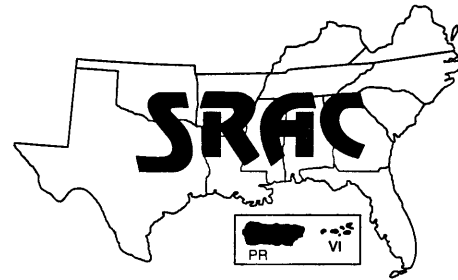


Southern Regional Aquaculture Center



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Revised

Cage Culture Species Suitable for Cage Culture

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Many species of fish are suitable for cage culture. Species which have been researched and successfully reared in cages in the southeastern region of the U.S. include: **catfish, trout, tilapia, striped bass, red drum, bluegill sunfish, crappie, and carp.** Other species may be suitable for cage culture but research has lagged behind other aquaculture research in recent years. Interest in cage culture has been revived as an alternative crop for farmers outside traditional fish farming areas and in areas with topography not conducive to levee ponds. As this interest continues to increase, more research into cage culture techniques and alternate species will no doubt occur.

A great deal of variability exists in the research and commercial literature about suitable pond sizes, growing season, stocking densities, and size of fingerlings to stock. Stocking rates or densities are dependent on species, cage volume and mesh size, pond surface area, availability of aeration, and desired market size. In general, stocking densities are calculat-

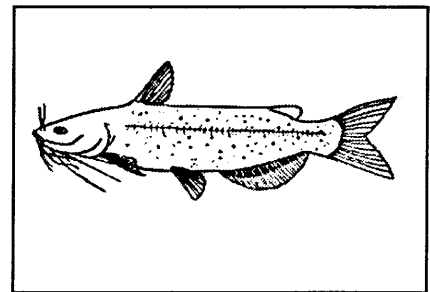
ed on the number of pounds of fish which can be reared per surface acre of pond and per cubic foot of cage. A pond without aeration can produce from 500 to 1,500 pounds of fish per surface acre. In a pond with aeration, 2,500 to 4,000 pounds of fish per acre have been achieved. The maximum pounds of production per cubic foot of cage seldom exceed 14 pounds in small cages and 11 pounds in large cages (< 270 cubic feet). Commonly, cage production will be between 5 and 8 pounds per cubic foot.

Cage production is possible in ponds, lakes, reservoirs, strip pits, rivers and streams, and in cages which range in size from 27 cubic feet to several thousand cubic feet (in large reservoirs). In this fact sheet, ponds will be the frame of reference and only cages smaller than 300 cubic feet will be considered.

Catfish

The channel catfish is the species most commonly cage cultured today in the Southeast. Channel catfish have a well established market and fingerlings are generally available. They tolerate many extremes in water quality and generally adapt to cages.

Channel catfish are warmwater fish. Optimum growing temperature for channel catfish is between 80 and 85°F. Good growth occurs between 70 and 90°F. Above 95°F fish feeding is reduced and deaths may occur. Below 70°F feeding slows and, therefore, growth slows. Feeding essentially stops below 45°F.



Channel catfish

Channel catfish should be stocked only in a certain range of water temperatures. Handling stress associated with stocking and quality of fingerlings stocked are critical factors to be considered (see SRAC Publication No. 164, *Cage Culture—Handling and Feeding Caged Fish*). Channel catfish can be stocked into cages almost any time when the water temperature is above 50°F. However, stocking

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at temperatures above 80°F may adversely stress the fish and lead to disease and possibly death. Stocking poor quality fingerlings before the water reaches 60°F (when predictable feeding occurs) can lead to handling stress compounded by nutritional stress from the lack of food intake. For these reasons it is probably best to stock when water temperatures are between 60 and 70°F. Of course, fish farmers may have to learn how to handle and stock fingerlings at any range of temperatures to be competitive and meet their marketing objectives.

Size of catfish fingerlings to be stocked depends on the length of growing season, availability, and marketing strategy. The minimum size fingerling which can be stocked into a cage made of 1/2-inch mesh is approximately 5 inches. Generally 6- to 8-inch fingerlings are stocked into cages. If a 1 1/4- to 1 1/2-pound fish is the desired market size at harvest it may be necessary to stock a larger fingerling or stock at a lower stocking rate. A larger fingerling must be stocked in the northern part of the southeastern region (or at high elevations) where the growing season is shorter. It is not uncommon to stock 8- to 10-inch fingerlings where the growing season is 180 days or less. Availability and cost of larger fingerlings may make stocking these sizes prohibitive. A fingerling over 10 inches in length may not adapt well to a cage.

Uniformity of fingerling size is also important. Research has shown that catfish fingerlings of uniform size (all within 1/2 inch of the same length) will grow more homogeneously, reaching a larger average size and increasing total cage production over fingerlings with a 1 inch or longer variation in length.

The strain or variety of channel catfish stocked into cages can make a great difference in production or yield. Different strains have been developed or selected at both public and private hatch-

eries throughout the Southeast. Not all of these strains do equally well in cages even though they may grow well in open ponds. In fact, strain research in cages suggest that some strains can grow as much as 50 percent faster than other strains. Therefore, probably the best general advice is to talk to other cage producers in your area and ask which fingerling source they like and have been successful with. Research done at Auburn University has shown that strains with a Kansas or Marion (named after the Federal hatcheries) ancestry do well in cage conditions. This same research has shown that many private hatcheries, but certainly not all, have channel catfish strains that grow well in cages. Ask other cage producers and use a strain that has a good reputation.

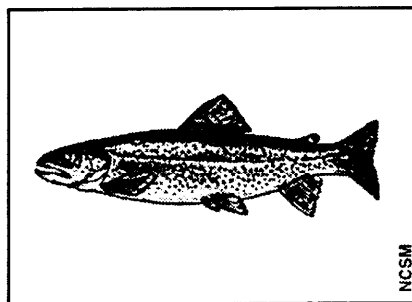
Stocking densities for catfish fingerlings in cages range from 5 to 14 per cubic foot of cage. This equates to 250 to 600 fish in a 4 x 4 feet cylindrical cage. Generally speaking it is best to stock at the low densities (5 to 8 per cubic foot) when first attempting cage culture, particularly if supplemental aeration is not present. Do not stock below a density of 5 per cubic foot or catfish may fight, leading to injury and disease. Some recommended stocking rates for small cages are given in Table 1. Even with supplemental aeration available it may be advantageous, for stress reasons, to stock additional cages rather than overstock individual cages. Overstocking can reduce growth and increase disease problems.

Cage Size	Stocking Rates
4 x 4 feet (round)	250 - 400
4 x 4 x 4 feet	320 - 500
8 x 4 x 4 feet	640 - 1,000
8 x 8 x 4 feet	1,280 - 2,000
6 x 12 x 4 feet	1,500 - 2,300

Blue catfish, hybrid catfish (blue catfish male x channel catfish female), and bullhead catfish have been stocked in cages with limited success. Blue and hybrid catfish do not grow as well in cages as channel catfish. Bullhead catfish have been raised in cages and appear to do relatively well. Recommended stocking size is a 6-inch fingerling. Bullheads do not grow as large as channel catfish, however, and are expected to get to only 1/2 pound in a growing season. Bullhead fingerlings are generally difficult to find and may be expensive.

Trout

Rainbow, brown, and brook trout can all be reared in cages. Rainbow trout are most often cultured because of the availability of fingerlings, established market, and adaptability to cages. Basic culture of all three species is similar. Rainbow trout will be described here, but the information should apply to other trout species.



Rainbow trout

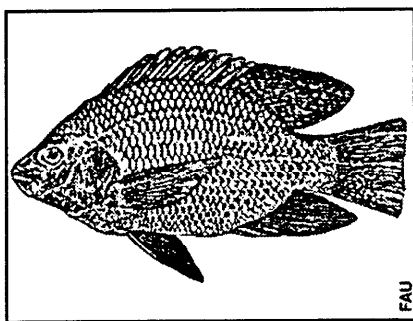
Trout are coldwater species. Optimum growth temperature for trout is between 55 and 65°F, but good growth is attained between 50 and 68°F. At 70°F severe heat stress begins, usually followed by death if exposure is prolonged. Below 45°F feed conversion drops significantly and, therefore, growth. These temperature regimes make cage culture of trout a wintertime only activity in most of the southeastern United States, except where cold spring water or high altitude lowers summertime water temperatures.

It is necessary to stock a 6- to 8-inch fingerling trout in most of the Southeast to obtain 1/2- to 1-pound trout by the end of the growing season. Stocking should begin in the fall as soon as the water temperature drops below 65°F. Failure to harvest before water temperatures reach 70°F in the spring will mean loss of your product and profit.

Stocking densities for trout in cages may be a little higher than those for catfish. The higher oxygen levels maintained by cooler water and smaller sizes at harvest allow trout to be stocked at the higher densities (Table 1) without much concern for low dissolved oxygen problems. In fact densities as high as 15 trout per cubic foot may be acceptable.

Tilapia

Several species of tilapia and their hybrids have been reared in cages. Species most often cultured are *T. nilotica*, Florida red tilapia, Taiwanese red tilapia, Aurea red tilapia, and *T. aurea*. Some tilapia species or hybrids are illegal or restricted in many states. Check with your state Department of Natural Resources, Fish and Wildlife, or an Extension fisheries (or aquaculture) specialist before culturing these species.



Tilapia

Tilapia are truly a tropical fish with origins in central Africa. They tolerate high temperatures well, can feed on plankton and detritus, are resistant to water quality deterioration, reproduce

readily, and have excellent flesh quality. For these reasons they have been stocked all over the tropical world and probably rank as the most widely cultured tropical freshwater fish. In temperate climates, however, they cannot survive winter water temperatures. Optimum temperatures for tilapia are from 80 to 90°F, but good growth is maintained between 75 and 95°F. Death occurs at approximately 50 to 55°F depending on the species, and diseases become common below 60°F. Tilapia should not be stocked until the water temperature reaches 70°F.

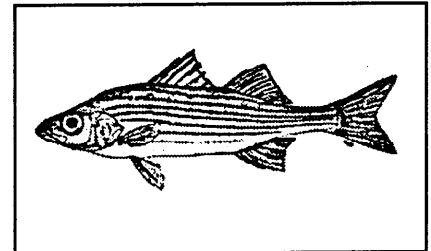
Fingerlings should be stocked at 4 to 5 inches long (or larger) and can be stocked at the densities described in Table 1. One distinct advantage in the cage culture of tilapia is that they are unable to reproduce in cages and, therefore, do not overpopulate the pond. Better growth is achieved if all-male populations are stocked. At the lower stocking densities tilapia will have excellent feed conversion because they filter feed on plankton passing through the cage. Tilapia should be harvested before water temperature reaches 60°F.

Tilapia can be stocked in the same cage with channel catfish (called polyculture). Research has shown that tilapia polycultured with catfish will increase catfish growth because they stimulate the catfish to feed more aggressively, increasing feed consumption. In polyculture with catfish, tilapia should be stocked at rates between 1 and 3 tilapia per 10 catfish.

Striped bass

Striped bass and their hybrids have been successfully reared in cages. Striped bass are illegal or restricted in many states. Check with your state Department of Natural Resources, Fish and Wildlife, or an Extension fisheries (or aquaculture) specialist before culturing these species.

Striped bass temperature tolerances and preferences are similar to those for channel catfish (described previously). One observed problem with striped bass is their poor growth and survival in soft water. Because of this, it is recommended that striped bass and their hybrids should be stocked in waters with total alkalinity of at least 50 ppm. Stocking densities recommended are the same as given in Table 1.



Striped bass

At present the greatest problem in cage culture of striped bass is the availability of large or advanced fingerlings. Most fingerlings are sold at sizes too small to be stocked into cages. A minimum 4-inch fingerling is needed for stocking and 8-inch fingerlings would be preferable. Fingerlings should be graded closely as cannibalism is a problem in young striped bass.

Red drum

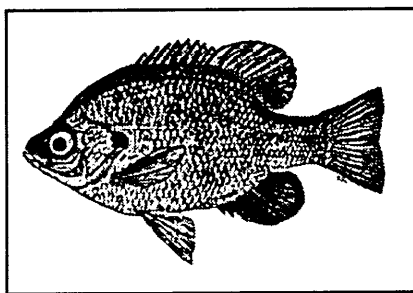
The culture of red drum (redfish) is a recent phenomenon. The research in cage culture of red drum is very limited. At present temperature tolerances and preferences of red drum appear to be about the same as those for channel catfish (described previously), except that red drum do not appear to tolerate rapid temperature drops and require water of high alkalinity and total hardness. For this reason, harvest is recommended before the temperature drops sharply in the late fall. Do not overwinter these fish in cages.

At present the greatest problem with red drum, like hybrid striped bass, is the availability of large

fingerlings for stocking. The recommended stocking size is a 6- to 8-inch fingerling. Cannibalism is also a problem in red drum, so fingerlings need to be graded closely.

Bluegill

Bluegill sunfish and their hybrids have been reared in cages with some success. Temperature tolerances and preferences of bluegill are similar or slightly lower than those for channel catfish (described previously). Bluegill are aggressive and will take food at lower temperatures than catfish and should be stocked before the water temperatures reach 60°F. Limited research on bluegill culture in cages has shown poor feed conversions.



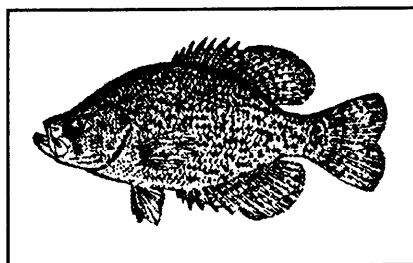
Bluegill

Fingerling bluegill/hybrids should be 3 to 4 inches or larger at stocking and should be graded carefully to assure uniformity. Stocking densities for bluegill should be in the upper range of those given in Table 1.

Crappie

Limited research has been conducted on the cage culture of crappie (black, white and hybrids) in the Midwest. These crappie were captured from the wild then transported and stocked into cages. Results of these preliminary studies indicate that black crappie adapted best to cage conditions but overall survival and growth

were poor. The fish were fed a high protein (43 percent) semi-soft diet. More research needs to be conducted on the culture of crappies in cages.



Crappie

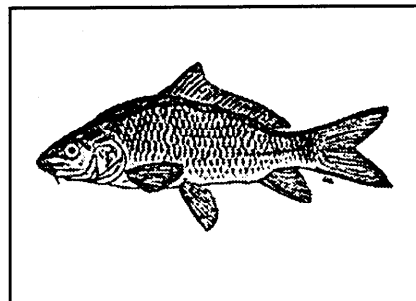
Carp

Common carp (including German, Israeli, mirror, and other varieties) have been successfully cultured in cages and are commercially produced in cages in much of Europe, Asia and the Middle East. Total production of common carp in cages is usually higher than that of most other species. It is not uncommon to produce up to 400 pounds of common carp per cubic yard of cage.

Chinese carp (grass, silver, big-head, and silver x bighead hybrids) also have been reared in cages. These Chinese carp are illegal or restricted in many states. Check with your state Department of Natural Resources, Fish and Wildlife, or an Extension fisheries (or aquaculture) specialist before culturing these species.

Common, grass, silver, and big-head carp (and silver x bighead hybrids) have approximately the same temperature preferences and tolerances as channel catfish (described previously). Fingerlings should be stocked into cages at a minimum of 4 to 5 inches in length at the same stocking densities listed in Table 1. Common and grass carp are usually fed a 32 to 36 percent protein complete floating pellet. Silver and bighead carp (and their hybrid) are filter feed-

ers and can be placed in cages in nutrient rich ponds (eutrophic) without any supplemental feeding. The reason for stocking grass carp in cages is to produce a larger fingerling for stocking into recreational ponds (for weed control) with large predatory fish.



Carp

One research study has been done using silver x bighead carp hybrids cultured in cages. The hybrids were stocked at densities of approximately two per cubic foot or 120 in 8 x 4 x 4 rectangular cages. The cages were not fed and no artificial water circulation provided. These fish fed on plankton and grew quickly from 10 inches to average 3.7 pounds in one growing season.

Choose species carefully

Picking the fish species that will do well in cages in your particular location is important. For example, it is difficult to get enough growth on trout during the short winters in Gulf coastal plain locations but not in the longer winters in states like Kentucky. Probably the most important decision in determining which species you should culture in cages is: Is there a market for them? Furthermore, is that market local or must they be transported for long distances? Is it a live market or a processed market? What size is preferred in the market? All potential producers should evaluate markets before selecting the species to be cultured.