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BYCATCH AND BYCATCH REDUCTION IN RECREATIONAL SHRIMPING

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ABSTRACT: We estimated the bycatch from recreational shrimping by quantifying the catch from fishery independent trawling and through a survey of licensed recreational shrimpers in Alabama during 1990. We used paired trawls to test two net modifications (fish shooter and Florida fisheye) for bycatch reduction. The mean fish bycatch was 5.4 kilograms per 20 minutes tow and contained 426 fish primarily from three families (Sciaenidae, Engraulidae, and Clupeidae). The total recreational shrimping effort for Alabama was an estimated 37,244 h resulting in a potential fish bycatch of 603,000 kg or 47.6 million fish. The fish shooter did not significantly reduce the bycatch in either weight or numbers while the Florida fisheye significantly reduced bycatch in both weight (26 percent) and number (46 percent). Further testing of the Florida fisheye with the position of the nets reversed revealed no significant reduction in weight but a significant reduction in bycatch number (36 percent).

The incidental catch (bycatch) of non-target species by commercial shrimping operations is one of the most important issues facing fishery biologists and managers in the Southeastern United States. Bycatch from shrimping is estimated at 2.8 to 18.0 kg per kg of shrimp caught (Watson and Taylor 1988) and may include 5 billion Atlantic croaker (*Micropogonias undulatus*), 19 million red snapper (*Lutjanus campechanus*), and 3 million Spanish mackerel (*Scomberomorus maculatus*) in the Gulf of Mexico (Nichols et al. 1990). Reviews on the history and current status of the bycatch issue are found in Rulifson et al. (1992), Murray et al. (1992) and CMC (1992).

The concern over bycatch has led to research efforts to reduce bycatch through modifications of the fishing gear (Rulifson 1992 et al. and Watson et al. 1986). These trawl modifications include turtle excluder devices (TEDs) which have become a standard part of offshore shrimp trawls, and various designs that increase the chances of fish to escape.

Most by catch reduction research has concentrated on large, offshore shrimp vessels, and little attention paid to smaller, inshore operations. Recreational (sport) shrimping has been particularly ignored. This type of shrimping usually includes a lower license fee than is charged for a commercial license, a restricted net size (commonly 4.9 meter headrope length) and limits on daily catch. Sport shrimpers operate in the shallow estuaries that are nurseries for many of the economically important species harvested from the Gulf region (Day et al. 1989). Little or no information is available on the effect of this type of shrimping on fish populations.

Our purpose was to measure the bycatch from recreational shrimping in Mobile Bay, Alabama, and to investigate

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methods of reducing this bycatch.

METHODS

Two trawls (4.9-m headrope, 6.8-m footrope, 19.0-mm (sq) body mesh, 12.7-mm (sq) cod end mesh, and 40-cm by 75-cm doors) were fished simultaneously for 20 min from a 7.7-m vessel equipped with two 2.5-m outriggers. Sampling areas included Mobile Bay, Mississippi Sound and Perdido Bay, Alabama. Those areas were selected based on our knowledge of sport shrimping activities. Trawling took place from June 7 to September 26, 1990.

The catch from each net was weighed, identified, and counted. Up to 30 individuals of each species were measured (total length, carapace width for crabs) in one centimeter intervals. In samples with over 100 individuals of a single species, abundance was determined from a subsample. If either of the nets tore, or caught a large object, the catch from both nets was eliminated from analysis.

Initially, eight paired tows were made to test for differences between trawls without any modifications for bycath reduction. Thereafter, one trawl was modified for bycatch reduction and the other trawl left unmodified resulting in paired comparisons between modified and unmodified nets. Results from all unmodified net tows were combined to document bycatch.

To estimtae the extent of bycatch from sport shrimping, a survey which requested information about shrimping effort (number of trips, number of tows per trips, length of tows, etc.) was sent to 2,423 of 2,608 licensed recreational shrimpers in Alabama. Results of the survey were combined with data on bycatch to calculate the total bycatch attributable to sport shrimping.

Two devices for net modifications were tested for bycatch reduction. The first modification, called a fish shooter (FS), was a 18.8-cm (7 meshes) wide cut across the top of the net body, 1.7 m from the end of the net. A small weight attached in front of the cut and a float behind the cut kept the hole open. This modification is a traditional method for reducing bycatch and was suggested by a local netmaker.

The second modification was a cone (30 x 15 x 40 cm) constructed from aluminum with an elliptical opening (Figure 1) referred to as the Florida fisheye, (FFE). The FFE was installed by National Marine Fisheries Service (Pascagoula, MS Laboratory) personnel 2.6 m forward from the end of the net on the bottom surface and positioned to ride without snagging by using flotation and a small lifting foil in the cone. The FFE was tested on both the port and starboard sides of the boat. We used a paired t-test ($\alpha \leq 0.05$) to test for all differences.

We made 57 paired tows of which 40 were used in the analaysis. Of these, eight were with both nets unmodified, nine with the FS in the starboard net, 13 with the FFE in the starboard net, and 10 with the FFE in the port net. A total of 48 unmodified tows were available for bycatch documentation.

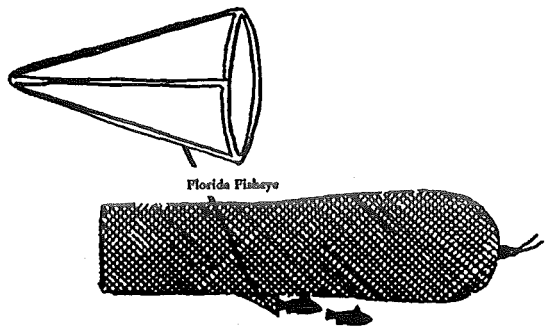

Figure 2. Length Frequencies of *Micropogon undulatus* and *Leiostomus xanthurus* from Unmodified Trawls and from Trawls Modified with the Florida fisheye (FFGE).

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RESULTS

Over 20,000 fish weighing 262.2 kg were caught as bycatch in the unmodified net in 48 tows. Mean fish bycatch was 5.4 kg/20 min (SE = 0.9, range = 0.5 to 27.8 kg) and contained 426 individuals/20 min (SE = 75.9, range = 47 to 1,111). Forty-three species of fish from 24 families and two species of portunid crabs were reported in the bycatch. Fish from the Sciaenidae, Engraulidae, and Clupeidae made up 56%, 18%, and 5% of the catch respectively. The majority of the catch was dominated by juvenile fish (Table 1).

The mean portunid crab bycatch was 0.6 kg/20 min (SE = 0.1, range = 0 to 2.8 kg) and 14.8 individuals/20 min (SE = 4.7, range 0 to 63). The penaeid shrimp catch ranged from 0 to 1.7 kg/20 min ($\bar{x}$ = 0.4, SE = 0.1) and from 0 to 225 individuals/20 min ($\bar{x}$ = 46.1, SE = 8.1). The weight ratio of fish to shrimp was 14.9:1 (range = 1.2:1 to 93:1)

We received a 19.6 percent return (474 surveys) from our fishermen surveys. Of these, 80 were judged unusuable because of missing data. The remaining 394 surveys (15.1 percent of the licensed recreational shrimpers) indicated that recreational shrimpers averaged 5.2 trips/year (SE = 0.3, range = 0.45), 4.3 tows/trip (SE = 0.1, range = 1-20) and 38.3 min/tow (SE = 0.7, range = 13-90) in 1990. The total effort exerted by 2,608 recreational shrimpers was estimated at 37,224 h. Based on our catch per unit effort for similar size trawling gear, the fish bycatch attributable to recreational shrimping in Alabama waters was an estimated 603,000 kg composed of 47.6 million fish or 44.5 kg and 3,500 fish per trip respectively. The total shrimp catch based on the recreational survey was calculated at 49,000 kg.

Analysis of the eight paired tows with both nets unmodified revealed no significant difference in weight or numbers of bycatch (Table 2). The FS modification did not significantly reduce the bycatch in weight or numbers. The mean bycatch weight was the same in both nets, but 46 percent lower in numbers for the modified net (Table 2). Shrimp catch was 42 percent lower in the modified net, but the difference was not

Table 1. Summary of the bycatch of the more numerous or economically important animals caught in 48 tows with a standard (unmodified) 4.9 shrimp trawl.

	Number			Length (cm)		
Species	N	Mean	Range	N	Mean	Range
Micropogonias undulatus	6542	136.3	1-654	825	10.2	4-18
Leiostomus xanthurus	6159	128.3	0-491	742	9.7	4-17
Anchoa mitchelli	3045	63.4	0.626	510	4.7	2-8
Dorosoma petenense	747	15.6	0-181	263	11.4	7.22
Portunid crabs	713	14.8	0.63	579	8.1	2-19
Arius felis	560	11. 7	0.236	201	18.0	4-28
Polydactylus octonemus	469	9.7	0-88	270	11.0	8-16
Bagre marinus	348	7.2	0-133	222	10.0	7-15
Chloroscombrus chrysurus	346	7.2	0-98	90	7.6	3-10
Lagodon rhomboides	303	6.3	0-115	73	10.9	5-16
Cynoscion arenarius	291	6.1	0-42	250	9.0	4-23
Synodus spp.	213	4.4	0-71	75	19.4	6-32
Anchoa hepsetus	179	3.7	0-51	124	7.0	5-11
Citharichthys spilopterus	159	3.3	0-37	96	10.4	4-16
Peprilus alepidotus	121	2.5	0-20	85	6.7	3-10
Eucinostomus argenteus	100	2.1	0-53	34	9.1	7-11
Scomberomorus maculatus	33	0.7	0-7	31	12.1	5-25
Orthopristis chrysoptera	31	0.6	0-12	19	12.8	6-15
Lutjanus synagris	26	0.5	0-9	26	12.9	8-16
Paralichthys lethostigma	20	0.4	0.4	16	16.9	6-30

Table 2. Summary of bycatch from unmodified and modified trawls.

Type of Modifiction	N	Mean Wt. (kg)	SE	Paired t-test (P)	Mean Number	SE	Paired t-test (P)
No modification	Port 8	4.1	0.6		361.1	109.4	
No modification	Starboard 8	4.2	0.6	0.6878	453.4	105.5	0.1883
No modifiсation	Port 9	6.4	2.5		639.6	369.0	
Fish Shooter	Starboard 9	6.4	1.8	0.9541	345.0	106.1	0.3155
No modification	Port 13	4.9	1.5		388.2	111.7	
Florida Fisheye	Starboard 13	3.6	1.0	0.0249	210.7	75.6	0.0077
Florida Fisheye	Port 10	7.2	2.2		245.7	47.1	
No modification	Starboard 10	10.4	3.0	0.1117	387.0	63.9	0.0031

significant.

The FFE modification significantly reduced bycatch in both weight and in number when the FFE was on the starboard side. The mean bycatch weight and number were 26 percent and 46 percent lower respectively in the modified net (Table 2). Shrimp catch was 14 percent lower in the modified net, but the difference was not significant. When the

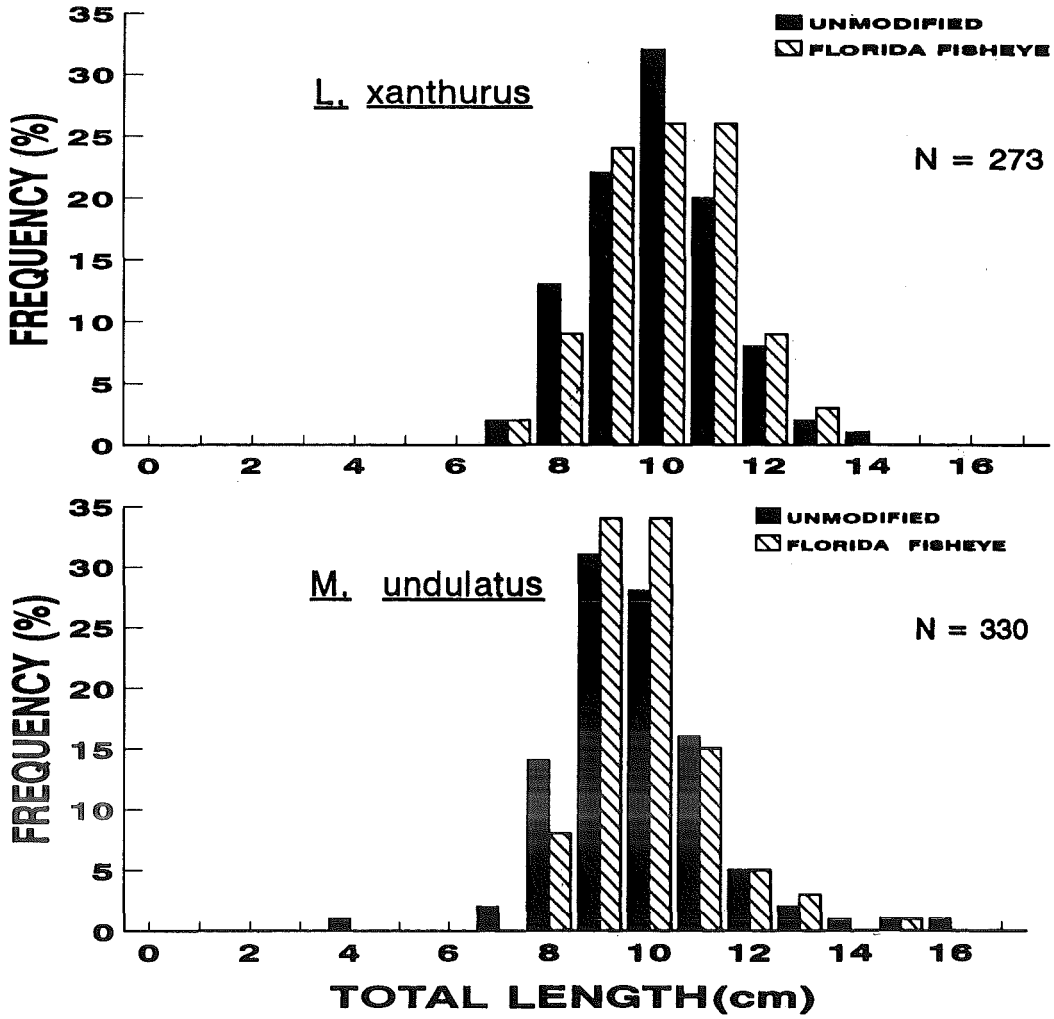

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Table 3. Examples of bycatch reduction from the Florida fisheye where more than 100 individuals of a species were caught in the unmodified net.

Species	Port Unmodified	Starboard (FFE)	%	Port (FFE)	Starboard Unmodified	%
Anchoa mitchelli	716	18	−97	8	200	−96
Arius felis	339	72	−79	33	135	−76
Chloroscombrus chrysurus	113	30	−73	237	232	+2
Brevooria patronus	268	106	−60			
Dorosoma petenense	387	201	−48	236	273	−14
Leiostomus xanthurus	1181	806	−32	599	1039	−42
Micropogonias undulatus	1608	1193	−26	539	802	−33
Eucinostomus argenteus				84	100	−16

FFE was moved to the port side of the vessel there was a substaintial but non-significant reduction in bycatch weight and a significant difference in bycatch numbers. The mean bycatch weight and mean numbers were 31 percent and 36 percent lower respectively in the modified net (Table 2). Shrimp catch was 5 percent lower in the modified net but not signficiant.

Species caught in large numbers (more than 100 individuals in the unmodified nets) showed reductions or increases of +2 to -97 percent using the FFE (Table 3). Examination of length frequencies for the two most abundant species did not reveal any notable difference in length between the FFE modification and no modification (Figure 2).

DISCUSSION

We captured fish species that are valued by anglers including, white trout (*Cynoscion arenarius*), crevalle jack (*Caranx hippos*), red snapper (*L. campechanus*), lane snapper (*L. synagris*), pig fish (*Orthopristis chrysoptera*), cobia (*Rachycentron canadum*), Spanish mackerel (*S. maculatus*), and southern flounder (*Paralichthys lethostigma*). Although the catch of these species was relatively small, calculation of the estimated total catch can be surprisingly large. For example, the 33 Spanish mackerel sampled represent 76,700 fish when expanded for the total sport shrimping effort in Alabama. Approximately 10,600 sport shrimping licenses were sold in the Gulf states in 1990 (personal communication from the resource agencies of the 5 Gulf states) indicating a potentially large bycatch of economically important species from sport shrimping.

The ultimate effect on the stocks of these species from such removals remains unknown. Powers et al. (1987) speculated that bycatch would hinder the recovery of redfish (*Sciaenops ocelatus*), red snapper, king mackerel (*S. cavalla*), and Spanish mackerel in the Gulf of Mexico. The ecological impact of bycatch mortality on both economically important species as well as the lesser known prey species is not well understood.

Bycatch reduction, while simple in concept is difficult to demonstrate statistically. The limits of cost and effort must often be balanced against the need for a large number of replicates (Rulifson et al. 1991). The NMFS (1991) recently recommended a minimum of between 16 and 20 paired tows to establish a difference between trawls at the 95 to 97.5 percent confidence level. We did not reach this level of replication so the findings of no significant reduction in number and weight for the fish shooter may be misleading. However, the percentage reduction was not promising. Placement of the opening closer to the end of the net or a larger opening might improve bycatch reduction.

The signifcant reduction in weight and number found for the FFE, despite the low number of replicates, is an indication of the utility of this device. However, the percentage reduction (26 percent in number and 46 percent in weight) fell short of the 50 percent bycatch reduction suggested as obtainable by NMFS (1991). Greater reduction may be possible by placing the FFE in the top of the net (Watson et al. 1993).

Despite this drawback, the Florida FFE has potential as a bycatch reduction device in small nets. It is relatively small, easily installed by a netmaker, and in no way interferes with the operation of the trawl. Further testing with different placements in the trawl, multiple devices, or devices further modified to direct fish out the openings may achieve greater reductions.

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