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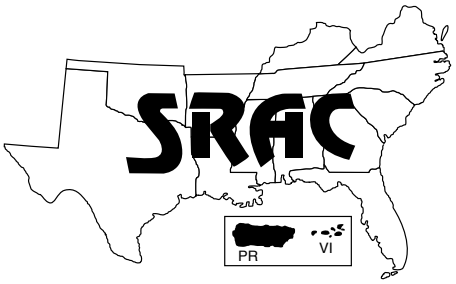

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Components and Use of an In-Pond Fish Grading System

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The production of most cultured fish species requires that they be graded for size periodically throughout the life cycle. Maintaining uniform size is important because it reduces cannibalism, increases growth rates, and improves overall production efficiency. Producers of fingerlings and stocker-size fish grade fish so they can provide a uniform product to their customers. Size grading is also important at harvest to ensure that only market-size fish are removed from the production pond.

Traditional methods of grading catfish use net pens called live cars. These are made from various sizes of mesh that retain the desired size fish while allowing smaller sizes to escape back to the pond. Typical live cars are 9 feet wide and 40 to 80 feet long and are loaded with about 500 pounds of fish per running foot. Aerated water is circulated through the live car throughout the typical 12- to 16-hour grading period. Live car grading requires minimal handling of the fish, but is often inefficient because it is a passive process. Live car grading is particularly inefficient in cold water because fish are lethargic. These inefficiencies in grading can reduce overall yield and increase processing costs. Live car grading does not allow the small fish that pass through the net to be retained.

Various mechanical grading systems have been used successfully with trout, redfish, tilapia, striped bass and others. These systems usually have parallel bars or a gradually widening v-belt mechanism to sort fish into various groups. Fish must be pumped or otherwise loaded into the grading system and are de-watered in the process. Catfish have pectoral spines that have always caused problems in these grading systems. When de-watered, catfish often extend these spines, which causes them to hang up rather than fall through the grading apparatus.

The in-pond, horizontal bar grading of food-size channel catfish was first described by Greenland and Gill (1972). This method was effective, but the early design was cumbersome because it required manual loading of the grading platform. Thus, it was not widely adopted by the industry. The original design was modified into a portable, adjustable, horizontal, in-pond grading system (UAPB grader), described below, that can be integrated into typical harvesting oper-

Figure 1. Grading channel catfish fingerlings with the UAPB in-pond fish grading system.

Aquaculture/Fisheries Center, University of Arkansas at Pine Bluff

ations for commercial catfish, striped bass, redfish, and possibly others (Fig. 1).

System design

The in-pond fish grading system has three major components: a trailer with an integrated 8-inch, re-lift style water pump; a fish eduction chamber; and a floating, adjustable, horizontal bar grader (Fig. 2). When grading through this device, fish never fully leave the water. Once fish are landed by the traditional method of seining them into a live car, the net is attached to the eduction chamber. A stream of water pumped through the eduction chamber directs fish and water up onto the horizontal grading surface.

Once in the grader, fish try to escape by swimming down through the parallel bars. Smaller fish that escape can be returned to the pond or caught in a live car under the grader. Fish too large to fit through the bars simply swim off the end of the grader and are collected in another live car positioned off the end. The bar spacing is fully adjustable (typically from 2-inch to 0.5-inch) by distorting the rectangular shape of the grader panel to a diamond or parallelogram shape.

Trailer/pump

The UAPB grader was designed for use in earthen ponds and can be transported easily between ponds with the trailer/pump unit. The backbone of the trailer is an integrated 8-inch, re-lift style water pump that can pump more than 3,000 gallons per minute. The water pump is PTO-driven (540 RPM) and can be powered by most small tractors used on fish farms (minimum 30-hp tractor recommended).

A standard 8-inch, bell-end, irrigation starter fitting is situated directly above the pump bowl as an attachment point for the 8-inch hose that connects to the grading system's eduction chamber. A 3-inch, type F, cam-lock-style fitting is positioned at the top back of the pump bowl (just below the 8-inch outlet) as an attachment point for a 3-inch hose that powers the water jet on the grading system.

Surrounding the water pump is a heavy duty, boat-style trailer frame with axle-protecting mud skids. The trailer frame carries a rack and 1,800-pound marine winch system that accommodates the fish grading platform.

Fish eduction chamber

The fish eduction chamber is essentially a fish cage with a water jet shooting through it. It operates on the principle of an eduction pump, where a liquid or gas under pressure is jetted through an open chamber and into a larger diameter pipe. This creates a negative pressure in the open chamber, where various materials can be introduced to the water stream.

The system described here uses pond water under pressure created by the 8-inch, re-lift pump. The 8-inch stream of water is directed through an open chamber and toward a 14-inch, urethane, flex-duct assembly that connects to the fish grading platform (Fig. 3). A standard 4-foot by 6-foot sock tunnel is fastened to the eduction chamber as an attachment point for a traditional fish live car.

When fish are crowded into the eduction chamber, they are pulled into the water stream and directed through the 14-inch, urethane, flex-duct assembly to the grading platform.

Horizontal bar grader

The horizontal bar grader design was adapted from and improved on an earlier design described by Greenland and Gill (1972). The grading system also incorporates a unique parallel bar panel design developed by David Heikes at the University of Arkansas at Pine Bluff (United States Patent No. 6,015,049) (Heikes, 2000). This panel design maintains the spacing of the parallel grading bars with fully threaded, 4-inch, tap bolt "pins" positioned at precise increments along six cross braces. This configuration allows the grading bars to be positioned well above the cross braces. Fish can travel the length of the grading surface without bumping into the

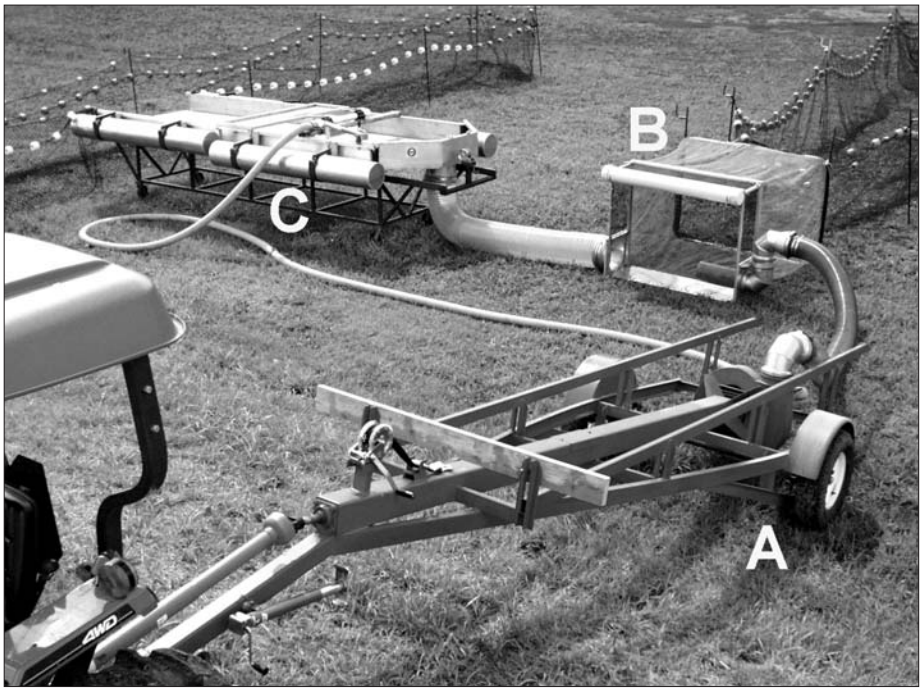

Figure 2. Components of the in-pond fish grading system: A) a trailer with an integrated, 8-inch, re-lift style water pump; B) a fish eduction chamber; and C) a floating, adjustable, horizontal bar grader.

Figure 3. Inside view of the eduction chamber with attached live car. The 8-inch water jet (bottom left) moves the fish across the eduction chamber and into the 14-inch, urethane, flex-duct assembly (bottom right). The 14-inch, urethane, flex-duct assembly connects to the in-pond grader.

cross braces, which is crucial in keeping fish moving across the grading surface unimpeded.

The grading panel is 6 feet wide by 16 feet long (Fig. 4). Panels designed to grade fingerlings and stocker-size fish (4inches to 0.33 pounds) are fashioned from thirty 0.75-inch, schedule 40 aluminum pipes. Food-fish panels are made with twenty 1-inch, schedule 40 aluminum pipes. Each grading bar is drilled and tapped and is attached to the cross brace by threading the tap bolt "pins" into the threads of the grading bar. This allows the entire panel to pivot slightly on the threads when the bar spacing is adjusted. The bars remain parallel, but get closer together as the rectangular shape of the grader is distorted to a diamond shape.

The side panels of the grader are 16 feet long by 1 foot high and are fabricated from 0.125-inch x 1.5-inch square tubing with a 0.063-inch aluminum skin fastened to the inside. The outside of the two side panels has adjustable attachment channels for the grader flotation pontoons. This allows for minor adjustment of the slope of the grading surface during grading. The panel must slope slightly downward as fish move across the grading surface in order to keep the fish moving.

One end of the fish grader box is enclosed with a special attachment mechanism "hopper" for the 14-inch fish delivery hose coming from the eduction chamber. The grading system is also fitted with a bar spacing adjustment mechanism and calibrated adjustment gauge.

Operation of the in-pond grading system

Before fish can be graded with the UAPB grader, they must first be seined from the pond and contained in live cars according to typical seining protocols. It is important to maintain excellent water quality in the live cars to reduce the stress associated with handling. The live car containing the ungraded fish is then positioned where water is 3 to 4 feet

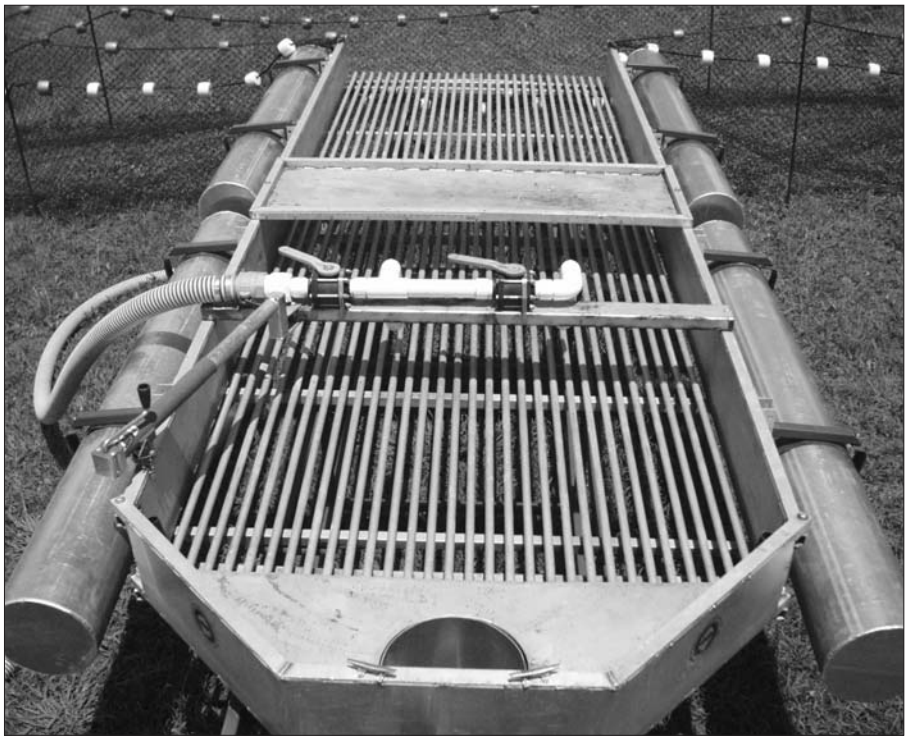

Figure 4. Top view of the in-pond grader showing the parallel bar grading surface, water jet system, and bar-spacing adjustment mechanism.

deep and held in position with 8-foot metal stakes at a right angle to and about 20 feet from the bank.

The fish grader is then backed into the pond and floated off the trailer, just like launching a boat. The eduction chamber is then attached to the frame or zipper system of the live car. Next, the grader is attached to the eduction chamber via the 14-inch, urethane, flex-duct assembly. The flex-duct assembly is permanently attached to the eduction chamber, but must be attached to the underside of the hopper end of the fish grader via a spring-loaded clip mechanism.

The grader is typically situated parallel to the bank and to the left (as you are facing the pond) of the live car containing the ungraded fish. Two additional hose assemblies are then connected. The 8-inch, urethane, flex-duct hose assembly connects the 8-inch water pump to the eduction chamber. The 3-inch EPDM hose assembly is then attached to connect the pump bowl to the water jet on top of the fish grader.

At this point, the grader should be adjusted to the appropriate bar spacing (discussed below). Next, if the small fish swimming through the grader are to be captured, a small-mesh live car should be situated under the grader. Cleats on the hopper end and the opposite end of the grading system hold the live car float lines securely in place. A third live car can now be positioned and attached to the end of the fish grader so that fish too large to escape through the grading panel will swim off the end of the grader and into the net. Once all the live cars are in place and secured with metal stakes, the throat leading to the ungraded fish can be opened.

The tractor PTO is engaged and the tractor engine speed (RPMs) is adjusted until an appropriate water flow is established through the grading system. For fingerlings, the 14-inch water plume should rise about 4 to 6 inches from the base of the loading hopper. For larger fish, the water plume should rise about 6 to 8 inches. When grading in cold water, flow can be reduced slightly to allow ample time for the grading of sluggish fish.

Fish must be carefully crowded into the eduction chamber. The recommended method of crowding is to use a floating pipe (crowding pipe) made from 6-inch x 16-foot PIP irrigation pipe capped on both ends. This crowding pipe can be inserted under the net containing the ungraded fish so that approximately 5,000 pounds of fish are "cut off" and contained between the crowding pipe and the eduction chamber. The pipe can then be moved toward the eduction chamber by carefully rolling the net up over the floating pipe and pushing the float toward the eduction chamber. Great care should be taken so that fish are not overcrowded and the water quality in the live cars is maintained. Overcrowding and oxygen depletion will stress the fish and cause them not to grade properly.

Recommended bar spacing

The UAPB grader has an adjustment mechanism and bar spacing gauge calibrated to the parallel bar panel in the grading system. The bar space and corresponding fish size (Table 1) are marked on the gauge to allow users to simply turn the adjustment crank to select for the desired size fish. This is the approximate split point (the spacing that allows about 50 percent of a size class to escape through the panel and 50 percent to swim off the end) based on an average population of fish. Fish in any particular pond may grade slightly differently because of their condition, the water temperature, and the particular strain of fish being graded. Additional information on grading can be found in SRAC publication no. 391, "Sorting and Grading Warmwater Fish."

Before grading, producers must understand the population to be graded. An accurate sample of fish should be analyzed to help in selecting the correct bar spacing. To assist with this process, a sampling protocol and an Excel spreadsheet program (Fingerling Calculator) have been developed for use with channel catfish. This process involves measuring a representative sample of fingerlings

Table 1. Bar spacing (width between bars) and corresponding length and weight of channel catfish retained by the in-pond grader.

Bar spacing (inches)	Length (inches)	Weight (lbs/1000)
0.500	4	19.1
0.625	5	35.3
0.750	6	58.8
0.875	7	91.0
1.000	8	133.3
1.125	9	187.1
1.250	10	333
1.375	11	432
1.500	12	573
1.625	12.5	650
1.750	14.25	1000
1.875	15	1180
2.000	15.35	1260

Values are approximate and can vary slightly with fish condition, water temperature and fish strain.

with a fish measuring board to the nearest 0.25-inch. The results are then entered into the Fingerling Calculator, along with an estimate of the total pounds caught in the live car. The spreadsheet program estimates the total number, total weight, and average weight of fish that would be retained or released at the various bar spacings. A copy of this spreadsheet program can be downloaded from the UAPB Web site at *http://uaex.edu/agfi/extension/equipment/*.

Advantages and disadvantages of the in-pond grader

To date, 19 catfish production facilities in Arkansas, Mississippi, Alabama and Oklahoma and at least four hybrid striped bass production facilities in Mississippi and North Carolina have adopted the UAPB in-pond fish grading technology. Most of these producers raise and sell graded fingerlings. Other producers raise stocker-size fish for their own production ponds. Producers who have adopted the system for grading fingerlings and stocker-size fish report significant improvement in the quality of grading (over net grading) and a major reduction in seining labor when more than one size fish is marketed from the same pond.

The standard method of net (live car) grading to sort fish into two sizes would require an initial seining, with fish being held overnight in a live car with a mesh size that allows the small fish to escape back to the pond. The pond then has to be seined a second time on the following day to capture the smaller fish. The in-pond grader allows a producer to seine the pond once and immediately separate the fish into two or more size groups. This allows the producer to fine-tune the grading to make certain the customer receives the size fish requested; it also eliminates the guess work and multiple seinings involved with passive overnight grading.

Another major advantage of the in-pond grader is that it can sort fish that could not be sorted by net grading. Hybrid striped bass, channel x blue hybrid catfish, tilapia and various other fishes have been graded successfully with the in-pond grader. To date, the only fish that has not responded well to the in-pond grader is the largemouth bass (*micropterus salmoides*), as they do not swim downwards as an escape response.

Research has shown that using the in-pond grader on commercial catfish operations is economically feasible (Trimpey, 2005). Partial budget analyses indicate positive net returns for all farm sizes adopting this grading system, with payback periods ranging from 0.1 to 2.0 years depending on the farm scenario. An additional benefit of the better grading of food-size catfish is the reduction of size variation at the processing plant. Keeping more sub-marketable fish in the production pond benefits the producer and markedly increases processing plant efficiency.

The primary disadvantage of the in-pond grading system is that it requires more labor than the passive sock grading of food fish. Grading large quantities of food-size fish is time consuming (typically 400 to 500 pounds per minute) and physically difficult. Some producers may not be willing to adopt the in-pond grading system for food-size catfish until they are offered a greater incentive to provide well-graded fish to the processing plants.

Vendors

Complete in-pond fish grading systems and/or grader components can be manufactured by contacting the following vendors:

Gatlin Services, Inc.
430 Grider Field Rd.
Pine Bluff, AR 71601-9795
870-536-3828

Geddies Machine and Repair Shop
223 Bailey Drive
Hollandale, MS 38748
662-827-2572

Delta Net and Twine
3148 Hwy. 1 South
Greenville, MS 38701
662-332-0841

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