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The performance of the "Gulf fisheye" bycatch reduction device (BRD) was evaluated on two vessels during inshore shrimp fishing operations in the northern Gulf of Mexico by comparing catch rates with control nets in twin-trawl configurations using typical inshore nets with 7.6-m headropes. The BRD produced substantial reductions in finfish bycatch with no shrimp (*Penaeus* spp.) loss in three of the four evaluations. Proper installation of the BRD in the net is critical in maximizing bycatch reduction and preserving the shrimp catch. For the inshore fishery in the northern Gulf of Mexico, the recommended distance to install the "fisheye" BRD in front of the bag tie on 7.6-m headrope shrimp trawls is 2.6 m. Because no shrimp loss attributed to the BRD was noted during all four evaluations in this study, the results suggest that the Gulf fisheye BRD could be used effectively year-round in the northern Gulf inshore fishery and not just when finfish are overly abundant on the shrimp fishing grounds.

Shrimp trawls are nonselective gears with a substantial bycatch of nontargeted fish and invertebrates. Mortality stemming from this bycatch affects the status of several stocks of fishes, many of which are important recreational and commercial targets. For example, in the Gulf of Mexico, the red snapper (*Lutjanus campechanus*) stock is heavily overfished, and although juvenile red snapper are a small percentage of the shrimp trawl bycatch in offshore waters, the incidental mortality arising from this bycatch affects the recovery of this stock. Concerns about the magnitude of the bycatch and the incidental fishing mortality associated with this bycatch prompted the implementation of federal regulations requiring the use of certified bycatch reduction devices (BRDs) in all shrimp trawls fished in federal waters.

Compared with the research studies on shrimp trawl bycatch that have occurred in U.S. federal waters and in the offshore shrimp fisheries elsewhere in the world (Watson and Taylor, 1990; Watson et al., 1993; Rogers et al., 1997; Brewer et al., 1998; Broadhurst et al., 1999, 2002), very limited work has been done to characterize the catch and bycatch in the inshore (state waters) shrimp trawl fishery. In contrast to the studies in the Gulf of Mexico offshore fishery involving cooperating commercial vessels, most of the studies in the inshore fishery have been undertaken by university and state fishery management agency personnel using their own research vessels. These fishery-independent studies reported results that indicated that commercial-scale quantities of shrimp were not captured during the evaluations.

To obtain data meaningful to commercial shrimpers for use in deciding whether or not to adopt different gear technology, evaluations should be conducted during different times of the year and in locations where shrimp fishing operations are normally conducted using the knowledge and expertise of professional fishermen. The purpose of this study was to evaluate BRD performance in the inshore fishery under actual commercial-scale fishing conditions using the same protocol that has been developed for BRD evaluations in offshore waters. This information can be used by fisheries managers when considering the use of BRDs in inshore and nearshore shrimp fisheries.

Materials and Methods

Bycatch reduction device performance was evaluated on two vessels during commercial inshore shrimp fishing operations in the northern Gulf of Mexico by comparing catch rates with control nets in twin-trawl configurations using 7.6-m headrope nets. These are the most common trawl nets used in the inshore fishery in the northern Gulf because of gear size restrictions imposed by the various state resource management agencies. Vessels rigged for twin trawls pull one net from each side of the vessel through the use of outriggers. A small (3.7-m headrope) test trawl or "try net" is typically used in addition to the two larger nets and is towed closer to the centerline of the vessel (Fig. 1).

To document the bycatch reduction attributable to the "fisheye" type of BRD, the nets used in this work were identical in all respects

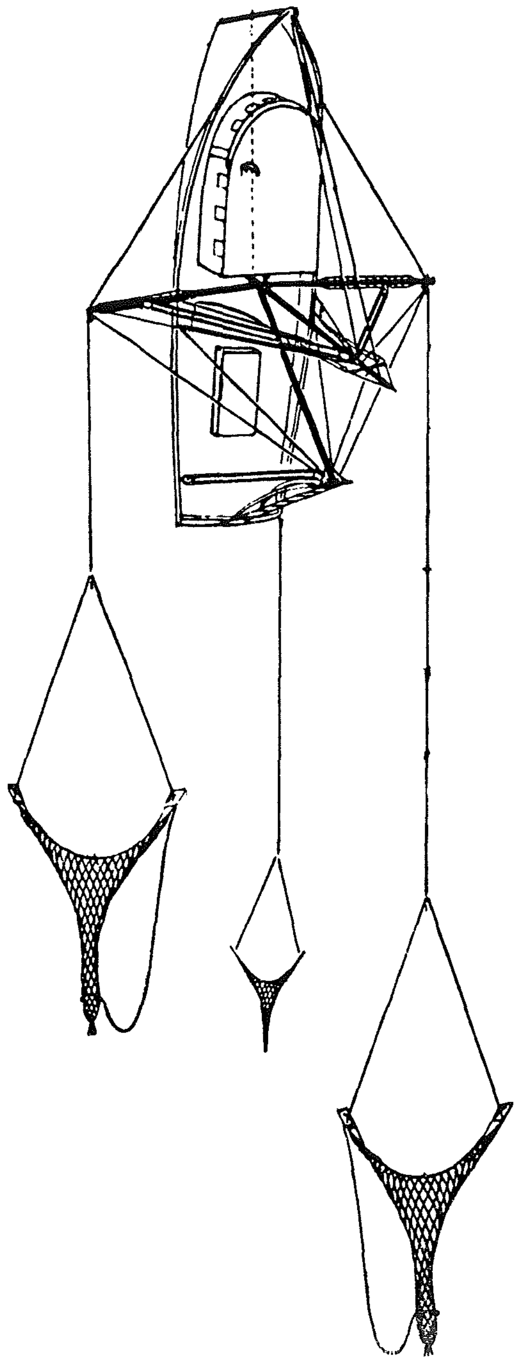

Fig. 1. Shrimp vessel rigged for twin-trawl operation. Note smaller test trawl or try net towed closer to the centerline of the vessel.

except for the presence of a BRD in one of the nets. Both the experimental (with BRD) and control (without BRD) nets were fitted with identical turtle excluder devices (TEDs) during each evaluation. Two research cruises were undertaken during the 2001 summer brown shrimp (*Penaeus aztecus*) season and two during the 2001 fall white shrimp (*P. setiferus*) season for a total of 43 d at sea.

The fishing grounds where BRDs were evaluated in this study included Mississippi Sound, Chandeleur and Breton sounds, Lake Borgne, and all the shallow-water area forming the western boundary of Chandeleur Sound known locally as simply the "Louisiana marsh" (Fig. 2). The average water depth fished was 4.6 m, and the average towing speed was 2.5–3 kt. Bycatch reduction device evaluations were conducted in both the brown and white shrimp seasons to determine differences in catch profiles related to different shrimp and finfish species, as well as different gear types and rigging. Shrimp catch rates and bycatch quantity and species composition were documented according to protocol and report forms established by the National Marine Fisheries Service (NMFS) for BRD testing (Nance, 1992; National Marine Fisheries Service, 1999). This facilitated data sharing because other commercial-scale BRD evaluations follow these protocols and use these standardized forms (National Marine Fisheries Service, 1991; Hoar et al., 1992).

The "Gulf fisheye" (Fig. 3) type of BRD was chosen because it is one of the two types of BRDs currently certified for use in offshore waters and fishermen were familiar with the device. The BRDs used in these evaluations all had an escape opening, which was 16.5 cm high by 29.2 cm wide. The device is typically installed in the top of the bag or "cod end" of the trawl (Fig. 4). Gear measurements and descriptions were performed following the protocol developed by NMFS for the bycatch observer program (Nance, 1992), and a log was kept on vessel position, vessel speed, water depth, bottom composition, weather conditions, tow duration, time of day, time of year, etc. Any tows exhibiting gear failures such as fouled tickler chains, clogged TEDs, or hangs were noted but not included in statistical analyses. Statistical evaluations for total shrimp and total finfish catch were performed using a paired t-test (SPSS, 1999) at an alpha of 10%, as stipulated in the *Gulf of Mexico Bycatch Reduction Device Testing Protocol Manual* (National Marine Fisheries Service, 1999), and the P values given represent $P(T \leq t)$ for a two-tail test. Testing was conducted by comparing the catches from 30 successful 2-hr tows. The experimental and control nets were alternated between both sides of the vessel after 15 useable tows by moving the entire net from one side

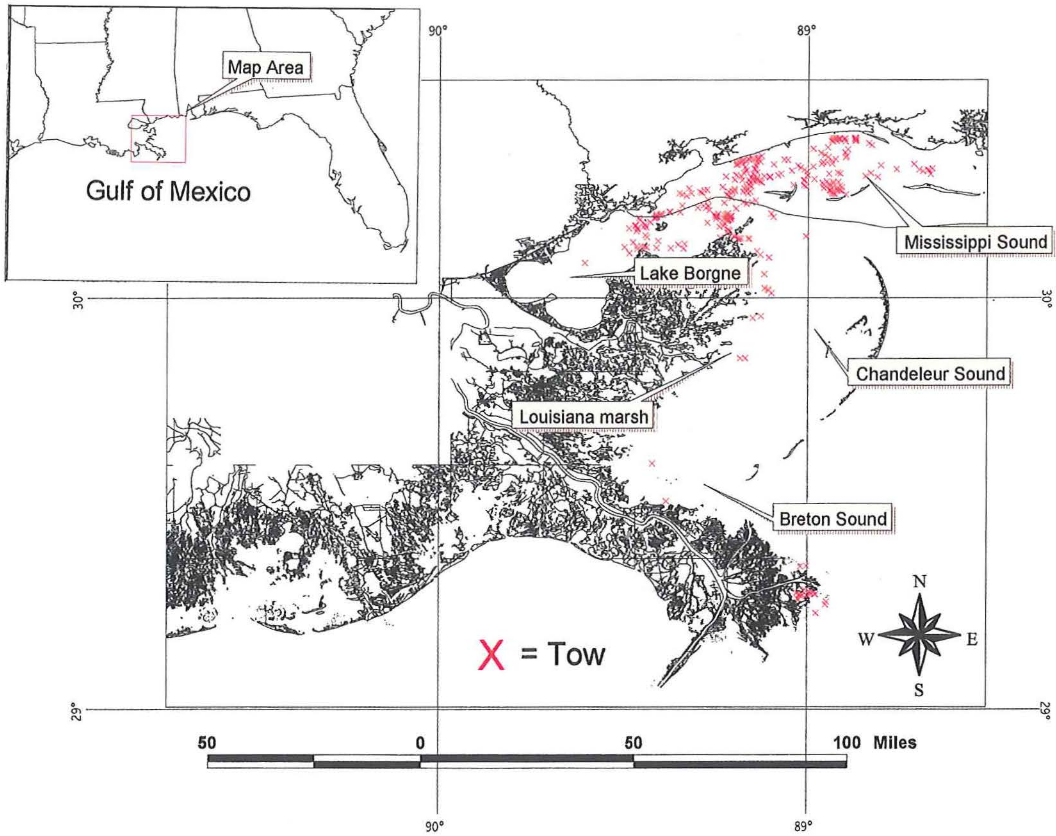

Fig. 2. Inshore trawling areas in Mississippi and Louisiana waters where tows were made during Gulf fisheye BRD evaluations.

to the other. This was done to control for any gear-related effects (e.g., door and bridle settings), test net influences, and vessel operational tendencies. It should be noted that this differed from the NMFS protocol that specifies that the BRD be moved from net to net to account for any net bias. Because the evaluations were being conducted on a twin-trawl configuration rather than on four nets used in offshore vessels and both the experimental and control trawls had been tuned for equal performance before the installation of the BRD, the investigator and vessel captains agreed that this change was acceptable and would minimize downtime during the evaluations.

The catches from the experimental and control nets were kept separate on the vessel. After each tow, the control and experimental catch were weighed for total biomass and shrimp. To determine the species composition of the bycatch, every other tow (tows 1, 3, 5, etc.) was sampled by filling a 19-liter bucket (approximately 15–17 kg) with mixed random shovelfuls of catch from the control and experimental nets. These samples were sorted according to the categories and species of interest outlined in the BRD protocol, and count and weight data were obtained for individuals within each species present in the catch. The purpose of the species sampling was to identify the type and size of listed organisms present in the catch, as well as to determine the BRD effects on species, number of individuals within species, and size. Protocol species of particular concern, such as red snapper, king mackerel (*Scomberomorus cavalla*), and Spanish mackerel (*Scomberomorus maculatus*), were examined by selecting these species from the total catch of both the experimental and control nets for each tow in which they occurred.

Summer brown shrimp gear description: F/V Aimee Lynn.—The *F/V Aimee Lynn* is a 375-horsepower 65-foot shrimp trawler displacing 57 gross tons. The control and experimental nets used for this evaluation were identical semiballoon trawls constructed of 3.8-cm stretched mesh #15 polyethylene webbing and measured 7.6 m

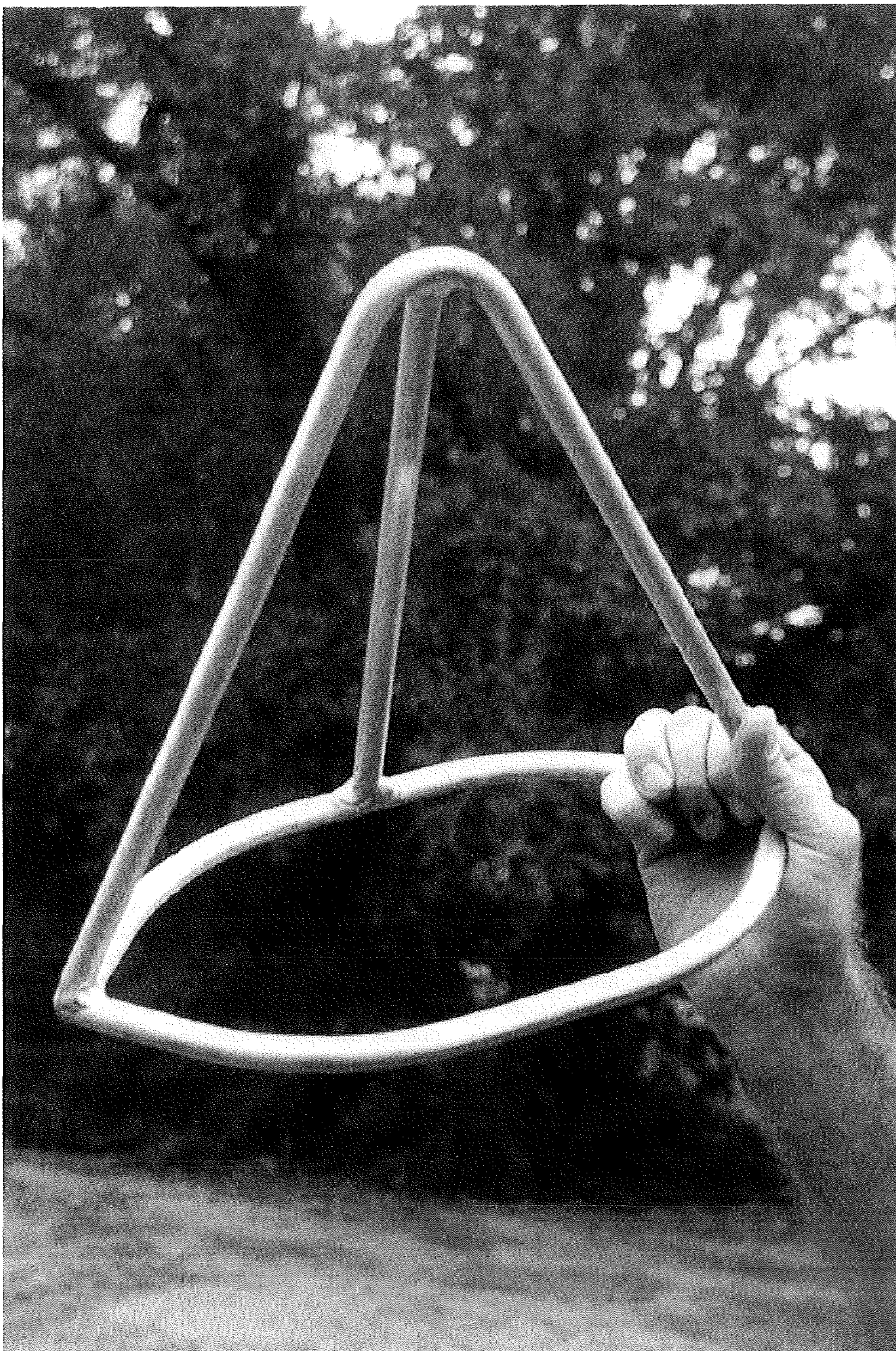

Fig. 3. Digital image of a Gulf fisheye BRD used in this study.

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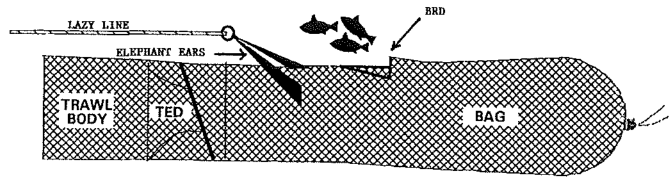

Fig. 4. Diagram of the typical orientation of a Gulf fisheye BRD installed in a shrimp trawl.

along the headrope and 10 m along the footrope (Fig. 5). The cod end was constructed of 3.8-cm stretched mesh #38 nylon webbing that was 110 meshes long by 140 meshes in circumference and fitted with mesh-type chafing gear. The lazy line was attached to the cod end using 91-cm-long elephant ears. The top leg length was 3.2 m, and the bottom leg length was 3 m. The trawls were pulled using 183- by 86-cm wooden doors. A 9.1-m tickler chain constructed of 0.8-cm chain was used on each trawl. The BRD was installed in the top center of the cod end, 2.7 m from the bag tie and 5 cm forward of the attachment point of the elephant ears. Turtle excluder devices used during the evaluations were standard curved-bar aluminum hard TEDs installed at an angle of 48°. The TED grid dimensions were 101.6 cm long by 76.2 cm wide, with a bar spacing of 10 cm, and each TED was fitted with two 15.2- by 22.9-cm oval floats.

Fall white shrimp gear description: F/V Aimee Lynn.—The white shrimp nets used for this test were 7.6 m long on the headrope and 9.7 m long on the footrope. They were constructed of 4.5-cm stretched mesh #12 nylon webbing. The bags were #38 nylon with a stretched mesh size of 3.8 cm and were 140 meshes in circumference and 140 meshes long. The top and bottom leg lines were 6.1 m long, and a 2.4-m "bib" with a 3.6-m middle leg was used on each trawl. "Bibs" are triangular extensions of the webbing in the top panel of the net designed to allow the trawl to open higher. The trawls were pulled with 183- by 86-cm wooden doors. An 8.5-m-long, 0.6-cm tickler chain was used. The BRD was installed in the top center of the bag 2.5 m forward of the bag tie and 43.2 cm behind the attachment point of the 76-cm-long elephant ears. The TEDs were weedless-design hard grids measuring 91.4 cm in length by 81.3 cm in width and installed at an angle of 50°. The TED grids were stainless steel and floated with two 15.2- by 22.9-cm oval floats on each TED.

Gear description: F/V Kar-Lyn-Dawn.—The *F/V Kar-Lyn-Dawn* is a 275-horsepower 42-foot trawler displacing 22 gross tons. The trawls

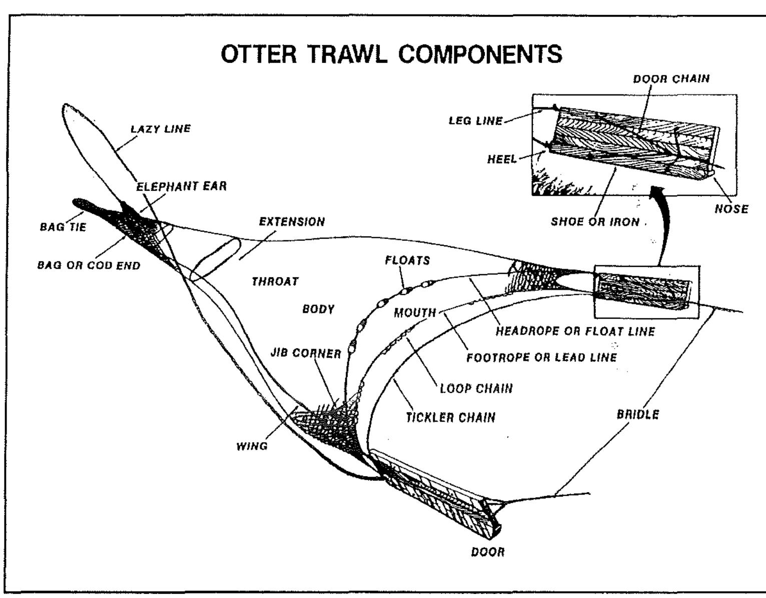

Fig. 5. Diagram of the components of otter trawls used during BRD evaluation in this study.

TABLE 1. Thirty-tow total shrimp and finfish catch comparisons (kg).

		Shrimp	All finfish
F/V *Aimee Lynn* Summer[a] (f)	Control	1,072.0	3,829.8
	BRD	1,031.0	2,947.5
	Percent difference	−3.8	−23.0
F/V *Kar-Lyn-Dawn* Summer	Control	337.5	1,492.0
	BRD	346.5	1,437.5
	Percent difference	2.7	−3.6
F/V *Aimee Lynn* Fall[a] (f)	Control	381.5	2,936.0
	BRD	385.5	1,910.0
	Percent difference	1.0	−34.5
F/V *Kar-Lyn-Dawn* Fall[a] (f, s)	Control	239.0	950.0
	BRD	250.5	547.0
	Percent difference	4.8	−42.4

[a] f = statistically significant difference in fish catch; s = statistically significant difference in shrimp catch.

used during both summer and fall evaluations were two-seam flat nets known as "Louisiana Mongoose" trawls. The trawls were 7.6 m long on the headrope and 9.7 m long on the footrope and constructed from 3.5-cm #12 stretched mesh polyethylene webbing. Although the nets were fitted with bibs, the bibs were disabled during the brown shrimp season by installing a line for that purpose along the top of the net and attaching the extra bridle to the door. The cod end was constructed of 3.5-cm stretched mesh #24 nylon webbing and measured 100 meshes deep by 140 meshes in circumference. Both the top and bottom leg lines were 2.4 m long. The tickler chain was 8.8 m on each trawl and constructed of 0.5-cm chain. The trawls were spread using 183- by 86-cm aluminum doors. The lazy line was attached to the bag with 101.6-cm elephant ears. The nets were fitted with standard "supershooter"-type TEDs with grid measuring 106.7 cm in length by 86.4 cm in width. The grid was installed at a 50° angle, and each TED was floated with one 15.2- by 22.9-cm oval float. The TEDs were fitted with accelerator funnels, and the grid bar spacing was 6.2 cm. During the summer brown shrimp evaluations, the BRD was installed in the top center of the net 3 m front of the bag tie and 20.3 cm forward of the elephant ear attachments. During the fall white shrimp evaluations, the bibs and extra bridle were enabled, and the BRD was installed 2.6 m forward of the bag tie.

RESULTS

During all four evaluations, eight of the 19 categories and species outlined in the Gulf of Mexico Bycatch Reduction Device Testing Protocol Manual were identified in the catch or catch samples. The categories and species were as follows: crabs, lobsters, etc. (Crustacea) grouped; other invertebrates (grouped); sea trout (*Cynoscion*), all species except spotted sea trout (*Cynoscion nebulosus*); Atlantic croaker (*Micropogonias undulatus*); southern flounder (*Paralichthys lethostigma*); Spanish mackerel (*S. maculatus*); other finfish (grouped); and debris. Protocol species of particular concern, such as red snapper, king mackerel, and Spanish mackerel, were either not encountered or encountered too infrequently to permit statistical analyses.

The summer brown shrimp evaluations aboard the *F/V Aimee Lynn* indicated that the BRD net caught 41 kg or 3.8% less shrimp than the control net, but the statistical analysis showed that the difference was not significant (P = 0.188) (Table 1). Overall, the BRD net caught about 882.3 kg or 23% less finfish. This difference was statistically significant ($P < 0.001$). Organisms sorted from alternate tow catch samples included taxa from targeted categories outlined in the protocol. The two most prevalent of the protocol finfish species present in the samples were Atlantic croaker (*M. undulatus*) and sand sea trout (*Cynoscion arenarius*) (Table 2). There were no statistically significant differences in the number of fish and mean individual fish weights of Atlantic croaker between the control and BRD nets (P = 0.183 and 0.229, respectively). Similarly, there were no significant differences in the number and mean weights of sand sea trout (P = 0.130 and 0.124, respectively). The other protocol species encountered, southern flounder, was captured infrequently and in quantities too small to permit statistical analysis. The species most responsible for the difference observed in bycatch was Gulf menhaden (*Brevoortia pa-*

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TABLE 2. Total BRD protocol finfish species obtained from catch samples.

Species	F/V *Aimee Lynn* Summer		F/V *Kar-Lyn-Dawn* Summer		F/V *Aimee Lynn* Fall		F/V *Kar-Lyn-Dawn* Fall	
	Control	BRD	Control	BRD	Control	BRD	Control	BRD
Atlantic croaker (#)	10,754.0	12,180.0	3,691.0	3,439.0	1,259.0	1,216.0	1,172.0	1,132.0
Atlantic croaker (kg)	117.8	134.0	59.8	56.7	48.2	42.7	44.0	47.3
Mean individual Atlantic croaker weight (gm)	10.9	11.0	16.2	16.5	35.1	38.3	37.5	41.8
Sand sea trout (#)	3,417.0	5,211.0	1,630.0	1,784.0	580.0	1,454.0	930.0	776.0
Sand sea trout (kg)	37.2	58.0	27.5	28.3	14.7	18.5	14.4	13.1
Mean individual sand sea trout weight (gm)	10.9	11.1	16.9	15.9	25.3	12.7	15.5	16.9
Southern flounder (#)	2.0	4.0	0.0	0.0	4.0	3.0	11.0	5.0
Southern flounder (kg)	0.6	1.5	0.0	0.0	1.5	1.0	4.5	2.0
Spanish mackerel (#)	0.0	0.0	0.0	0.0	12.0	0.0	0.0	0.0
Spanish mackerel (kg)	0.0	0.0	0.0	0.0	5.5	0.0	0.0	0.0

tronus). For example, on tow 12, in which Gulf menhaden were encountered, the total finfish catch in the control net was 270 kg, whereas the total finfish catch in the BRD net was 110 kg. The overall finfish to shrimp ratios (by weight) were 3.6:1 in the control net and 2.9:1 in the BRD net.

During the *F/V Kar-Lyn-Dawn* summer brown shrimp evaluations, the 2.7% (9 kg) increase in shrimp catch by the BRD net was not statistically significant (P = 0.169). Although there were 3.6% (55 kg) less fish in the BRD net, the difference was not statistically significant (P = 0.121) (Table 1). When it became obvious during the testing that the BRD was not excluding finfish, a few longer tows (3–3.5 hr) were made to determine whether the total amount of catch in the bag might be a factor in increasing exclusion rates. This did not seem to make any difference. It was hypothesized that the BRD was mounted too far forward in the trawl. Samples obtained for species identification showed that the predominant finfish in the bycatch were Atlantic croaker and sand sea trout (Table 2). There were no significant differences in the number of fish and mean individual fish weights of Atlantic croaker between the control and BRD nets (P = 0.349 and 0.329, respectively). There were also no significant differences in the number and mean weights of sand sea trout (P = 0.389 and 0.823, respectively). The majority of fish in the "grouped" category of the BRD protocol were Gulf menhaden and hardhead catfish (*Arius felis*). The overall finfish to shrimp ratios were 4.4:1 in the control net and 4.1:1 in the BRD net.

The *F/V Aimee Lynn* fall white shrimp evaluations showed that there was a 34.5% (1,026 kg) significant reduction in finfish bycatch (P = 0.002). The BRD net caught a total of 4 kg more shrimp than the control net, but the 1% difference was not statistically significant (P = 0.623) (Table 1). Gulf butterfish (*Peprilus burti*) and Gulf menhaden made up the largest portion of the finfish bycatch. Of the finfish species listed in the BRD evaluation protocol, Atlantic croaker and sand sea trout were dominant (Table 2). There were no significant differences in the number of fish and mean individual fish weights of Atlantic croaker between the control and BRD nets (P = 0.522 and 0.702, respectively). Likewise, no significant differences were found in the number and mean weights of sand sea trout (P = 0.299 and 0.344, respectively). Southern flounder averaging 0.4 kg in weight were captured in both the control and BRD nets. Spanish mackerel were captured in the control net only and averaged about 0.5 kg each. The overall finfish to shrimp ratios were 7.7:1 in the control net and 5:1 in the BRD net.

During the fall white shrimp evaluations aboard the *F/V Kar-Lyn-Dawn,* the 4.8% (11.5 kg) increase in shrimp catch in the BRD net was statistically significant (P = 0.087). The 42.4% (403 kg) reduction in finfish bycatch was also significant ($P < 0.001$) (Table 1). Gulf butterfish and Gulf menhaden made up the largest portion of the finfish bycatch. Atlantic croaker and sand sea trout were the predominant protocol species in the catch (Table 2). There were no significant differences in the number of fish or mean individual fish weights of Atlantic croaker between the control and BRD nets (P = 0.722 and 0.338, respectively). No significant differences were found in the number and mean weights of sand sea trout (P

= 0.715 and 0.738, respectively). The southern flounder in both the control and BRD nets averaged about 0.4 kg each. The overall finfish to shrimp ratios were 4:1 in the control net and 2.2:1 in the BRD net.

Discussion

Although the requirement for BRD use in the Gulf of Mexico offshore penaeid shrimp fishery became effective in 1998, some shrimpers have been using gear modifications to reduce unwanted finfish catch for many years. These modifications range from simple cuts in the bag webbing to the installation of dedicated devices such as the Gulf fisheye BRD. The devices have historically been used in areas and at times when finfish abundance on the shrimp fishing grounds was so high that shrimp fishing would be nearly impossible without them. In these instances, the shrimpers perceived a trade-off between the loss of some shrimp production because of this additional "hole in the net" and the ability to keep working in an area where both shrimp and fish were plentiful. Because of this perception, BRDs were typically removed from the trawls or disabled as soon as finfish abundance decreased. Because no shrimp loss attributed to the BRD was noted during all four evaluations in this study, the results suggest that the Gulf fisheye BRD could be used effectively year-round in the northern Gulf inshore fishery and not just when finfish are overly abundant on the shrimp fishing grounds. Anecdotal observations provided by shrimpers before the evaluations indicated that the BRDs were most effective for schooling species such as Gulf menhaden and Gulf butterfish. The results of the study agreed with the shrimpers' information.

Florida and Texas are the only Gulf of Mexico states to currently require the use of BRDs in inshore waters (Gulf States Marine Fisheries Commission, 2002). Before considering the implementation of BRD regulations in state-managed waters, fishery managers and fishermen need more information about the species caught (or excluded) by the gear used in the fishery, as well as the shrimp retention and bycatch reduction characteristics of BRDs available for use in the inshore fishery (Murray et al., 1992). Bycatch reduction devices are not being used by more inshore fishermen in the northern Gulf because of a lack of information on inshore BRD performance, as well as a paucity of trained individuals available to assist them in selecting, installing, and using BRDs.

Another impediment to BRD use is that inshore BRD evaluations are difficult to conduct, primarily because of the relatively greater amount of gear-clogging debris on the fishing grounds when compared with offshore waters. For example, to obtain the required 120 comparison tows used in this study, over 160 tows were actually made. The tows that could not be included in the statistical analyses were most often lost because of gear malfunctions associated with the capture of derelict crab traps and logs washed out of coastal rivers during storm events. It is important to note that none of the unsuccessful tows could be attributed to the fact that the Gulf fisheye BRD was installed in the net. For the BRD to work properly, the catch must be able to enter the bag area of the net. Any debris that is lodged in the throat of the trawl or against the TED grid prevents the catch from entering the bag and subsequently exiting the BRD opening. The BRD was not responsible for any of the lost tows observed during the evaluations. In fact, blockage of the TED grid by debris caused most of the problems.

The overall finfish to shrimp ratios during this study were 4.9:1 for the control nets and 3.6:1 for the BRD nets. The control nets showed a higher finfish to shrimp ratio during the fall white shrimp evaluations than during the summer brown shrimp evaluations (5.9:1 and 4:1, respectively), but the finfish to shrimp ratios remained constant in the BRD nets (3.6:1 in the fall and 3.5:1 in the summer). These ratios were higher than the 3:1 ratio reported in inshore waters by Adkins (1993) and the 2.4:1 ratio reported by Martinez et al. (1993). The observed ratios were lower than the offshore average of 5.3:1 (Renaud et al., 1993; Watson et al., 1993; U.S. Department of Commerce, 1995).

When comparing the finfish to shrimp ratios observed by this study with other shrimp trawl bycatch studies conducted in inshore waters, it is important to distinguish between those studies in which BRDs were evaluated and those where BRDs were not used. Also, in this study and others cited here, no attempts were made to isolate the relative contribution to bycatch reduction associated with the use of TEDs. This study used identical TEDs in the control and experimental nets to help ensure that any observed results would be attributable solely to the BRD, but when comparing the results with the work reported by other researchers, one must be aware that different TEDs have different bycatch reduction characteristics. Burrage (1997) tested various TED designs against a "naked net" in a twin 7.6-m trawl configura-

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tion to document the finfish reduction achieved by TEDs in the Mississippi inshore shrimp fishery. Mean finfish bycatch exclusion rates ranged from a gain of 7.3% to a reduction of 43.6%. Two of the five TED designs evaluated exhibited statistically significant shrimp loss.

Adkins (1993) reported a 3:1 mean ratio of discards to shrimp (by weight) in 53 samples taken from 7.6-m (headrope length) trawls in Louisiana inshore waters. During the same study, a 2.2:1 ratio was reported from samples taken from larger trawls in Louisiana offshore waters. No BRDs were being used during these evaluations. Bycatch characterization sampling from commercial shrimpers in various Texas bays showed a higher catch per unit effort in the spring season when compared with the fall season, but the bycatch to shrimp ratios were higher during the fall season (Fuls, 1995). Earlier detailed studies in Galveston Bay, Texas, showed that overall, bycatch species comprised 38% of the total number of individuals captured and averaged 71% of the total catch by weight. Nine species accounted for 80% of the bycatch by number and 79% by weight (Martinez et al., 1993). No BRDs were used during these evaluations.

Rogers et al. (1997) tested four BRD designs using 6.1-m headrope trawls in 20-min comparison tows against control nets in Louisiana inshore waters. Seventy-two comparison tows were conducted for each BRD design tested. Finfish biomass exclusion rates of 21–42% were documented, but the concomitant loss of 14–17% of shrimp biomass was deemed too high to make the BRDs feasible for use in commercial applications. Wallace and Robinson (1994) reported an average ratio of 15:1 discards to shrimp by weight in the Alabama small-boat recreational fishery. Their study also examined fisheye type BRDs and noted that although bycatch was reduced, shrimp loss ranged from 14 to 19%. Steele et al. (2002) evaluated two BRD designs in three different net sizes in Tampa Bay, Florida, by comparing BRD-equipped nets against controls in 20 tows using 30-min tow times. Finfish and shrimp catch differences between the BRD and control nets varied considerably (+28 to −60% and +18 to −29%, respectively). The average shrimp catch rates reported were about 1 kg in weight and 60 in number per 30-min tow. Steele et al. (2002) also reported that 10 commercially and recreationally valuable species accounted for 7% of the bycatch by number. These species were: southern kingfish (*Menticirrhus americanus*); scaled sardine (*Harengula jaguana*); striped anchovy (*Anchoa hepsetus*); bay anchovy (*Anchoa mitchelli*); spot (*Leiostomus xanthurus*); spotted sea trout (*C. nebulosus*); Gulf menhaden (*B. patronus*); Gulf flounder (*Paralichthys albigutta*); pompano (*Trachinotus carolinus*); and permit (*Trachinotus falcatus*).

Proper installation of the BRD in the net is critical in maximizing bycatch reduction and preserving the shrimp catch (Broadhurst et al., 1999, 2002). This can be seen by comparing the BRD performance aboard the *F/V Kar-Lyn-Dawn* during the summer brown shrimp evaluations with the fall white shrimp evaluations. During the summer brown shrimp evaluations, a standard oval fisheye BRD was installed in the top center of the net 3 m in front of the bag tie and 20.3 cm forward of the elephant ear attachments (see Fig. 3). This position for the BRD was chosen because it was about midway between the minimum distance of 2.6 m and maximum distance of 3.8 m from the bag tie specified in the federal BRD regulations for offshore waters. The same trawls were used during the white shrimp season with the bibs and extra bridle enabled. The TEDs and all rigging were identical to the brown shrimp evaluation with the exception that the BRD was installed 2.6 m forward of the bag tie. The theory that moving the BRD closer to the bag tie would result in better performance seemed to be supported. On the basis of the results of this study, the recommended distance to install the fisheye BRD in front of the bag tie on 7.6-m headrope shrimp trawls is 2.6 m for use in northern Gulf inshore waters.

Using the Gulf fisheye BRD resulted in substantial reductions for finfish bycatch in three of the four evaluations and no shrimp loss in all four evaluations. Regarding the effects of the inshore shrimp fishery on finfish species targeted in other commercial and recreational fisheries, no red drum and only 11 spotted sea trout were caught in well over 320 hours of trawling. Also, no red snapper were captured during these evaluations on the inshore shrimp fishing grounds. However, the BRDs were very effective in reducing the bycatch of Gulf menhaden, which is targeted by a directed commercial fishery in the Gulf and is an important prey species.

The positive results observed during these evaluations in northern Gulf inshore waters may or may not be applicable to other regions or to deeper offshore waters. The operational problems noted in offshore waters associated with net surge and concomitant loss of catch through the BRD during haul back (Graham and Overman, 1997) were not encountered during this study because of the shallow waters and relatively calmer sea conditions in the study area. Also, because finfish reduction appeared to vary with the species encountered, other regions with different species assemblages present on the shrimp fishing grounds might experience different reduction rates.

The Gulf fisheye BRD can help inshore shrimpers in the northern Gulf region produce a better quality of shrimp by reducing the weight of fish in the cod end, which can crush the shrimp. Shrimp quality is also enhanced and labor is minimized by reducing the time it takes to cull the catch and get the shrimp iced. Perhaps the most telling testimonial regarding the potential benefits of using the Gulf fisheye BRD lies in the fact that both the cooperating captains involved in this study now use them year-round in their shrimp trawls.

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