

# Skimmers: Their Development and Use in Coastal Louisiana

STEPHEN HEIN and PAUL MEIER

## Introduction

The development of new and more efficient methods for harvesting seafood has been a part of the Louisiana fishing industry for many years. Louisiana fishermen, as some of the Nation's leaders of seafood production, have been the source of innovative ideas for the development and improvement of fishing gear for generations. Seines, originally adopted from France and other parts of

Stephen Hein and Paul Meier are with the Louisiana Department of Wildlife and Fisheries, P.O. Box 189, Bourg, LA 70343. Views or opinions expressed or implied are those of the authors and do not necessarily reflect the position of the National Marine Fisheries Service, NOAA.

*ABSTRACT—The origin, development, and utilization of the skimmer net is reviewed along with other historical shrimp gears used in coastal Louisiana. The skimmer was developed to catch white shrimp, *Penaeus setiferus*, observed jumping over the cork line (headrope) of trawls being worked in shallow waters. A description of the gear is presented including basic components and various frame designs used by fishermen during its development. The advantages of skimmers over bottom trawls include: multiple use as both trawl and butterfly net (wing net), ease of deployment, increased maneuverability, reduction and greater survivability of bycatch, and ability to cover more area due to increased speed and continuous fishing capability. Disadvantages may include compromising vessel stability when stored upright on the deck, possible damage to water bottoms when improperly rigged, and limitation to a 12-foot (3.6 m) maximum depth due to size restrictions. The growing popularity of the skimmer net is evident by its introduction into North Carolina and inquiries from other southeastern Atlantic and Gulf coast states.*

Europe, were used in the early 1800's to harvest shrimp in Lake Pontchartrain; by 1878, seines and cast nets were the primary methods of shrimp harvest (Wurzlow, 1985).

By 1915–17, availability of gasoline engines, introduction of the otter trawl, and the advent of shrimp drying led to a greatly expanded market and shrimp fishery in Louisiana (Viosca, 1957). In addition, beam trawls, plumb-staff beam trawls, bib trawls, and many variations of them were employed by fishermen throughout the years, and in certain areas some are still in use.

Boats and trawls increased in size during the 1940's, and by the 1950's double-rig trawls were adopted. In the late 1950's, twin trawls were being experimented with in Louisiana and Texas. By the early 1970's, they were becoming more efficient and popular.

Butterfly nets (wing nets or "paupiers") were introduced in the 1950's and used on stationary platforms and on shrimp boats either under power or while anchored. A butterfly net consists of a square metal frame which forms the mouth of the net. Webbing is attached to the frame and tapers back to a cod end. The net can be fished from a stationary platform or a pair of nets can be attached to either side of a vessel. The vessel is then anchored in tidal current or the nets are "pushed" through the water by the vessel.

Vietnamese fishermen began moving into Louisiana in the early 1980's and introduced a gear called the "xipe" or "chopstick" net around 1983. The chopstick was attached to a rigid or flexible frame similar to the butterfly net; however, the frame mounted on the bow of

the boat was attached to a pair of skids and fished by pushing the net along the bottom. As with butterfly nets, the contents of the net could be picked up and dumped without raising the entire net out of the water as is necessary with an otter trawl (Perret and Bowman, 1992). The chopstick beam trawl was designated an illegal gear for fishing in both inshore and offshore waters of Louisiana in 1984.

## Development and Application

The latest gear to be developed and utilized in coastal Louisiana is the "skimmer" or "bay sweeper." This gear was developed around 1983 after much experimentation by shrimpers from the Barataria, La., area, including Will Rojas who helped pioneer the technique (Fritchey, 1989). Rojas and others who first used skimmer nets indicated that the primary reason for the development of the net was to catch the white shrimp, *Penaeus setiferus*, they observed jumping over the cork line as their trawls were being towed in shallow water. The skimmer net frame allows the net to be elevated above the water while the net is fishing, thus preventing shrimp from escaping over the top.

Rojas developed the idea from his son who had worked with other shrimpers using an earlier version of a similar gear used to catch shrimp in the shallow waters along the beach at Grand Isle, La. (Rojas<sup>1</sup>). Other fishermen report that this gear was developed from variations of the butterfly and chopstick nets;

<sup>1</sup> Rojas, W. 1994. Commercial shrimper, P.O. Box 433, Venice, LA 70091. Personal commun.

an early design consisted of trawls on frames with boards to open the net and a wheel in place of the skid (shoe) to roll along the hard sand bottom. Rojas indicated that many shrimpers were not convinced of the effectiveness of skimmer nets until some Vietnamese fishermen in Barataria, Empire, and Buras, La., successfully employed variations of his design after the chopstick nets were declared illegal. Owing to increased shrimp catch rates, less debris or bycatch, and lower fuel consumption experienced by commercial fishermen, use of skimmer nets quickly spread to other Louisiana areas.

Initially this gear was used by fishermen in Jefferson and western Plaquemine Parishes from 1983 through 1987. Use of this gear spread west into the communities of Dulac and Theriot in Terrebonne Parish around 1988. Increased use of skimmers then moved easterly to Lafourche Parish by 1990, to eastern Plaquemine Parish around Point a la Hache by 1990–91, then to St. Bernard Parish (Fig. 1). By 1992–93 widespread adoption of skimmer nets occurred in all of these parishes in southeastern Louisiana as reflected by skimmer license sales; also licenses were sold as far north as Ouachita and Franklin Parishes (Fig. 2, 3). Recently, use of this gear has been reported from North Carolina (Hines et al., 1993).

According to Louisiana Department of Wildlife and Fisheries interviews with shrimp fishermen and wholesale shrimp dealers, skimmer nets were outcatching trawls 3:1 in western Terrebonne Parish in the fall of 1988 (unpubl. data<sup>2</sup>). During this period shrimp appeared more active at night and remained buried during daylight hours. Skimmer nets were easier to maneuver between the numerous crab traps, while trawlers were generally limited to only daylight hours when they could more easily avoid crab traps to prevent them from fouling in the trawls and boat propellers. Due to efficient maneuverability and the capability of following shoreline contours, as opposed to

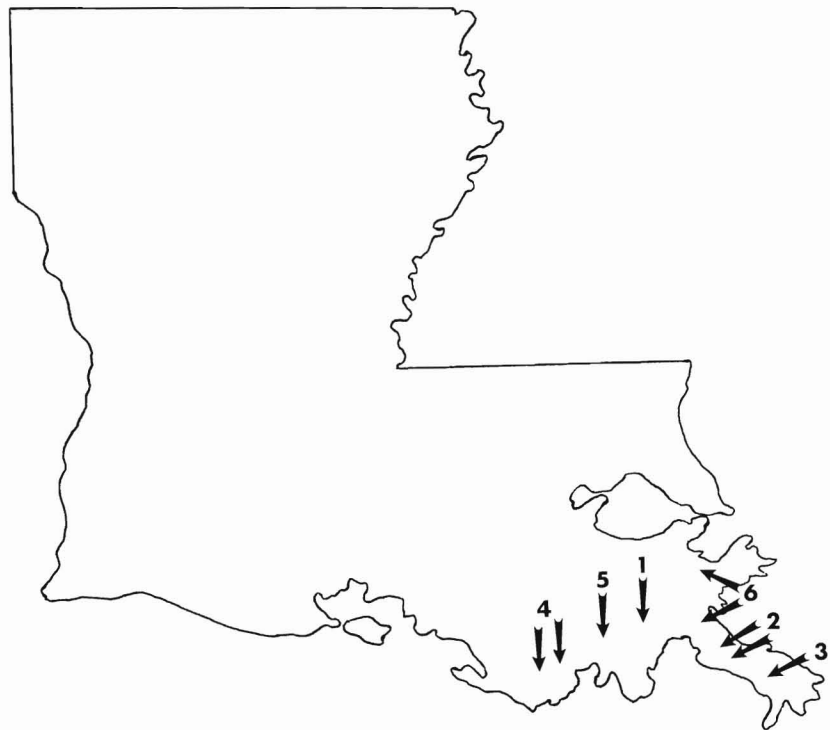


Figure 1. — Approximate dates, communities, and parishes where skimmers first began to be fished: 1 = Lafitte, 1983; 2 = Empire and Buras, 1984–85; 3 = Venice, 1987; 4 = Theriot and Dulac, 1988; 5 = Bayou Lafourche (Cut Off), 1990; and 6 = Point a la Hache (eastern Plaquemine Parish) and St. Bernard Parish, 1990–91.

the zig-zag method employed by single rig otter trawl fishermen to keep the net out of the vessel's prop wash, skimmers are more effective in small shallow ponds. Because skimmers are pushed, rather than pulled, prop wash is not a factor.

Initially, skimmer nets were licensed as butterfly nets. In 1989, the Louisiana legislature made an unsuccessful attempt to ban skimmer nets via House Bill 669. This bill defined skimmer nets and would have prohibited their use. The introduction of the bill, the controversy surrounding the use of skimmer nets as an undefined gear, the perception that water bottoms were destroyed or altered by the bullet weights and skids, and the belief that this gear allowed excessive harvest of small shrimp discouraged many fishermen from investing in skimmers. The future of the gear was uncertain owing to the general perception that it would go the way of the chopstick net and be declared an illegal gear.

In September 1991, however, the Louisiana Legislature in House Bill 533 legalized skimmer nets and defined them as "a net attached on two sides to a triangular frame and suspended from or attached to the sides of a boat, with one corner attached to the side of the boat and one corner resting on the water bottom. A ski and one end of the lead line are attached to the corner of the frame that rests on the water bottom and the other end of the lead line attached to a weight which is suspended from the bow of the boat."

House Bill 403 of the 1993 Louisiana legislative session further prohibited the tying of individual skimmer nets together to exceed existing specifications and also prevented the use of any trawl in conjunction with a butterfly or skimmer net. Also, such nets were not supposed to impede or restrict normal navigation.

Since the legalization of skimmers in 1991 and the beginning of license sales

<sup>2</sup> Unpubl. data, 1988, from weekly shrimp reports on file with the La. Dep. Wildl. Fish., P.O. Box 189, Bourg, LA 70343.

by 1992, the number of skimmer licenses has increased while butterfly net and trawl licenses have decreased (Table 1). After Hurricane Andrew swept across coastal Louisiana in August of 1992, many butterfly net platforms and some trawl boats were simply abandoned rather than repaired. These and other circumstances, combined with the fact that many fishermen continue to convert to skimmers, has resulted in fewer sales of butterfly net and trawl licenses (Table 1).

**Table 1.—Louisiana resident and nonresident commercial gear licenses sold. These do not represent numbers of licensed fishermen since most fishermen fish more than one net and must have a license for each net. Source: LDWF License Section.**

Year and type	Skimmer	Butterfly net	Shrimp trawl
<b>Resident</b>			
1991	0	7,982	14,949
1992	3,748	4,746	13,866
1993	4,583	3,809	11,349
<b>Nonresident</b>			
1991	0	48	3,757
1992	42	32	3,454
1993	56	24	3,216

The introduction of the skimmer has had a major impact on the shrimp fishery in Louisiana. A series of public meetings along the Louisiana coast were sponsored by the Governor's Task Force on Shrimp Management during March 1994. Results of a questionnaire distributed during those meetings indicated that the skimmer was the second most common shrimping gear (29%) following the otter trawl (56%), which remains the primary gear. About 84% of the fishermen who use skimmers believe they should remain a legal gear, and of all respondents, regardless of their primary gear, 52% agreed skimmers should remain legal, 43% indicated they should be illegal, and 5% had no opinion. Most skimmer fishermen surveyed (97%) work inshore waters and 71% use vessels of 26–44 feet (7.8–13.2 m) in length, suggesting its primary use is in shallow water areas by the small to medium vessel fleet (unpubl. data<sup>3</sup>).

<sup>3</sup> Unpubl. data, 1994, from questionnaires by the Louisiana Governor's Task Force on Shrimp Management on file with the La. Dep. Wildl. Fish., P.O. Box 98000, Baton Rouge, LA 70898.



Figure 2. — Resident skimmer net gear licenses sold for 1992 (total = 3,748). Normally only two gear licenses are sold per fisherman.



Figure 3. — Resident skimmer net gear licenses sold for 1993 (total = 4,583). Normally only two gear licenses are sold per fisherman.

### Gear Description

Of all current legal gears, skimmers most closely resemble butterfly nets. Both gears are "pushed" alongside the vessel, always fished in pairs (except stationary butterfly nets) on the sides of the vessel, held open by some form of metal framework, deployed and retrieved in a similar manner, fished continuously with little or no interruption in fishing time, and subjected to similar legal restrictive measures in mesh size and net dimensions. The gears differ in frame design, the necessity of

some form of weight to spread the skimmer net open, a "tickler" chain and lead line on the bottom of the skimmer, and the need of a skid or "shoe" for the skimmer's outer leg to allow operation along the water bottom. The skid is an optional feature on the butterfly net since it is not normally fished along the bottom.

To effectively handle the gear, the vessel must possess some style of A-frame or superstructure to which the net frames are secured, generally in the vessel's forward one-third to one-half (Fig. 4). A short shaft capable of swiv-

eling up and down is located at the base of the A-frame onto which the net frames slide and are secured by a bolt or pin. Net frames are raised and lowered by winches and pulleys and folded against the vessel fore or aft for transit.

The basic components of the skimmer gear include net frames, nets, heavy weights, skids or "shoes," winches, and tickler chains. The net frame is usually constructed of schedule 80 steel or aluminum pipe or tubing and is either L-shaped (with an additional stiff leg) or a trapezoid design as one of the original skimmer frames was constructed

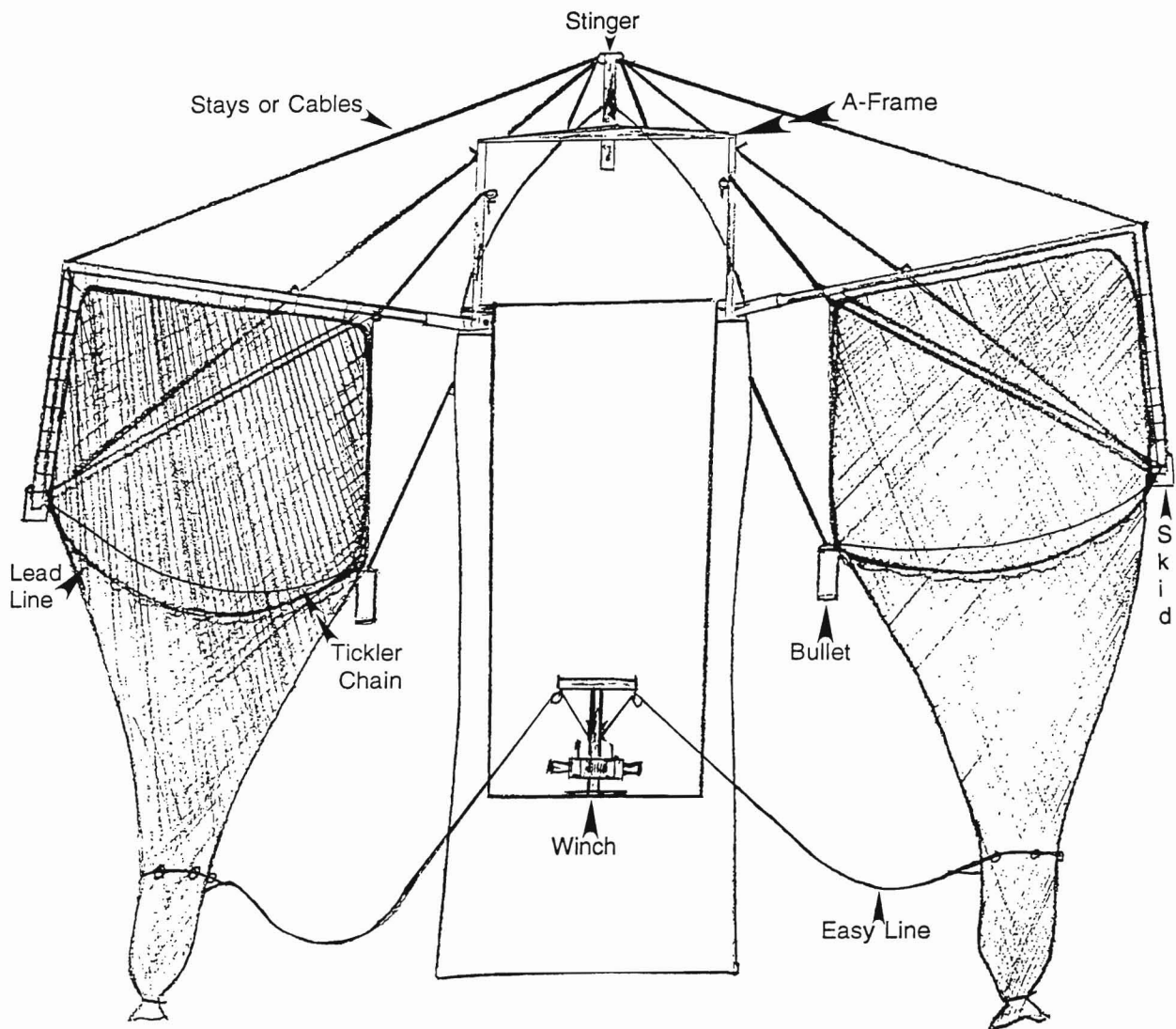


Figure 4. — Illustration of skimmer nets deployed on a vessel.

(Fig. 5). The upper portion of the net frame accounts for the distance from the water to the freeboard of the vessel (Fig. 6). When net frames are deployed or "working," they are aligned perpendicularly to the vessel and cocked or tilted forward and slightly upward. This position allows the net to fish better and reduces the chance of the leading edge of the skid digging into the bottom and subsequently damaging the gear. The frames are maintained in this position by two or more stays or cables to the bow. The horizontal portion of the frame includes a 24-inch (61 cm) maximum legal allowable clearance from the side of the vessel plus the 16-foot (4.8 m) maximum legal allowable width of the net (Fig. 6). The outer leg of the frame is held in position with a "stiff leg" to the horizontal pipe and determines the maximum legal depth (12-feet [3.6 m] allowed) at which each net is capable of working (Fig. 6). To the bottom of the outer leg is attached the skid or "shoe" which allows the frame to ride along the bottom, rising and falling with the bottom contour. Before skimmers were legally defined to require a 90° angle on the 16 × 12-foot (4.8 × 3.6 m) frame, early rigs had a "kickout" which

was an angled portion of the frame on the outside corner, extending the width of the net allowing it to fish more water and also to flex more easily when the net came into contact with steep bayou banks.

Skids differ greatly in design and size according to area fished, vessel and frame size, and fisherman preference, although aluminum plate is most often used. The general design is flat or U-shaped with an upturned leading edge. The most frequent skid sizes encountered were 3 feet × 18 inches (0.9 m × 45.7 cm) and 3½ feet × 24 inches (1.1 m × 61 cm), though smaller and larger ones were noted. One end of the tickler chain and net is usually attached to the skid although variations of this method do exist.

Earlier forms of skimmer frames had an inside leg which was shorter than the outer leg, thus allowing the frames to be raised and lowered in shallow water without bending or burying the inside leg in the bottom sediments (Fig. 5). The inside leg has been largely replaced by a heavy weight to which the other ends of the tickler chain and bottom of the net are attached. Depending upon geographical location the weight is referred

to by fishermen as a "bullet," "dummy," or "torpedo." The primary purpose of the bullet is to help spread the net vertically and horizontally. Attempts to replace the bullet with skids, dummy doors, and trawl boards have proven largely unsuccessful, and the bullet remains the primary device used.

The amount of weight used varies with vessel size, engine horsepower, bottom type, mesh, and net size. While weight can range upwards to 400 pounds (180 kg), 90–200 pounds (40.5–90 kg) are most commonly encountered. Bullets are generally constructed from a length of round pipe filled with cement and beveled upward (ski-like) on the leading edge. Some fishermen have replaced the pipe with a flat steel plate but have retained the beveled leading edge. Pipe diameter and length, as well as plate size and number, vary considerably.

The weights are deployed and retrieved with winches using cable or rope. They are commonly tethered to the bow near the waterline or in some situations to a "stinger" or bow extension. When set, the heel of the bullet is in the same vertical plane as the frame and slightly forward of the net, reducing the tendency to burrow.

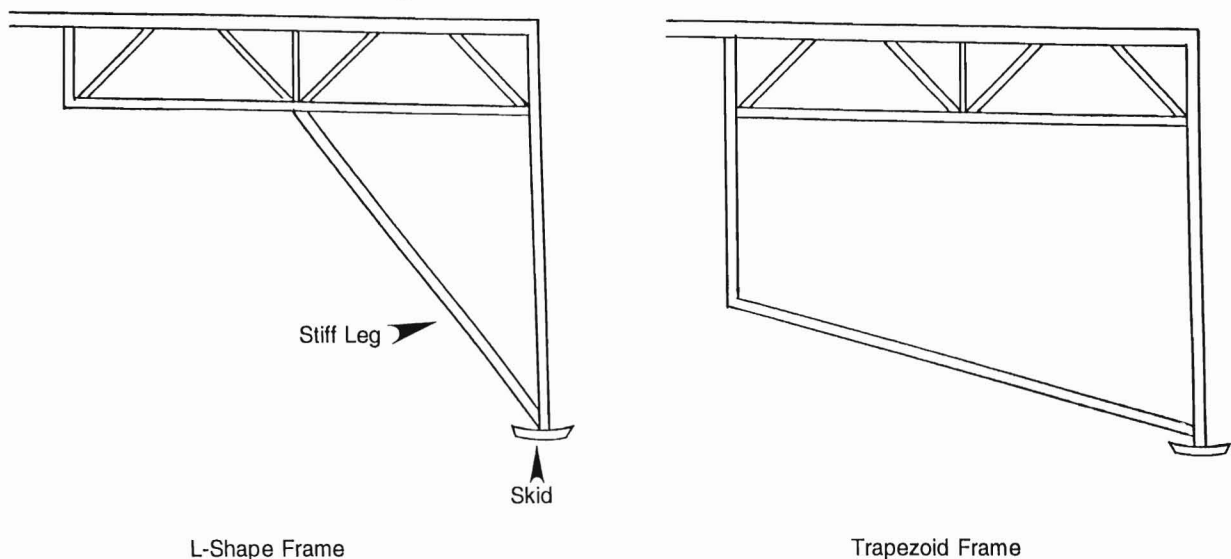


Figure 5. — Basic skimmer net frame designs.



Tickler chains and lead lines comprise the bottom of this gear. The lead line cannot exceed 28 feet (8.5 m). The chain is commonly  $\frac{1}{8}$  or  $\frac{3}{16}$  inch (0.3 or 0.5 cm) but may be  $\frac{1}{4}$  inch (0.6 cm) or more for larger vessels; lighter chains are used on soft or muddy substrates and heavier chains on hard or sandy bottoms. Depending on areas fished and fishermen preference, the chain is usually set 12–18 inches (30.5–45.7 cm) shorter than the lead line so that it rides slightly ahead of the net. The chain is set closer to the lead line for white shrimp than for brown shrimp, *Penaeus aztecus*. Lead lines resemble those of trawls and may contain additional “loop” chains or mud rollers (depending upon area fished). Some boats use a “four point” attachment method to secure the webbing to the frame, where only the four corners of the net are attached to the corners of the frame and to the bullet weight, allowing the net to

fish several feet behind the frame. The farther back the net is set the closer it remains to the bottom and the better it will fish in deep water. The webbing may also be attached directly to the frame.

Nets are usually constructed of traditional knotted nylon webbing. Knotted and knotless polyethylene have recently gained attention and are believed to be stronger, perform more efficiently, and reduce fuel consumption and bycatch (Fritchey, 1989). Net type consists of a two- or four-seam design and contains various amounts of “setback” similar to conventional trawls. The two-seam nets are more easily built and somewhat cheaper in cost but have a tendency to “pocket” the catch and restrict its path to the cod end. Adjustments in design often offset this tendency.

Net patterns, preference of mesh, twine size, hanging, and length are diverse. A generic net would be about 350 meshes long, have a 120- 170 mesh cod

end, and consist of  $1\frac{1}{2}$  to  $1\frac{3}{4}$  inch (3.8–4.5 cm) mesh of number nine twine for the first 100 meshes,  $1\frac{3}{8}$  to  $1\frac{1}{2}$  inch (3.5–3.8 cm) mesh of number seven twine for the next 200–250 meshes and  $1\frac{1}{4}$  to  $1\frac{3}{8}$  inch (3.2–3.5 cm) mesh of number fifteen twine for the cod end. The stronger twine in the mouth of the net reduces the chance of tearing from the constant strain on this portion of the net.

There is usually more webbing in the skimmer net than in a standard trawl, allowing the fisherman to pick up the tail of the skimmer and dump his catch while most of the net remains in the water and continues to fish. Also, the lead line is prevented from rising off the bottom and allowing shrimp to escape underneath. According to Bobby Boudreaux<sup>4</sup>, there is normally about 40

<sup>4</sup> Boudreaux, R. 1994. Net maker, 105 Rogers Street, Lafitte, LA 70067. Personal commun.

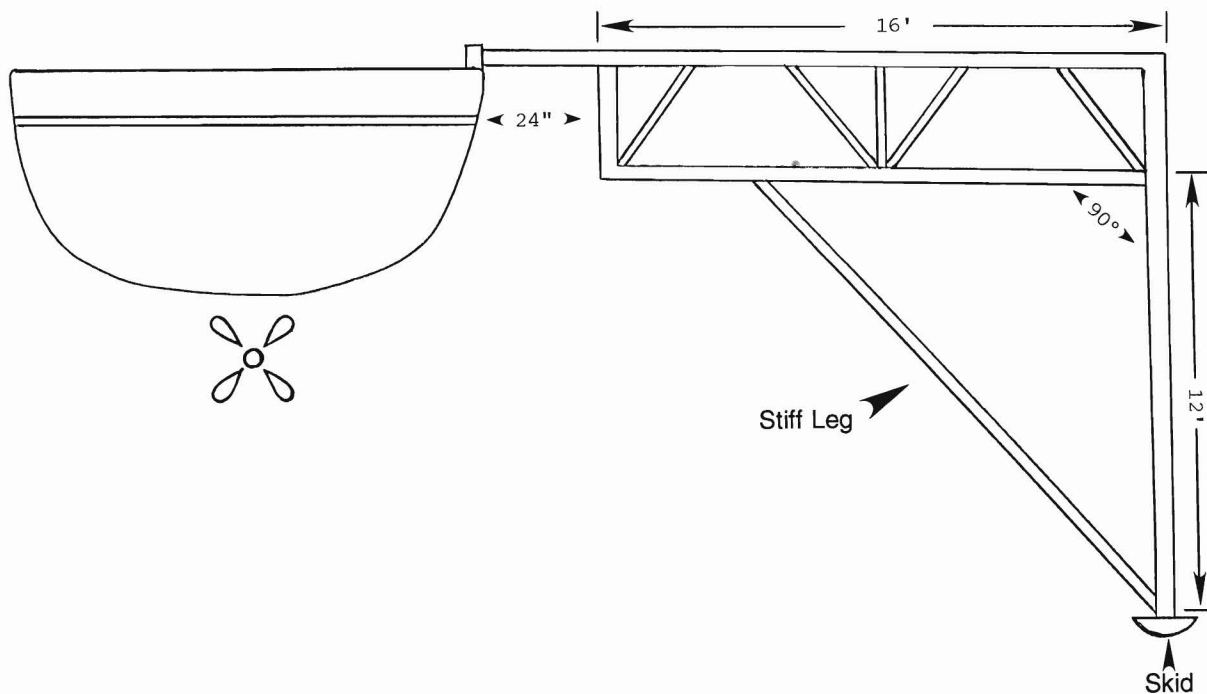


Figure 6. — The horizontal frame must have a maximum allowable distance of 24 inches (61 cm) from the side of the vessel according to Louisiana law.

pounds (18 kg) of number seven webbing of 1½ inch (3.8 cm) mesh in a set of 16 × 12-foot (4.8 × 3.6 m) skimmer nets while there is about .25 pounds (11.3 kg) of number seven webbing of 1½ inch (3.8 cm) mesh in a 50-foot (15 m) trawl.

An easy line, or lazy line, encircles the cod end through a series of rings sewn onto it. The rope typically is run through a pulley or block on the vessels' rigging and raised via a winch (electric, hand, or hydraulic). A recent feature is a 5-foot (1.5 m) nylon zipper sewn onto the top of each net just ahead of the cod end allowing fishermen to more easily remove bulky or unwanted items from their nets. Different types of fish excluder devices are used by some fishermen to reduce bycatch.

### Operation

While skimmers are pushed alongside the vessel, the otter trawl is towed at various distances behind the vessel using a pair of boards to spread the net. Single rig trawls are towed so as to maximize net spread while keeping them out of the prop wash, generally in a zig-zag or semi-circular pattern. By contrast, the opening of the skimmer net is always in front of the vessel's prop wash.

Trawls are deployed overboard followed by the tickler chain and a set of doors. Water resistance forces the doors to spread and open the webbing. Care is taken to avoid tangles and flipped boards. Tow lines are then payed out until the desired length is achieved. This process is reversed to retrieve the gear and results in some loss of actual fishing time, plus additional labor.

Skimmers are deployed by lowering the frames and bullets to the desired fishing depth and releasing the tickler chain and webbing overboard. Only the cod ends are retrieved to maximize fishing effort.

Both otter trawls and skimmers can be legally fished in daylight or darkness. Although versatile, each gear is restricted by its design and method of operation. Fishermen representing each staunchly defend their gear, although skimmers appear to have many advantages over traditional otter trawls including:

1) They can replace the need for multiple fishing gears, can be used instead of the trawl, and are capable of being used as butterfly nets by adding weight to the bullet.

2) They eliminate the need for a "test" net. The gear itself is deployed and cod ends are checked for catch. If dissatisfied with the results, the fisherman then raises the rig and travels to a different area. This gives the fleet more mobility and efficiency.

3) The gear continues to fish while cod ends are emptied. This gives additional fishing time and reduces work involved in retrieving the entire rig.

4) Cod ends can be checked more easily and more often so that the catch is dumped much more often. This results in a reduction in bycatch (Hines et al., 1993) and may eliminate the need of "salt" boxes.

5) Better survivability of nontarget organisms is achieved. Fish, crabs, and other animals are not dragged around and packed in heavy concentrations for long periods. Since return to the water occurs behind the openings of the nets, chances of bycatch recapture are reduced.

6) Higher quality shrimp are produced. Frequent dumping of the catch prevents damage to shrimp from crabs, fish, and debris which can occur during longer trawl tow times.

7) They can be effectively fished in shallow nursery habitat, generally consisting of small bays, bayous, and ponds, as well as larger open bays.

8) They are more maneuverable and can more easily avoid snags and crab traps. The need to zig-zag, as with the single rig otter trawl to keep the net out of the prop wash, is reduced.

9) They can cover an area quicker and more effectively. Entire shorelines can be swept vs. only portions being covered by a conventional trawl.

10) There are no TED restrictions. If only skimmer nets or butterfly nets are rigged for fishing, the shrimper is exempt from the use of a TED.

11) Safety is improved as there are no heavy doors in rigging.

12) The entire water column up to 12-feet can be fished. This is especially effective for white shrimp.

Some disadvantages of skimmers include:

1) They are limited to the depth fished by the 12-foot maximum depth of the outer leg, although they can be used as butterfly nets in deeper water.

2) They may require more vigilance, especially at night near shorelines and obstructions.

3) If the gear is improperly tuned or poorly designed for the vessel, skids and bullets are thought to cause bottom damage. There have also been complaints of prop damage to the bottom in shallow areas.

4) When nets are stored upright on the deck they may affect vessel stability and safety in rough seas.

In 1990, University of North Carolina Sea Grant Program researchers initiated a study of the skimmer in North Carolina waters (Hines et al., 1993). They compared a pair of 16 × 12-foot (4.8 × 3.6 m) skimmers on one vessel to a pair of 35-foot (10.5 m) otter trawls on another vessel. Tow time for trawls was 90 minutes vs. 30-minute intervals for the skimmers. Due to various problems, results during the brown shrimp season were mixed. After fine tuning the rigs for the white shrimp season, Hines et al. (1993) reported that bycatch for the entire study was about 12% less per unit of time with the skimmers and 30% less for comparable time during the white shrimp season. During that season, the fish to shrimp ratio was about 1:1 for skimmers and 8:1 for otter trawls. Skimmers were found to be extremely efficient and outfished otter trawls by 5:1.

Catch was culled immediately following dumping of the cod end. They found that the shorter culling time gave higher survival of bycatch and shrimp, resulting in a better quality catch. Comparison of average survival rates for selected species from trawl and skimmer bycatch indicated 12 of 16 finfish species and brown, white, and pink shrimp, *Penaeus duorarum*, had greater survival in the skimmers (Table 2) (Hines et al., 1993). Some initial tests with the Florida fish excluder appeared effective in further reducing bycatch (Hines et al., 1993).

In addition to the advantages of skimmers over otter trawls already stated, the

North Carolina study noted that skimmer costs were comparable to trawls, 5–15% better fuel efficiency was recorded, and greater ground coverage (at about 2.5 knots, it was faster than the otter trawl) was noted. However, skimmers tended to foul with seagrass and seaweed and did not fish well on highly irregular bottoms. The study also documented increased survival of the three predominant shrimp species from the skimmer (Hines et al., 1993). However, if undersized shrimp were culled overboard it is still unknown what long-term survival would be achieved.

### Discussion

Some areas in coastal Louisiana have subsided and eroded so greatly that the skimmer has become one of the most effective methods available to harvest shrimp. Marsh subsidence along with erosion of shorelines and canal banks eliminate the possibility of using traditional gear (butterfly nets and trawls) in some areas. Additionally, mud lumps,

detritus, and marsh vegetation often congest trawls being worked in shallow ponds where marsh deterioration is prevalent. Skimmers can be set to fish above the bottom debris making them more efficient at catching shrimp under these conditions.

Continued marsh degradation has actually increased production with the introduction of nutrients to estuaries, increased marsh/water interface, and has contributed to shrimp landings averaging 109.4 million pounds (heads-on weight) annually in Louisiana over the past 10 years (1984–93). This condition will be short-lived as marsh deterioration continues, and eventually production will decline as the marsh vegetation and substrate which provides food and shelter cease to exist (Perret and Melancon, 1991).

Although the gear has its proponents, many fishermen we have interviewed dislike it because of potential water bottom damage and destruction of juvenile shrimp. Personal communication with numerous fishermen, net makers, and others in the industry indicated they felt most shrimp no longer reached the larger bays and open Gulf of Mexico, regarded as the traditional fishing grounds, as they did historically. Also, they believed nursery areas should be protected, but were not in favor of restricting “their” fishing grounds. Most of the skimmer fishermen interviewed said while they did not like to use the gear, their competitive nature dictated that they use it.

This gear has proven to be an effective and efficient method of harvesting shrimp with numerous advantages over the more conventional methods. However, its adaptability for use in extremely small, shallow, northerly portions of the estuary should be reviewed. As one state fisheries agent phrased it, “skimmers may be too efficient. The quest for efficiency is what keeps the fishing industry alive, but where do you draw the line? After all rotenone is a poison, a more efficient way of taking fish, but we don’t allow that. There must be limits to efficiency; yet if we ban the skimmer will we be legislating for inefficiency, and will that kill us down the road?” (Fritchey, 1989).

Resource management strategy often leads to prohibition of efficient gear owing to real and/or perceived over-exploitation. Often decisions are based upon competition among user groups for the same resource rather than documented overexploitation by a specific gear.

Future resource competition may require some additional regulation of this gear; presently, no biological data exists to indicate such a need. Rather, other management methods should be more closely examined, such as limited entry, license fee increases, stricter penalties for violations, and sanctuary establishment.

Compared to more traditional shrimping methods, the skimmer is still in its infancy. As fishermen fine-tune their rigs, additional advancements are possible. Presently, there appear to be as many ideas on adaptations and improvements of the skimmers as there are skimmer fishermen.

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**Table 2.**—Comparison of average survival rates for selected finfish and shellfish species collected by otter trawl (control) and skimmer trawl in the Straits of Marshallberg and the North River, N.C., in 1991. Survival rates assume a tow time of 90 minutes for the otter trawl, 30 minutes between retrievals for the skimmer trawl tailbag, and immediate culling of the catch after placement of the catch in the culling tray. Source: Hines et al. (1993).

Species	Otter trawl		Skimmer trawl		Relative change in survival (%) <sup>2</sup>
	N <sup>1</sup>	% Alive	N <sup>1</sup>	% Alive	
Blue crabs	12	94.28	12	92.33	-1.95
Pinfish	13	76.23	18	87.24	+11.01
Pigfish	10	68.11	11	90.91	+22.80
Pink shrimp	4	64.43	4	89.39	+24.96
Atlantic croaker	6	63.03	11	86.36	+23.33
Brown shrimp	5	60.67	6	64.52	+3.85
Weakfish	2	58.33	3	42.86	-15.47
Atlantic spadefish	3	50.00	3	100.00	+50.00
White shrimp	2	34.27	6	56.02	+21.75
Spot	14	33.79	21	70.28	+36.49
Bluefish	3	33.33	3	25.00	-8.33
Silver perch	3	33.33	6	36.67	+3.34
Atlantic menhaden	7	30.10	14	49.60	+19.50
Sea robins	5	26.67	5	60.00	+33.33
Silver jenny	6	20.83	5	46.31	+25.48
Atlantic thread herring	9	17.11	20	8.30	-8.81
Lizardfishes	5	10.00	8	6.25	-3.75
Bay whiff	9	0.00	3	8.33	+8.33
Spanish mackerel	8	0.00	12	7.64	+7.64
Anchovies	4	0.00	13	0.96	+0.96

<sup>1</sup> N = Number of tests.

<sup>2</sup> Positive change means better survival in skimmer trawl.