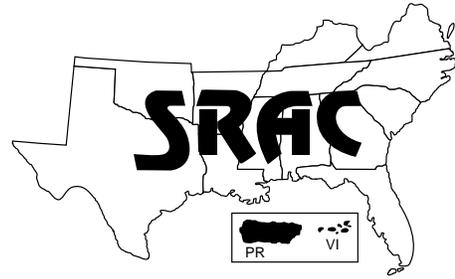


**Southern  
Regional  
Aquaculture  
Center**



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## Species Profile Largemouth Bass

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The largemouth bass (*Micropterus salmoides*) is a member of the sunfish family (*Centrarchidae*) along with breams (*Lepomis* spp.), crappies (*Pomoxis* spp.) and several other genera. Members of the genus *Micropterus* are known as the black basses. The largemouth bass is native to the midwestern and southeastern United States and northeastern Mexico, but has been introduced throughout the United States and many other countries. The great demand for largemouth bass and their high selling price (compared to other cultured species) have raised interest in their commercial culture.

### Natural history

There are two recognized subspecies of largemouth bass, the Florida and the Northern. These subspecies blend genetically in areas of overlap and subspecies can be positively identified only biochemically.

In the southern U.S. largemouth can spawn when 1 year old if they have reached at least 10 inches in length. Males begin to select nest



sites when temperatures remain higher than 60° F. The male will fan out a nest about 20 inches in diameter and 6 inches deep. A substrate of sand or gravel is preferred, but silt or clay will be used if necessary. Nests are usually constructed within 7 to 8 feet of shore at depths of 1 to 4 feet (sometimes deeper if the water is very clear). Nests are usually at least 20 feet apart.

Once the nest is constructed and temperatures reach 65 to 75° F (April to June in most areas of the south), the male will begin to circle the nest attempting to entice a female to spawn. When a female joins the male, they circle the nest side by side. Actual spawning occurs when the male and female tilt on their sides, with their vents in close proximity, and release eggs and sperm.

Individual females usually contain 2,000 to 7,000 eggs per pound of body weight, with an average of about 4,000 eggs per female. The female usually lays a few hundred adhesive eggs at a time. She will then move off, returning later to that nest or another nest. A male's nest will normally contain a few hundred to several thousand eggs contributed by several females.

Males guard the nest and the eggs during incubation. Eggs normally hatch in about 10 days at 65° F or 5 days at 80° F. Fry will remain in the nest until their yolk sacs are absorbed (1 to 2 weeks) and disperse when they are about 0.5 to 1 inch long. The male usually remains on guard until then. The nesting period is very stressful on males, and those in poor condition before spawning may die. Many eggs, and often entire nests, are lost to predation by other fish-

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es (especially bluegill) despite the males' attempts to protect them.

After swim-up, and while they are still in schools guarded by the male, fry begin feeding on zooplankton (primarily cladocerans, rotifers and copepods). At about 1.5 to 2 inches in length largemouth begin adding larger food items, such as insect larvae and then smaller fish, to their diet. It is during this natural changeover period, when bass are "reprogramming," that they can be trained to accept artificial diets under intensive culture conditions.

As with most fish, the growth rate of largemouth bass is highly variable and depends on food supply and environmental conditions. Largemouth can grow to more than 2 pounds their first year under ideal conditions, but in nature about 0.5 pound is normal. Females are normally larger than males. The maximum size of the Northern largemouth is about 10 pounds, while a large female Florida largemouth may reach 20 pounds.

## Culture techniques

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

In the 1960s, Jack Snow at the U.S. Fish and Wildlife laboratory in Marion, Alabama studied the raising of largemouth bass to 6 to 8 inches on feed as a method of increasing and intensifying hatchery production for sportfish stocking. During the 1980s, a number of federal and state hatcheries refined feed training techniques, again to maximize hatchery production. In recent years aquaculturists have become interested in the culture of feed-trained largemouth bass to larger sizes. There

is an increasing demand for these large bass for corrective stocking in sportfish ponds, for use in commercial "trophy" fishing lakes, and as a food fish among ethnic Asians.

## Broodstock procurement

The production of largemouth bass fry follows well established procedures dating back to the 1930s. Largemouth bass are usually spawned in ponds and do not require hormone or photoperiod manipulations. Broodfish must be in good condition and must be legally obtained according to the state laws. In most states, broodstock cannot be captured from the wild except with special permission. Purchasing broodstock from fish farms or fish brokers is acceptable. If the broodstock are transported across state lines, all papers and documentation of their purchase must be available during transport to avoid the interstate aspects of the Lacey Act.

Transportation information and guidelines are covered in SRAC publications 390-393.

Broodfish are usually more than 2 years old and weigh at least 1.5 pounds. Very large fish are harder to handle and less dependable as spawners. Sexing of broodfish is most easily accomplished in the spring when ripe females should have distended abdomens and males freely emit milt when stripped. Bass larger than 13 to 15 inches usually can be sexed by examining the scaleless area around the urogenital opening. This scaleless area is almost circular in males but more elongated in females. The surest way of sexing is to gently insert a capillary tube into the urogenital vent to remove eggs or milt.

Broodfish are stocked into 0.5- to 1-acre spawning ponds at 50 brood pair per acre. Ponds must be free of existing fish. Spawning ponds are normally not fertilized so that spawning behavior, eggs and fry can be observed easily and so that the ponds can be harvested more easily. Broods may be stocked when temperatures reach 65° F and spawning should begin

soon after. In Texas, largemouth bass are often spawned in raceways with good results.

Because spawning ponds are not fertilized, a nursery pond should be prepared as soon as spawning begins. Nursery ponds are fertilized with organic and inorganic fertilizers so they will contain plenty of food (zooplankton) for the bass fry (See SRAC 469 and 471). When large numbers of fry can be seen in the spawning pond, they should be transferred to the nursery pond and stocked at 40,000 to 80,000 fry per acre. After 3 to 4 weeks in a properly prepared nursery pond, bass should reach 1.5 to 2.0 inches in length and be ready for feed training.

## Feed training

To feed train largemouth bass (and several other species), the basic concept is to remove the fish from any natural source of food, crowd them at high densities, and present them with highly palatable prepared foods at frequent and regular intervals. To begin feed training, fingerlings (1.5 to 2.0 inches) are seined from the nursery pond, graded to uniform sizes, and stocked in flow-through tanks (round or rectangular) at a high density (200 to 500 per cubic foot), which is determined by water flow. Fish are then offered either freeze-dried krill, ground fish flesh, or fish eggs. Freeze-dried krill is especially effective, commercially available, and easy to feed and store. These highly palatable products are then gradually mixed with a high quality salmonid diet. Mixing fish flesh and/or fish eggs with the commercial diet produces a semi-moist diet with improved texture for feed training. Each day's feed ration should contain increasing amounts of the manufactured feed. By day 7 the fish should be consuming straight feed. Fish that have been trained to take the feed will, by this time, be thick bodied with large bellies, and can be removed with graders. The "feed-trained" fish should be moved to a separate tank or compartment

and maintained on feed for several more days before pond stocking. Fish not obviously trained can be left in the tank and continue to receive the moist training diets or krill. After an additional week most of these fish should adapt to the prepared diet. Optimally, about 80 to 90 percent of the fish originally stocked should accept artificial diets. Recent studies have shown that offspring from second or third generation feed-trained fish can be trained more easily than those from forage-fed fish, which indicates improvement from domestication.

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

After the fish have been feeding actively in tanks for at least 2 weeks, they can be stocked into ponds at 20,000 to 30,000 per acre and fed two or three times per day using a 40 to 48 percent protein salmonid diet with 8 to 10 percent fat. Feed the fish all they will readily consume at each feeding. Largemouth bass will feed voraciously on some days and not so actively on others. This is probably associated with temperature, sunlight and/or water quality changes. A floating diet allows the person feeding to observe the fish more easily and feed to satiation.

### Growout

Bass should grow to 6 to 8 inches (with some larger individuals) by the fall. This size is well suited for

pond stocking and currently brings approximately 75¢ per fish wholesale and \$1.50 per fish retail. Producing fish weighing more than 1 pound will require at least 1 additional year of growth. Fish can be thinned to grow-out densities either in the fall or spring; however, fish should not be handled when water temperature is below 55° F because of fungal infections. Some papers have recommended a grow-out density of 2,000 per acre. However, research at Kentucky State University (KSU) found no difference in average weights of fish stocked at 5,000 or 2,500 per acre, while the higher density produced double the amount of fish per unit of pond. Additional research at KSU found production was best in bass stocked at 5,000 to 6,000 per acre and fed a 46 to 48 percent protein diet with 6 to 8 percent lipid. Fish were fed once daily to satiation and production was approximately 4,500 pounds per acre of fish, which averaged just less than a pound (0.9 pound). Bass can be harvested with untreated seines using procedures similar to those used for catfish. They are actually easier to seine than catfish, but will jump over the seine if the top is not held up out of the water.

### Water quality tolerances

Water quality tolerances in largemouth bass vary with age and other culture conditions. Feed conversion efficiencies are reduced when dissolved oxygen (D.O.) concentration is below 4 mg/L. Bass actively avoid waters with D.O. levels less than 3 mg/L, but can tolerate a D.O. of 1.4 mg/L at 25° C. Their ammonia tolerance is similar to or slightly less than that of channel catfish, with a 24-hour un-ionized ammonia LC<sub>50</sub> value (a concentration that kills 50 percent of fish in 24 hours) of 1.69 mg/L. However, centrarchids appear to be very tolerant of high nitrite concentrations because of an ability to prevent absorption. The 96-hour LC<sub>50</sub> for nitrite is 24.8 mg/L in channel catfish, but 460 mg/L in largemouth bass.

### Diets

Nutritional research on largemouth bass is extremely limited. In the 1960s, Jack Snow at Marion successfully used the Oregon Moist Pellet, formulated for salmonids, to raise juvenile bass to a size of about 8 inches. In the 1980s, nutrition studies determined a protein requirement of 41 percent for 1- to 2-inch fish. Pond studies on raising second-year fish to approximately 0.75 pound demonstrated that diets containing 42 to 48 percent protein could be advantageous. Most largemouth bass in commercial production are currently fed high protein (more than 40 percent) salmonid diets based primarily on availability rather than nutritional suitability. However, reported problems concerning pale, fatty livers and mortality are thought to be related to nutrition. Liver problems may reflect a skewed protein/energy ratio or excess carbohydrates in the diet. Winter mortality in pellet-fed fish also has been reported, and it could be related to nutrition, especially vitamin deficiencies. Additional nutritional research is sorely needed as it relates to the efficient aquacultural production of this fish.

### Diseases

Largemouth are susceptible to many of the parasites and bacterial diseases common to most cultured fishes, especially columnaris during feed training. Diseases specific to the largemouth bass are not common, although there are recent reports of a largemouth bass virus. In the summer of 1995, about 1,000 adult largemouth bass died in the Santee-Cooper Reservoir in South Carolina. Subsequent studies by the Southeastern Cooperative Fish Disease Project at Auburn University implicated an iridovirus, which has been tentatively named the largemouth bass virus. No serious viral infections had previously been known in largemouth bass specifically, or in the Centrarchid family. Little is known about how infectious the virus is, what damage it produces,

whether certain sizes of fish are more or less susceptible, or if there is a seasonality to infections.

The best advice for avoiding disease problems is to minimize handling during the summer and winter. Like other centrarchids, especially crappies, largemouth are very susceptible to columnaris (saddleback) disease, especially during the training period. During the winter juvenile bass are prone to fungal infections (saprolegneosis) when handled at temperatures less than 55° F, and mortality can be high.

## Marketing

Asian consumers appear to prefer live largemouth bass to most other freshwater fish. They desire fish of 1.5 to 2.0 pounds, which may require a third year of growth. A study at KSU showed relatively slow third year growth as fish went only from 0.9 pound to 1.2 pounds during the third summer. Interestingly though, fish grew better at high densities. Production methods for growing fish to more than 1 pound should be investigated further, as demand for fish of this size has been estimated at more than 700,000 pounds per year, at a price of more than \$3.00 per pound live weight. However, once producers have identified dependable markets they can be very protective of them. New producers should identify markets before they begin production.

Processing of largemouth has not been reported. However, preliminary data from KSU indicates that they have dress-out values similar to catfish (60 percent whole dress, 40 percent filet), with relatively high protein levels and extremely high levels of omega-3 fatty acids. These are the fatty acids reported to be advantageous for human health (i.e., heart healthy).

## Economics

There are few sizable largemouth bass production systems from which one can estimate farm yields and activity levels. Production and economic estimates were taken from research results at Kentucky State University, and were based on a catfish production system composed of four 5-acre ponds under Kentucky conditions.

Based on a stocker price of \$0.50 per feed-trained fingerling, a yield of 4,250 pounds per acre, and a selling price of \$3.00 per pound (live sales), approximately \$12,750 per acre gross revenues are generated. This produces a return of \$6,623 per acre above variable costs and \$5,950 after operator labor. A break-even estimate under these assumptions would be \$1.60 per pound. Again, these numbers are based on specific and limited live markets.

## Legal considerations

In many states, game or sportfish such as bass cannot be grown and sold as food. In other states, fish (including bass) can be sold for any purpose as long as they are raised under proper permits. It is essential that potential producers contact their state fish and wildlife agencies to determine the legal requirements in their states.

The Lacey Act of 1900, the Lacey Act amendments of 1981, and the Black Bass Act of 1926 come into play when fish are transported across state lines. However, these laws are only relevant if the fish are "illegally taken" and states have different definitions of that term. Again, contact your local wildlife agency regarding the legalities of securing broodstock, what can and cannot be sold, and what permit is needed for transport. Even if you satisfy your own state's requirements, when transporting out of state you must check the regulations of states you cross through, as well as regulations at your final destination.

## Recommended additional reading

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