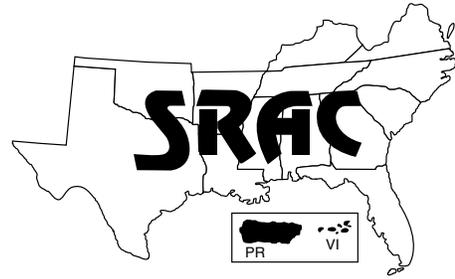


**Southern
Regional
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Center**



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Advances in Catfish Harvesting Gear: Seines and Live Cars

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Since the introduction of live cars (socks) and mechanized seines in the 1960s, innovations in catfish harvesting have been largely the result of trial-and-error by commercial net builders, fish producers and custom seining crews. Although there were minor modifications in the design of seines and live cars based on research in the 1970s, research played little part in the early development of harvest technology.

The Southern Regional Aquaculture Center (SRAC) funded a 3-year study in 1990 to develop new and improved harvest technologies. From that study, several new technologies appeared to have the potential to improve seining efficiency, including modified seines with rubber-roller mud lines. Little of this technology was implemented by the catfish industry, and inefficient harvesting and improper fish sizing continued to be major problems. As a result, catfish culturists requested that further research be conducted. The Harvest/Gear Technology program began in 1996 at the Thad Cochran National Warmwater Aquaculture Center (NWAC) in Stoneville, Mississippi, in collaboration with the National

Marine Fisheries Service's (NMFS) Harvesting Systems Division in Pascagoula, Mississippi. The goal of the program was to develop new harvest/grading technologies for the catfish industry. The program was supported, in part, by a 3-year SRAC project entitled "Development of Improved Harvesting, Grading and Transport Technology for Finfish Aquaculture." This report presents the specifications for a more efficient seine/live car based on this research. Although developed for catfish culture, this technology should apply to other fish grown in ponds and harvested by seining.

A limited discussion of typical catfish harvest techniques is included to highlight the benefits of the experimental seine. For a more in-depth description of fish harvesting techniques, see SRAC Publication No. 394, "Harvesting Warmwater Fish," or "Catfish Harvesting" (<http://msucares.com/aquaculture/catfish/harvest.html>).

General harvesting methods

Catfish seines are usually 6, 9 or, more rarely, 12 feet deep. They range from 1,000 to 1,400 feet long to reach across the longest parts of ponds. Currently, most food-size catfish are harvested with a 1 ⁵/₈-inch mesh seine, which allows fish under a pound

to grade through the seine as it is pulled through the pond. This greatly reduces the stress of crowding on the fish. Seines typically have 1/2-inch poly-plus ropes on the top and bottom with 3-inch x 3-inch floats every three ties on the top line and a 2-ounce lead every two ties on the bottom line. Another bundled nylon netting mud line is tied to the lead line to help hold the seine on the bottom as it is pulled. Some seiners pay more for larger floats (4-inch x 3-inch or 3 ³/₈-inch x 5 ³/₈-inch bullet shaped) with grommets, which reduces losses caused by the pressure of the reel on the floats as the seine is reeled in. The larger floats help reduce the tendency of the seine to sink below the pond surface when mud accumulates along its bottom. A funnel area is built into each seine about 150 feet from one or both ends as an attachment point for a live car.

A seine is loaded onto a large, tractor-driven, hydraulic reel (Fig. 1), which allows it to be reeled in or out easily as needed during seining. Ponds are usually seined from the deep end to the shallow end to keep fish from escaping under the seine bottom once the fish are concentrated in the harvest area. However, ponds can be seined toward the deep end if the seine has sufficient depth to work properly.

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Figure 1. Seine being loaded on a seine reel.

Seining and loading procedures have become relatively standardized in the catfish industry. To begin seining, the seine-reel tractor is positioned near one corner of the pond deep end (with the mud line side of the reel nearest the pond). The free end of the seine is attached to a second tractor that pulls the seine off the reel and across the starting levee. Once the second tractor is on the other side, both tractors pull the seine through the pond toward the shallow end (Fig. 2). The tractors can be moved forward simultaneously or alternately, depending on how badly the seine bogs down in the mud. A seining boat equipped with a 25- to 35-horsepower outboard motor and a front-mounted push-rack (Fig. 3) catches the seine top and pushes it forward to dump mud from the seine. Once the accumulated mud is dumped, the tractor drivers are signaled to move forward again. Having to continually clear mud from the seine can increase seining time by several hours, especially in old, shallow, muddy ponds. A harvest area about 70 x 150 feet in size is established once the pull tractor gets around the last pond corner and reaches a point near the seine reel tractor. Depending on the number of fish in the pond, the pond size, and the number of fish grading through the seine, there could be 50,000 to 100,000 catfish of various sizes trapped in this small area.

At this point, seining stops and one or two workers attach a live car to the seine by joining the zippers in the end of the live car and seine funnel (Fig. 4). Then the two sides of the seine and the attached live car are pulled slowly and evenly to the bank, forcing the fish through the seine funnel and into the live car. Generally, several workers will spread out around the sides of the seine to make sure the seine top does not go under water, which could allow fish to escape. Figure 5 illustrates how the sides of the seine, funnel area and live car of the experimental seine line up, giving the fish an unrestricted path

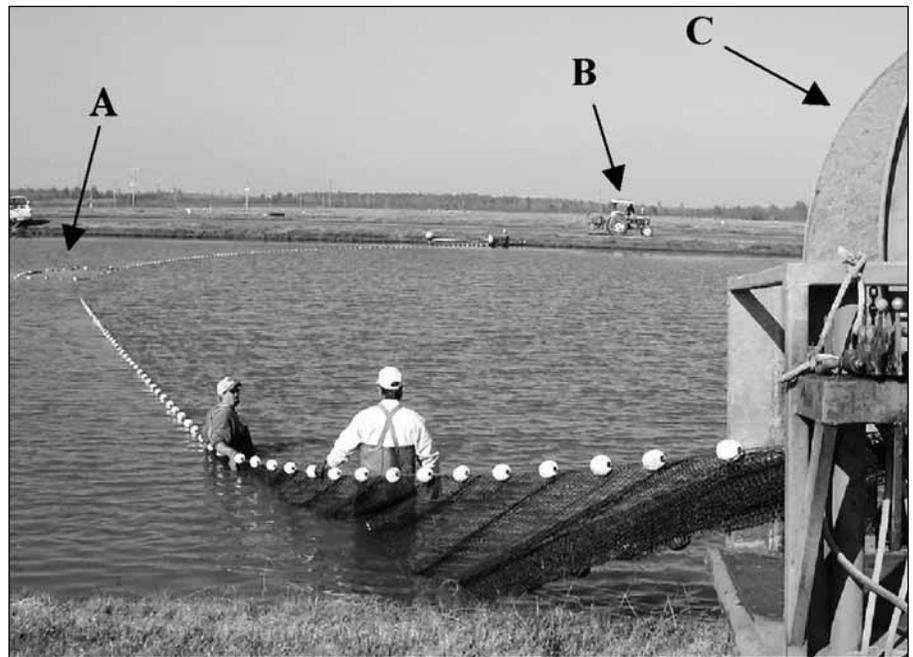


Figure 2. A = Seine funnel (closed); B = Pull tractor; C = Seine reel (tractor not pictured).



Figure 3. A = Seine funnel; B = Live car (in bottom of boat); C = Seine push rack.

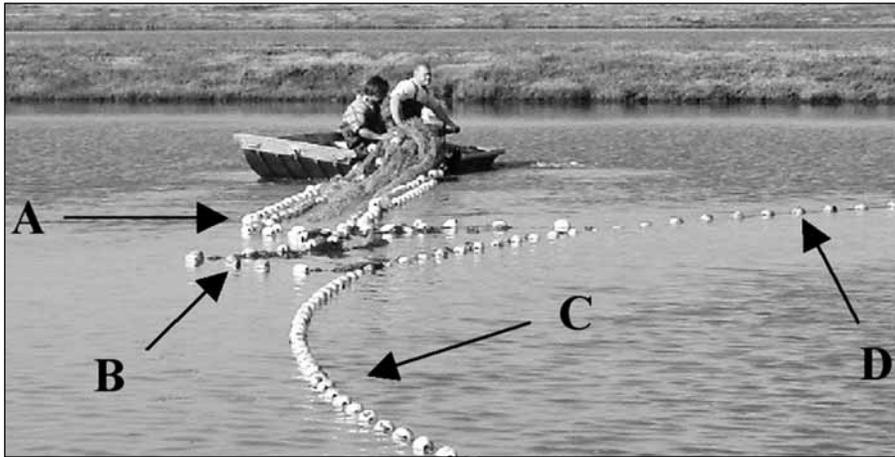


Figure 4. A = Live car; B = Seine funnel; C = Pull side of seine; D = Reel side of seine.

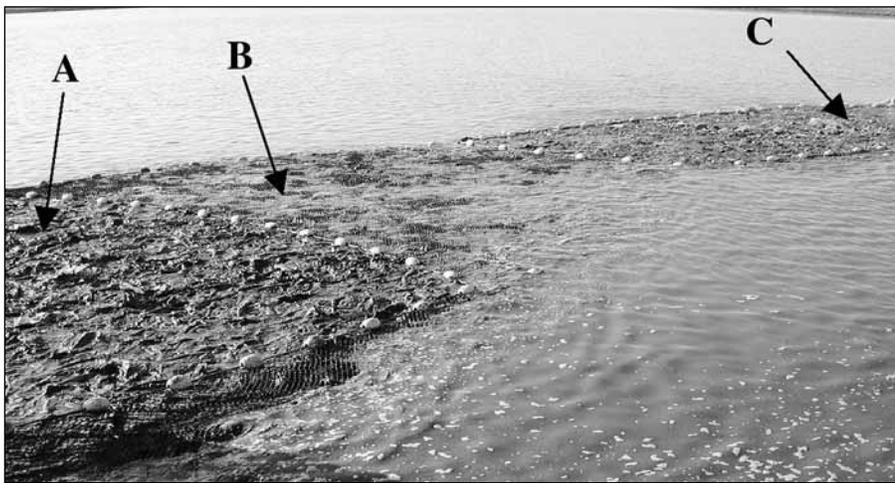


Figure 5. A = Harvest area; B = Funnel area (top covered); C = Front end of live car; note that all areas shown are densely packed with fish.

into the live car. Once all fish are in the live car, it is unfastened from the seine funnel and the zipper closed. Additional live cars can be added if all captured fish can not be safely loaded into a single live car. (Photographs in Figures 15 were taken during a pond harvest using an experimental seine.)

In hot weather, or if the water is shallow and muddy from fish or worker activity, the detached live car can be pulled into clear, deeper water and staked out. At this point, most farmers place a slow-turning, tractor-driven paddle wheel or pump near the live car for aeration; the fish can now be safely held until it is time for them to be loaded onto the live-haul truck for transport to the processor.

Sometimes workers will split a sock for loading when the weather is hot or when the live car is heavily loaded with fish (Fig. 6). When possible, fish are allowed to grade until the majority of fish are the size needed by the processing plant. Moving small fish to the plant is costly to both the producer and processor. The loading process involves crowding the fish to one end of the sock so that a full basket of fish can be captured with each dip (Fig. 7) and swung up above an open tank door on the live haul truck and dumped (Fig. 8). (Photographs in Figures 6-8 were taken during a pond harvest using a conventional seine.)

Live cars are usually 8 to 10 feet wide by 50 to 100 feet long with large floats spaced around the outside top line. Additional floats are placed along the inside edge of a skirt designed to minimize the number of fish escaping over the top of the live car. Live cars come in a variety of mesh sizes so a farmer can choose a mesh size that will hold the size fish needed by the processing plant and at the same time release the smaller fish back into the pond. About 50,000 to 100,000 pounds of catfish can be held in one live car at a fish biomass as high as 20 pounds per cubic foot. The fish may be loaded



Figure 6. A = Live car split for loading; B = Loading basket being inserted in the edge of the live car.



Figure 7. A = Full loading basket being picked up out of the live car.

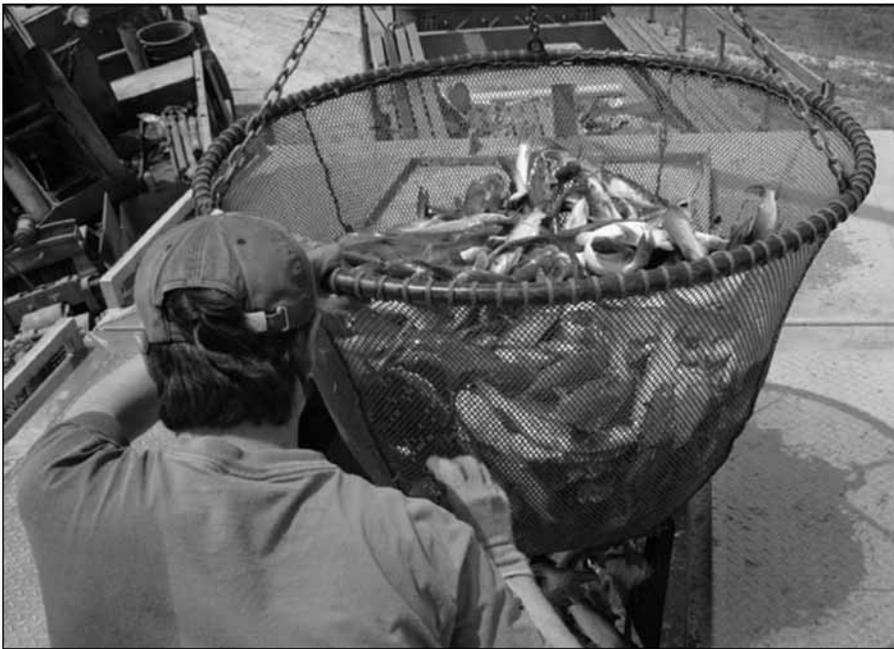


Figure 8. Loading basket being dumped on live-haul truck.

immediately onto the live-haul truck, allowed to grade for a few hours, or held overnight if the processor needs them early the next morning.

Experimental Design and Seine Evaluation

The catfish industry identified the major problems with typical harvesting procedures as inefficient harvesting and improper fish sizing. Our research focused on those

areas. Conventional seining/grading gear was modified based on recommendations from the NMFS' Harvesting System Team. These included: 1) using webbing hung on the bar (square shaped) instead of the point (diamond shaped) to construct the seine and live car; 2) replacing the mesh mud line with a "traveling," semi-buoyant, rubber-roller mud line attached to the lead line with short links of chain; 3) increasing the width and length of the funnel section of the seine; and

4) using marine zippers instead of small metal frames to attach the live car to the seine funnel. Experimental seines were tested in both experimental and commercial catfish ponds. In addition, studies were conducted in tanks and ponds to evaluate the durability and fish grading characteristics of different webbing materials.

Square-meshed webbing

The experimental seine and live cars were constructed of braided, polyethylene, meshed webbing (BPE) hung on the bar (square shaped) instead of the conventional twisted, polyethylene, meshed webbing (TPE) hung on the point (diamond shaped). This bar-hanging technique is used in trawls to release undersized fish. The principle behind the technique is that the force on the webbing as it is pulled through the water is transferred along the bars of the webbing, which maintains a maximum mesh opening. When the webbing is hung on the point, the water force causes the mesh to elongate, reducing the size of the opening.

Tests were conducted in concrete vats and in live cars in ponds to compare the grading characteristics of BTE webbing hung on the bar with TPE webbing hung on the point. In the concrete vat studies, wood grading frames were fitted with webbing of the mesh sizes listed in Table 1. To conduct each test, 100 food-size channel catfish were placed in a 6-foot x 25-foot vat, crowded to within about 6 feet of one end of the vat, and allowed to grade for 1 hour. Efforts were made to keep the size distribution of the 100 fish used in all tests relatively equal. The results of the vat studies are given in Table 1. Live car grading studies conducted in ponds helped determine how many catfish in various size ranges remained in the live car after grading for 6 hours (Table 2). Results of these helped participating farmers compare the grading characteristics of conventional live cars they were accustomed to using with those of the experimental live cars.

Table 1. Effect of mesh size and type on the minimum size of channel catfish retained in live cars.

Mesh type	Mesh size (in)	Size of fish retained (lb)
Conventional (knotted, twisted, diamond)	1 ⁵ / ₈	≥ 0.75
	1 ³ / ₄	≥ 1.00
	1 ⁷ / ₈	≥ 1.25
Experimental (knotted, braided, square)	1 ⁹ / ₁₆	≥ 0.75
	1 ⁵ / ₈	≥ 1.00
	1 ¹¹ / ₁₆	≥ 1.25
	1 ³ / ₄	≥ 1.50

Table 2. Average percentage of various sizes of catfish remaining in experimental live cars of different mesh size after grading for 6 hours.

Mesh size (in)	Size classes (lb) with average percent not graded			
	< ³ / ₄	³ / ₄ to 1	1 to 1 ¹ / ₄	1 ¹ / ₄ to 1 ¹ / ₂
1 ⁹ / ₁₆	6	23	15	11
1 ⁵ / ₈	1	4	19	24
1 ¹¹ / ₁₆	0	0	3	6

“Traveling” mud line

Including a “traveling,” rubber-roller mud line on the experimental seine instead of the bundled, mesh mud line commonly used on conventional seines represents a major change. The purpose of the “traveling” mud line was to improve seining time and catch efficiency by reducing the number of times the pull tractors had to be stopped so the push boat could dump accumulated mud.

The bundled, mesh mud line on a conventional seine is tied directly to the lead line (Fig. 9). The new “traveling,” rubber-roller mud line is attached to the lead line by short sections of chain (Fig. 10). This allows the rubber-roller mud line to move in and out of the mud on the pond bottom without loading the seine with mud. The custom-designed, 4-inch x 8-inch, football-shaped, rubber rollers are slightly buoyant, which helps free them from the mud when they become bogged down. These rollers increase the cost of the seine by about 40 percent.

Enlarged seine funnel and live car

Changes made in the design of the seine funnel and live car to reduce the time required to move fish from the harvest area into the live car, improve live car grading efficiencies, and reduce stress on fish. The funnel section of the

experimental seine was greatly enlarged and a 10-foot marine zipper was installed at the end of the tapered section. A similar zipper was sewn into one end of the live car. When open, both zipper centers are located at the bottom center of the seine funnel and live car, thus aligning them so they can be easily joined to form a 20-foot opening between the seine funnel and live car. Replacing the small metal frame commonly used to attach the seine funnel and live car with matching marine zippers greatly enlarged the opening between the seine and live car by lining up the sides of the seine funnel with the sides of the live car. The zippers can be fastened only if the sock and funnel are aligned correctly, which eliminates the serious problem of workers inadvertently blocking the entry of the live car by twisting the throat of the sock when tying the metal frame on the live car to the seine funnel. This error often goes unnoticed until fish have been severely crowded as the seine and sock are pulled toward the bank.

These changes in the seine-live car system are illustrated in Figures 11-14. Figure 11 shows the small funnel area of a conventional seine attached to the metal frame on a live car. Figure 12 shows the large funnel area of an experimental



Figure 9. Bundled mesh mud line.

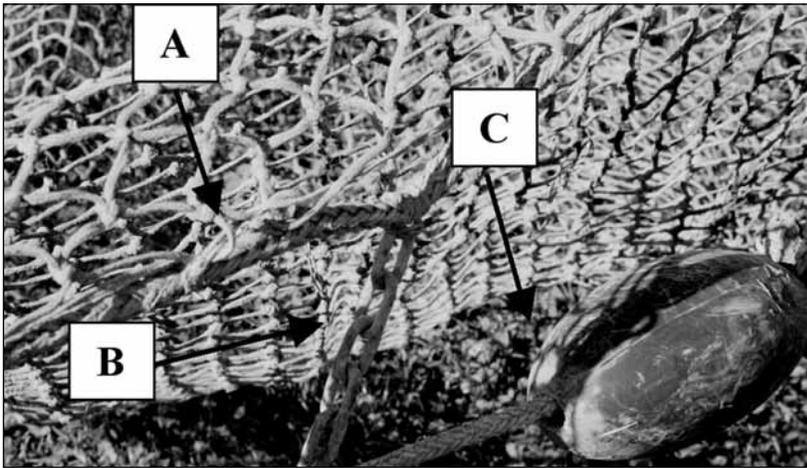


Figure 10. Traveling rubber-roller mud line system. A = lead line; B = one chain link; C = rubber-roller mud line.

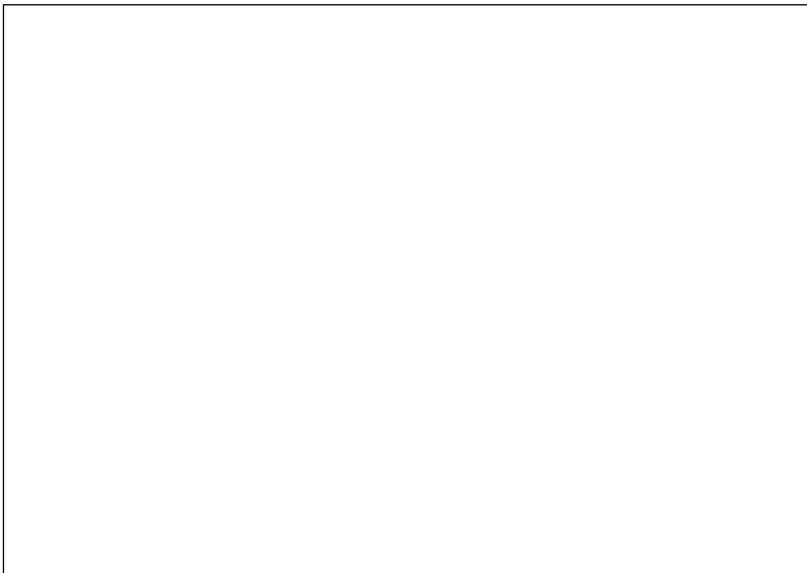


Figure 11. Conventional seine and live car attached using a small metal frame. A = small seine funnel; B = small metal frame; C = live car.



Figure 12. A = live car and sein funnel zipped together (dark area); B = piled up live car; C = seine funnel.

seine attached to the matching zipper on the wide-throated live car. Figure 13 shows a close-up of a live car zipper zipped to the seine funnel zipper. Figure 14 illustrates the differences in the sizes of the openings produced by a metal frame (A) and a marine zipper (B). The experimental seine is usually pulled with the seine funnel closed. Closing the seine funnel involves closing the zipper in the back and hooking the matching sides of the brummel hooks sewn across the width of the top and bottom of the front of the seine funnel. A closed seine funnel with hooked brummel hooks is shown in Figure 15. Brummel hooks are exceptionally strong and are rarely opened accidentally. A close-up of a closed brummel hook is shown in Figure 16. Both sections of the hook have slots that can be aligned to separate them. While not a common practice, the seine can be pulled with the live car attached to the seine funnel and the brummel hooks unhooked. This allows fish to load into the live car as the pond is seined. However, the bottom of the seine and sock are more likely to catch mud because of the additional weight and drag caused by the sock and loaded fish.

Harvest efficiency studies

Studies compared the harvest efficiency of a conventional and an experimental seine. Two empty 7-acre ponds were stocked with a known weight of food-size fish. Over a period of weeks, each pond was seined seven times using either a conventional or an experimental seine (1 ⁵/₈-inch mesh). The type of seine used in a pond alternated after each seining. The original fish were used multiple times following an acclimation period. The parameters measured during each seining were mean seining time, mean live car attachment time, number of laborers needed to attach the live car, and mean seining efficiency (Table 3). The seining efficiency (percent caught) was determined by dividing the pounds of fish caught in a single

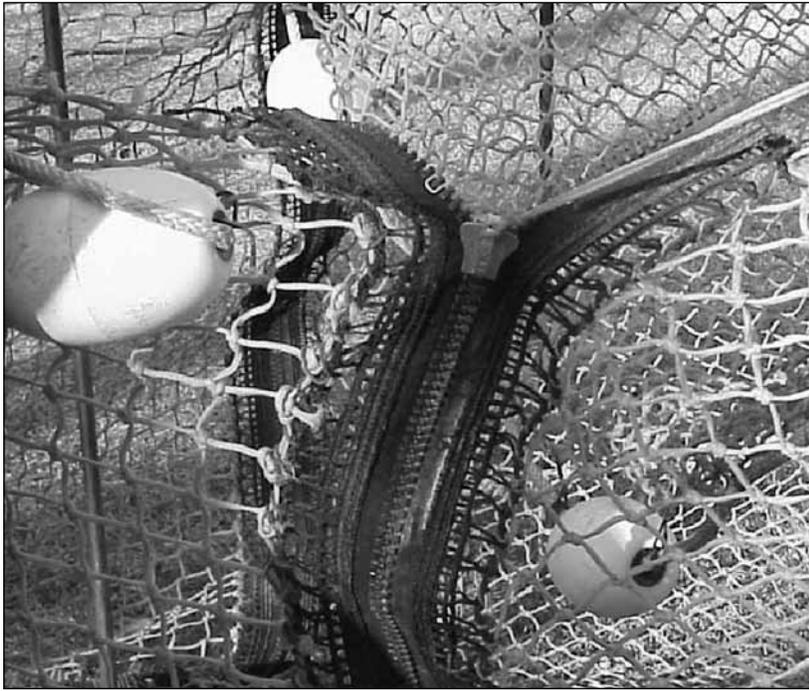


Figure 13. A close-up of a live car and seine funnel zipped together with a pair of marine zippers.

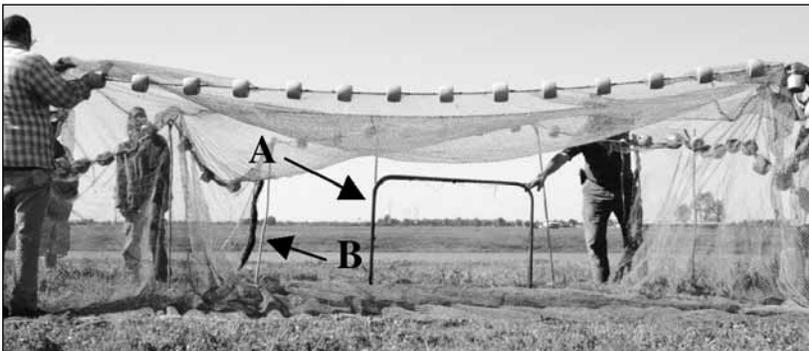


Figure 14. A = old style metal frame used to join live car and seine funnel; B = open zipper in new still seine funnel. Notice the size of the opening in the back of the new style funnel compared to the metal frame.



Figure 15. A number of fastened brummel hooks attaching the top and bottom of the seine funnel (keeps most fish out of the seine funnel during seining).

seining by the total pounds stocked. Using the experimental seine improved harvest efficiency, required fewer workers to attach the live car, and reduced seining time by reducing the number of times the pull tractor had to be stopped so accumulated mud could be dumped.

The efficiency of the experimental seine also was evaluated in a study at the National Warmwater Aquaculture Center. It was used for the routine harvest of ten research ponds (4- or 10-acre) that were being totally harvested at the end of a study (ponds contained a single year class of fish). Each pond was seined once and the pounds of fish caught was recorded. Subsequently, each pond was drained and the remaining fish in each pond were picked up by hand and weighed. On average, the experimental seine caught 94 percent of the fish in each pond.

Field trials

Several experimental seines and live cars were constructed and tested in commercial and research catfish ponds. The experimental seine was used by several farmers for extended times and they evaluated its performance under commercial harvesting conditions. The experimental seine features farmers liked most were the enlarged seine funnel and the use of marine zippers instead of a small metal frame to attach the live car to the seine funnel. All farmers who tested the seine were very positive about these modifications.

The most disliked experimental seine feature was the "traveling" mud-roller system, even though most farmers agreed that it greatly reduced the number of times a push boat had to dump mud from the seine. There were some minor objections to the new mud line technology, but cost was the major factor farmers thought would limit its adoption by the industry. Adding this technology to a seine increases its cost by about 40 percent.



Figure 16. A = Closed brummel hook.

Table 3. Harvest efficiency data: CTPE = conventional seine with twisted polyethylene webbing; EBPE = experimental seine with braided polyethylene webbing.

Seine type				
Parameters	CTPE	EBPE	CTPE	EBPE
	Year 1		Year 2	
Mean seining time (min)	90	60	152	76
Mean live car attachment time (min)	11	5	10	6
Laborers needed to attach sock	2	1	2	1
Mean catch efficiency (% caught in one seining)	69	83	55	63

Conclusion

Catfish producers who participated in this project generally liked the large floats with grommets, the enlarged seine funnel, the marine zippers for attaching the live car and seine funnel, and a conventional rolled, mesh mud line. The most disliked component of the experimental seine was the "traveling" mud roller system. Some producers and commercial harvesters thought fish could escape through the space between the lead line and mud roller line. Other issues were the perceived difficulty of handling the mud roller system when getting around aerators and the dislike of riding the "traveling" mud roller line commonly expressed by mud line riders. Even

so, there was general agreement that in certain pond types where mudding is a problem the "traveling" mud roller system did have merit. They thought the primary advantages of the experimental seine and live car were: 1) ponds could be seined more quickly with less pushing needed to dump mud; 2) fish transitioned into the live car more easily and appeared to be in better condition; 3) fish graded out of the live car faster; 4) little if any aeration was needed when loading the live car; and 5) the braided, polyethylene webbing appeared to be much more durable.

This project has stimulated a major change in the harvest technologies used in the catfish indus-

try. One large net manufacturer now puts large funnels and marine zippers in 80 to 90 percent of the new seines and live cars built and has installed 400 to 500 marine zippers in existing seines and live cars since 2004. Most seines and live cars continue to be built with knotted, twisted, polyethylene webbing hung on the point (diamond shaped) instead of the braided, polyethylene webbing hung on the bar (square shaped) used in the experimental equipment. Seines with mesh hung on the point (diamond shaped) are easier to repair in the field because the meshes next to damaged areas can usually be sewn together quickly without reducing the effectiveness of the seine. Rips and holes in square-mesh seines must be fixed by cutting out the damaged area and sewing in correctly cut patches. This is time consuming and requires more skill. Higher cost, weight and perceived usability issues limited the acceptance of the "traveling," rubber-roller mud line technology. Consequently, most seines built today use the bundled mesh mud line. Many producers and custom seining crews now cover the back halves of their live cars with webbing to prevent rapidly loading fish from sinking the live car and escaping.

Materials sources and net builders

Experienced net builders can take the information given in Figures 17-20 and build a 9-foot-deep, 1 3/4-inch mesh experimental seine and live car. They will also be able to construct seines of different depths and mesh sizes and live cars of different lengths and mesh sizes by modifying these specifications.

Sources

Netting:

Ultra Services
P.O. Box 80504
Lafayette, LA 70598-0504
Phone: (337) 237-6596

Brummel hooks:
 Donovan Marine
 P.O. Box 19100
 New Orleans, LA 70179

Marine Zippers:
 YKK USA, Inc.
 Midwest Division
 232 Shadow Wood Court
 Loveland, OH 45140

Floats:
 Delta Net & Twine Co. Inc.
 3148 Highway 1 South
 Greenville MS 38701

Rubber mud rollers:
 National Warmwater Aquaculture
 Center
 Mississippi State University
 P.O. Box 197
 Stoneville, MS 38776-0197

Experienced Net Builders

S & S Trawl
 P.O. Box 789
 Supply, NC 28462

Delta Net & Twine Co. Inc.
 3148 Highway 1 South
 Greenville MS 38701

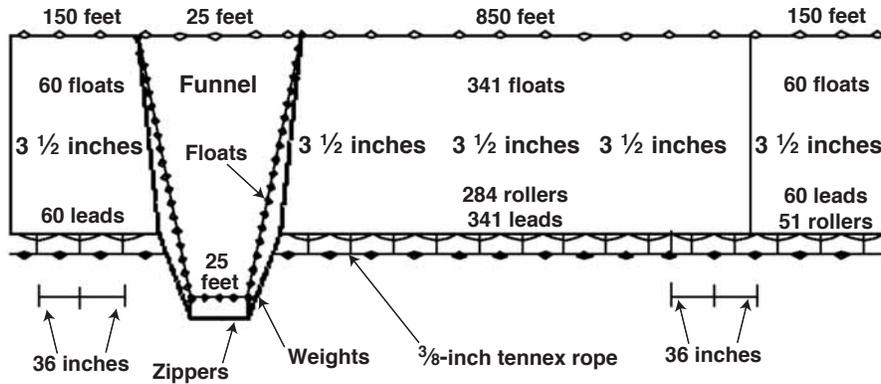


Figure 17. Construction diagram and specifications for making a 9-foot-deep experimental seine.

Webbing:	3 1/2-inch (= 1/2-inch mesh) x 3mm PE; 45 1/2 inches deep
Hanging:	3 meshes on 7 1/2 inches
Hanging ratio:	3 1/2 webbing on square 71%
Float line:	constructed of 3/8-inch tennex rope; 15-foot leg (bare rope) on each side
Float type:	White OS4SC (Spongex Manufacturing Co. product number) float with grommet
Float spacing:	30 inches apart
Lead line:	constructed of 1/2-inch polytron rope
Lead type:	2-ounce center hole
Lead spacing:	30 inches apart
Mud line:	constructed of 3/8-inch tennex rope; 15-foot leg (bare rope) on each side
Mud roller type:	4- x 8-inch football shape
Mud line drops:	5 links of 3/16-inch galvanized chain
Mud line drop spacing:	36 inches
Funnel:	25- x 25-feet with zipper
Zippers:	VFOR-151 (YKK Manufacturing Co. product number), 3-meter marine zipper with big teeth and stainless steel slides

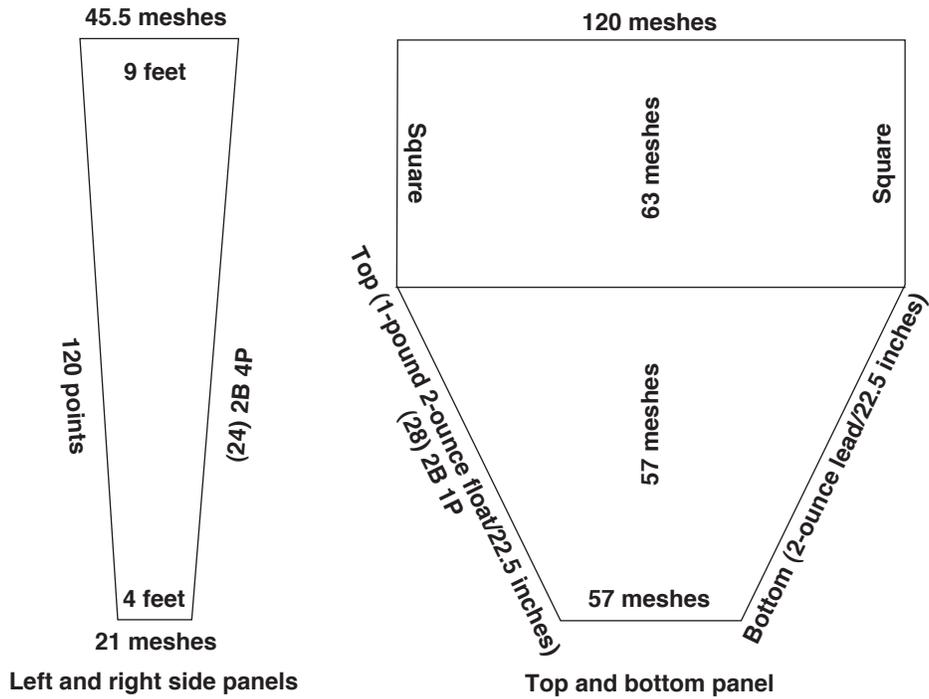


Figure 18. Design pattern for making the funnel section of a 9-foot-deep experimental seine.

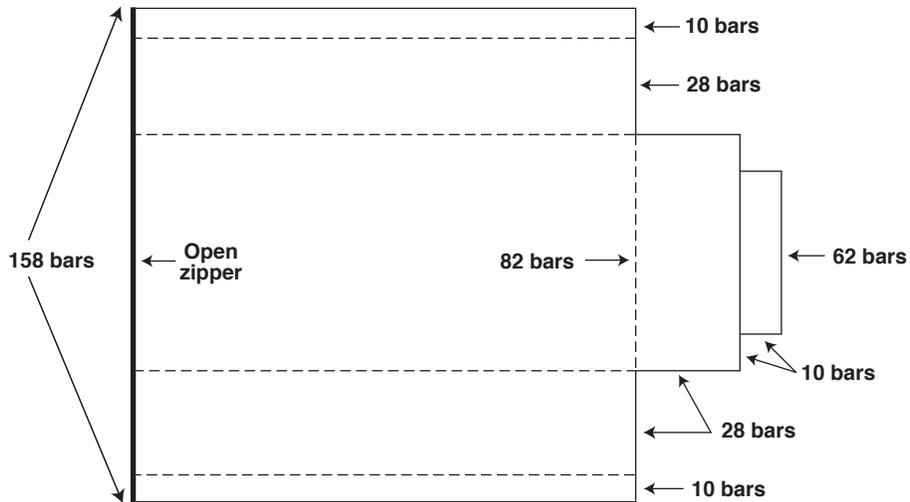


Figure 19. Design pattern for making a live car (75-foot, 1 1/2-mesh).

Hanging:	4 bars on 6 1/2 inches
Floats:	1 float every 3rd tie on the inside and outside float line
Float type:	White K4SC float with a grommet
Zipper:	YKK#10 with big teeth and stainless steel slides; 9.84 feet (3 m) long
Leads:	2-ounce lead every 18 squares as needed on the bottom of the live car

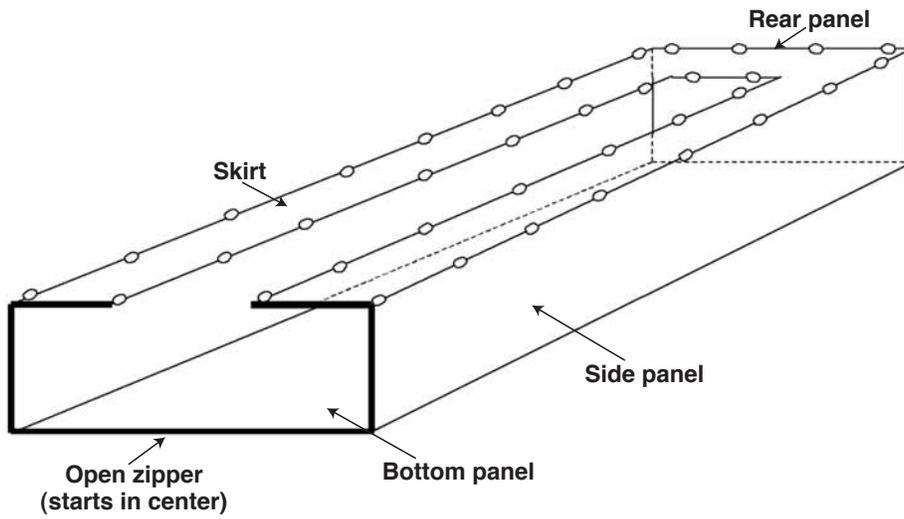


Figure 20. Stylized three-dimensional drawing of a typical live car with a zipper in one end for attaching the live car to the seine funnel.

Acknowledgments:

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