton (0.05 to 0.1 mm) should be present for the fry's first feeding. If fry were produced in a hatchery, the nursery pond should be filled and fertilized about 5 days before stocking fry. Schools of fry should be observed swimming along the shoreline within 7 to 10 days after hatching. Fry 0.25 to 0.5 inch (6.5 to13 mm) long are particularly prone to starvation if ponds are improperly fertilized. Check zooplankton density daily and fertilize as necessary. Adding small amounts of fertilizer frequently is more beneficial than adding large amounts infrequently. Zooplankton blooms can be maintained by fertilizing with granular18-46-0, liquid 11-37-0, or similar inorganic fertilizers. Organic fertilizers such as composted manure, alfalfa or soybean meal may be added as well. Supplement pond fertilization schedules with sinking feed within 30 days to maintain good fish growth. Sinking feed should be added at approximately 1 percent of the estimated weight of the fingerlings per day. Reduce stocking densities to 25,000 per acre (62,000 / ha) to obtain 4-inch (100-mm) fingerlings during the first season. Fry stocked at 5,000 per acre (12,000 / ha) should grow to 7- to 8-inch (175- to 200-mm) fingerlings.

Pond production of foodfish

Buffalo fingerlings are easily stressed during handling. They are easily bruised, and lose scales when handled with knotted mesh netting. Injuries sustained during handling increase the incidence of diseases. Fingerlings should be moved in water when possible, and handled only in small numbers when out of water. Age 0 fingerlings also can be polycultured with other species, but may increase *Lernea* (anchor parasite) infestations in other soft-bodied, scaled fish such as goldfish, fathead minnows and golden shiners. Age I fingerlings can be stocked at 100 to 250 fish per acre (250 per 620 / ha) in polyculture ponds for growout to market size of 2 to 5.5 pounds (1 to 2.5 kg) during the second year, with no effect on catfish food conversion. Take care to harvest market-sized fish annually. Buffalo will spawn, even with no apparent substrate, if they are allowed to remain in the polyculture ponds beyond year 2. It is possible that excessive populations of buffalo could occur if adults are not harvested. In catfish ponds, fingerling buffalo could serve as supplemental forage, but forage fish may contribute to off-flavor in catfish. Buffalo have water quality requirements similar to channel catfish. Bigmouth buffalo also readily take sinking fish food, but have not been observed feeding at the surface on floating feeds.

Harvest

Fingerlings or foodfish weighing less than 2 pounds (1 kg) should be handled with knotless mesh nets, if possible. Add 1 percent salt to the hauling water, maintain dissolved oxygen near saturation in the seining area and in the hauling tank, and keep fish in the hauling tank no longer than necessary. Harvest can be difficult in polyculture systems, where there are many sizes, species and behaviors of fish. If harvest is done with catfish seines, do not begin to sort the fish immediately after seining. Instead, give the fish sufficient room to move, as when the seine is positioned to allow small catfish to escape the mesh, and the buffalo will orient themselves at the edge of the fish mass near the upper margins of the seine. There, they can be removed easily by hand if the farm is small. On large farms, the buffalo should be seined with a large mesh seine so that only a fraction of the total fish biomass is caught. For livehaul markets, buffalo should be handled in loading baskets made with knotless mesh. Loading rates for livehaul markets are about the same as for channel catfish. Severe hemorrhage and scale loss will occur if buffalo are handled with knotted mesh nets. This will reduce their appearance and market value. Fish damaged during harvest should be processed, usually as gutted, fresh fish.

Diseases

Fingerling buffalo are particularly susceptible to anchor parasites, *Lernea cyprinacae*, but most buffalo are *Lernea*-free after they reach 12 inches (30 mm). The female parasite has holdfasts that attach to the fish between scale margins, at fin insertions, and at the edges of the operculum. The parasite is visible as a fine, wire-like protrusion from 1 / 16 to 1 / 2 inch (1.5 to 13 mm) long, often with a pair of pale green egg sacs 1 / 4 inch (6 mm) long. There is usually an inflamed, swollen lesion at the attachment site. Secondary infections of the protozooan *Epistylis* or the bacteria *Flavobacterium columnare* are common with severe anchorworm infections. Both appear as fuzzy, often brown growths near the anchorworm site. Secondary infections can be legally treated only with formalin-F®. There is no currently approved therapeutant for treatment of *Lernea* infestations on food fish. The best treatment is to stock at moderate rates and maintain good water quality. Maintain a bloom adequate for good production of zooplankton, but not dense enough to deplete dissolved oxygen. Infestation is aggravated by crowding and poor water quality.

Marketing

Buffalo marketing is currently hampered by large, seasonal variations in availability and product quality. These constraints are similar to those encountered in the early catfish industry when much of the supply was wild-caught. Buffalo are often marketed live, or as fresh, whole dressed fish. They have large, forked, intermuscular bones in the dorsal musculature anterior to the vent, which discourages the marketing of fillets. The live fish market is targeted to Asian consumers, who prefer to have the fish gutted with scales and head left intact. For African-American consumers, fish are whole dressed. The most common dish in restaurants is the fried rib section. However, the meat is particularly suited for sale as a smoked product. While most fish are now sold to live haulers for resale in large metropolitan areas, smaller markets do exist, or can be developed, throughout the U.S. for both live and processed fish. There is some market for selling fingerlings to other culturists.

Economics of buffalo production

Buffalo monoculture is not recommended. The capital investment associated with pond construction would probably not be recovered unless the fish were sold retail. However, when used as a polyculture fish, the overhead is drastically reduced except for labor needed during harvest. Buffalo are attractive primarily as a crop that can be produced on food sources (such as uneaten feed and plankton) that would otherwise be irrecoverable. Production costs increase with the intensity of the culture method. Harvest and handling are the biggest expenses. Table 1 presents partial budget analyses for producing fingerlings and foodfish in a catfish polyculture pond.

Assumptions for fingerling production were 10,000 fish per acre (25,000/ha), reared to 0.1 pound (45.0 g) and sold for $1.00 per pound ($2.50/kg). Hatchery costs for fingerling production included both carp pituitary and HCG ($10 per acre; $25/ha). The costs also included 150 pounds per acre (370.5 kg/ha) of sinking feed ($38 per acre, $94/ha), and 50 pounds per acre (56 kg/ha) of 18-46-0 fertilizer. Harvesting fingerlings cost $15 per acre ($37/ha).

Assumptions for foodfish production included a pond stocked with 5,000 catfish and 200 buffalo per acre (12,000 catfish and 500 buffalo/ha). An additional seine haul (with a large mesh seine) beyond that necessary for harvesting catfish was included ($15 per acre; $37/ha). Harvesting costs would increase substantially if a large mesh seine was purchased specifically for buffalo production. Alternatives include sharing a seine with other producers, having a custom harvester seine the buffalo, or seining the buffalo and the catfish together. No extra food was added to the pond for the buffalo. Fish were assumed to be sold wholesale ($0.65 per pound; $1.37/kg) at the pond bank; prices should be at least doubled for retail sales. These costs and returns do not reflect additional expenses associated with long distance live hauling.

Table 1. Partial budget analysis per surface acre (hectare) of buffalo production.

Culture phase	Total benefit	Total cost	Net benefit
Fingerlings, 6-8 in. (150-200 mm), 10,000/A (25,000/ha)	$1,000 ($2,500)	$78 ($193)	$925 ($2,285)
Foodfish, 200 fish/A (500/ha), mean weight 3.75 lbs. (1.7 kg)	$487.50	$15 (37.50)	$450 ($1111.50)

The work reported in this publication was supported in part by the Southern Regional Aquaculture Center through Grant No. 94-38500-0045 from the United States Department of Agriculture, Cooperative States Research, Education, and Extension Service.