



**Southern
Regional
Aquaculture
Center**



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Transportation of Warmwater Fish

Loading Rates and Tips by Species

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The misconception exists that "per gallon of water" includes water displaced by the fish. This is incorrect. Gallons of water should be determined before fish are loaded. The change in water volume (water displaced) after fish are added can be measured to determine the loading rate, as expressed in pounds per gallon:

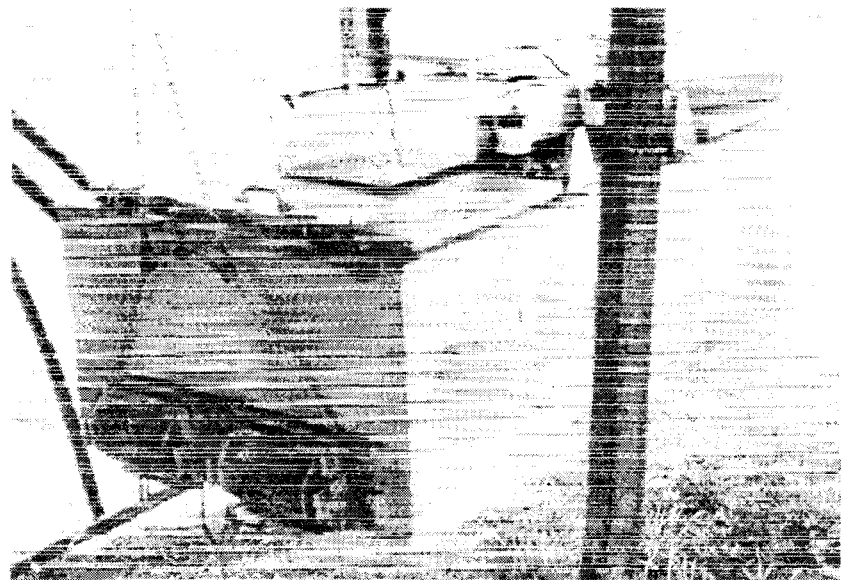
$$\frac{12 \text{ gallons water displaced}}{100 \text{ pounds fish}} \times 2,000 \text{ pounds fish} = 240 \text{ gallons water displaced}$$

Some fish species, like channel catfish and certain bait minnows, have been transported for many years. Government hatcheries have experience with transporting other cultured

species and distributing them at various sizes. Other species such as redfish, hybrid striped bass and tilapia are newcomers and experience with handling and transporting is more limited. The

	Pounds of fish
Tank Capacity - Water Displaced	
(gallons)	(gallons)

About 8 pounds of fish will displace about 1 gallon of water. This displacement factor is important for determining the proper capacity of a hauling unit or compartment based on anticipated fish load in pounds. For example, to transport 1,000 pounds of catfish weighing 250 pounds/1,000 at 5 pounds of catfish per gallon, your tank needs at least 200 gallons based on loading rate and 125 gallons for displacement (or 325 gallons). As an easy guide, 12 gallons of water are displaced per 100 pounds of fish weight. For example, 2,000 pounds of fish will displace about 240 gallons of water as shown in next column.



A typical pickup hauling tank used for hauling all sizes of fingerling fish. Photo shows slide on top and quick-opening gates at bottom left.

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following guidelines are based on recommendations from experience and research as a starting point. Higher loading rates are possible.

Channel catfish

Catfish transport well and are easier to temper when transported at 60° F in summer and 45 to 50° F in winter. If fingerlings less than 3 inches are transported above 70° F, extreme caution is required. A serious channel catfish virus disease is a threat to fingerlings at high temperatures. Hardness and alkalinity values above 75 ppm are recommended for transport water. Salt is beneficial at 0.2 to 1 percent.

Fry 3 to 7 days old can be transported in double-layered plastic bags at rates up to 15,000 fry per gallon of water. Fry 7 to 14 days old can be loaded at 7,000 per gallon for an 8-hour trip at 70° F. Fill the remaining volume in bag with compressed pure oxygen, and close tightly to prevent gas leakage.

Bags should have a flat bottom with four corners. Place the bag in a cardboard box or ice cooler. If only occasional plastic bag shipping is done, you may be able to obtain insulated boxes with shipping bags from local pet stores that sell ornamental fish.

Ice in zip-top plastic bags can be placed next to the container to maintain temperature below 80° F. Transport the boxes in an air-conditioned vehicle if possible. Avoid direct outdoor sunlight, and never leave an uninsulated container inside a closed vehicle on a hot, sunny day for more than a few minutes.

Fry transport well for up to 24 hours. On delivery, temper fry by placing plastic bag in tub of pond water and wait about 30 minutes for temperatures to equalize. Do not place bags in direct sunlight.

On farms, catfish fry are transported from hatcheries to ponds in small transport boxes of 50 to 100 gallons. Use diffused oxygen, not agitators. Do not overcrowd. If fry crowd to the surface, the fish load is excessive.

Catfish eggs can also be shipped in plastic bags with water (75° to 80° F) and pure oxygen. Two to three egg masses per plastic shipping bag work well. Do not ship eggs that may hatch during transit. To ship in hauling tanks place egg masses in a soft mesh bag suspended from a floating Styrofoam collar. This provides good water circulation.

Broodfish can be transported, but special care is required during the spawning season. Anesthetize broodfish or place them in burlap bags to prevent fighting.

Table 1 provides guidelines for transporting catfish fingerlings and food-sized fish. Numbers are pounds of fish per gallon of water at 65° F.

Adjustments for other conditions: Increase loading rate by 25 percent for each drop of 10° F below 65° F or if pure oxygen is used; decrease loading rate by 25 percent for each increase in 10° F above 65° F.

Bait minnows

Some species of bait minnows are more tolerant than others to handling. Golden shiners are especially delicate when temperatures are above 60° F and often suffer delayed mortalities when suddenly transferred from 60° F to 75° F water that is common in retail holding vats during the summer. Shiners haul well in salt solutions of less than 0.2 percent.

Golden shiners can tolerate a temperature drop of 15° F, but fathead minnows and bait-sized goldfish require gradual tempering. Haul goldfish and fathead minnows in water with the same temperature as the pond for short hauls. Goldfish can be shipped at 1 pound per gallon in summer and 2 pounds per gallon in winter. Smaller goldfish transport well at 1 1/2 pounds per gallon in winter at 55° F with LOX supplied at 5 liters per minute (lpm). Fish should be held in vats at least 24 hours prior to transport. Young goldfish less than 3 inches are very soft and delicate to handle. Minnows are successfully hauled with agitators and pure oxygen at 1 pound per gallon during cooler months and 0.7 pounds per gallon in summer.

Tropical fish

Tropical fish are usually starved for 48 hours prior to transporting. Salt and anesthetics are added to the water, which is reduced to 77° F. Some species

Table 1. Guidelines for transporting catfish.

Size of Fish Pounds per 1,000 Fish	Transport Time in Hours		
	8	12	16
0.1	0.20	0.20	0.20
1.0	1.25	1.00	0.70
2.0	1.75	1.65	1.25
4.0	2.20	1.75	1.50
8.0	2.95	2.20	1.80
20.0	3.45	2.50	2.05
250.0	5.00	4.10	2.95
500.0	5.90	4.80	3.45
1,000.0	6.30	5.55	4.80

can tolerate lower temperatures. Loading rates are 0.4 to 0.7 pounds per gallon. Water hardness above 100 ppm is preferred. Tilapia of 9 pounds per 1,000 fish can be shipped in plastic bags at up to 5 pounds per gallon at 60° F for 24 hours.

Striped bass and its hybrids

Striped bass and its hybrids can be grown in either fresh or brackish water, but these fish are very sensitive to handling and should always be moved in water whenever possible. Recent studies indicate that fry 5 to 30 days old are not as sensitive to netting and light shock as previously believed.

Harvest striped bass when pond water is cool and not muddy. Transfer fish immediately to a container with oxygenated water and 0.2 to 0.5 percent salt. Provide a rest period of several hours in 0.1 percent salt if possible, and then haul at the same salinity. Striped bass require no tempering from fresh water to

0.1 percent saline water. Hardness above 75 ppm is recommended.

Loading rates include 1,000 per pound fish at 0.15 pounds per gallon for 10 hours; 5 per pound fish at 1.5 pounds per gallon for 10 hours or 0.75 pounds per gallon for 15 hours; or 500 per pound fish at 0.5 pounds per gallon for 24 hours. Optimum water temperature is 55° to 65° F (70° to 75° F for adult broodfish) and salinity of 1 percent.

Striped bass fry at least 5 days old appear to survive transport and stocking better than younger fish. Place 40,000 fry per gallon in oxygenated plastic bags. For fry, temper gradually at a rate of one-half hour per 3° F difference in temperature. Do not haul fish smaller than 2 inches in units with agitators because of possible mechanical injury. Suggested loading rates for 2-inch striped bass include 0.5 pounds per gallon for 1 to 4 hours, 0.33 pounds per gallon for 4 to 8 hours and 0.25 pounds per gallon for more than 8 hours.

Largemouth bass

Harvest bass after 2 days without food, by seining or with glass V-traps before the water level is drawn down and water becomes muddy. Provide a resting period after harvest and before loading. Salt is used up to 0.5 percent. Pure oxygen is preferable, and DO should be 7 ppm for short trips and 10 ppm on trips longer than 8 hours. Bass may require up to 3 days to recover from hauling stress.

Bass sac-fry 1 to 3 days old can be shipped for 3 to 4 days in plastic bags at 11,400 fish per gallon. Square-bottomed bags are preferable. Water should be overlaid with pure oxygen (Figure 1).

Table 2 provides recommended loading densities for largemouth bass for trips less than 30 hours.

Table 2. Loading densities for largemouth bass.

Fish Size (Inches)	Loading Rate (pounds/gallon)
5	1.5
4	1.0
3	0.66
2	0.50
1	0.33

Recent studies with transporting bass indicate the usefulness of prophylactic disease treatment. Starve fish 3 days before loading. Sedate fish with MS-222 at 50 ppm before crowding and loading. Haul fish in 60° F water with a hardness and an alkalinity of at least 150 ppm with MS-222 at 25 ppm.

Bluegill

Table 3 provides guidelines for transporting bluegill at temperatures between 65° and 80° F and up to 16 hours. Bluegill are normally hauled with 0.3 to 0.5 percent salt.



Figure 1. These are typical plastic bags and styrofoam boxes used for transporting small fish. Water temperature must be adjusted before adding fish, and oxygen must be added before transporting.

Table 3. Guidelines for transporting bluegill.

Fish Size (inches)	Loading Rate (pounds/gallon)
4	1.00
3	0.66
2	0.50
1	0.33

Red drum (redfish)

Information on this species is scarce, but practices similar to those for striped bass should be a good guide. Haul red drum in water about 70° F. Do not haul in fresh water. Transport in full strength seawater when stocking fish into water near 30 ppt salinity. If fish will be stocked into fresh water, use 10 percent

saline water and dilute slowly with fresh water for 1 to 4 hours before unloading. Acclimate fish at least 5 hours if fish are moved from water of about 10 ppt salinity to fresh water.

Loading rates for 1- to 2-inch fish include 0.33 pounds per gallon for less than 8 hours and 0.25 pounds per gallon for longer trips. One-inch fish have also been transported at 0.1 pounds per gallon at 80° F in 32 ppt salinity for 5 hours. Fingerlings 5 to 8 inches long transport well in salinities from 4 ppt to 32 ppt.

More information is needed on optimum hauling temperatures and salinities for different sizes of red drum at various loading densities. Acclimation rates for different conditions also need further evaluation.



Pickup and tank equipped with oxygen used for fingerling delivery.

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