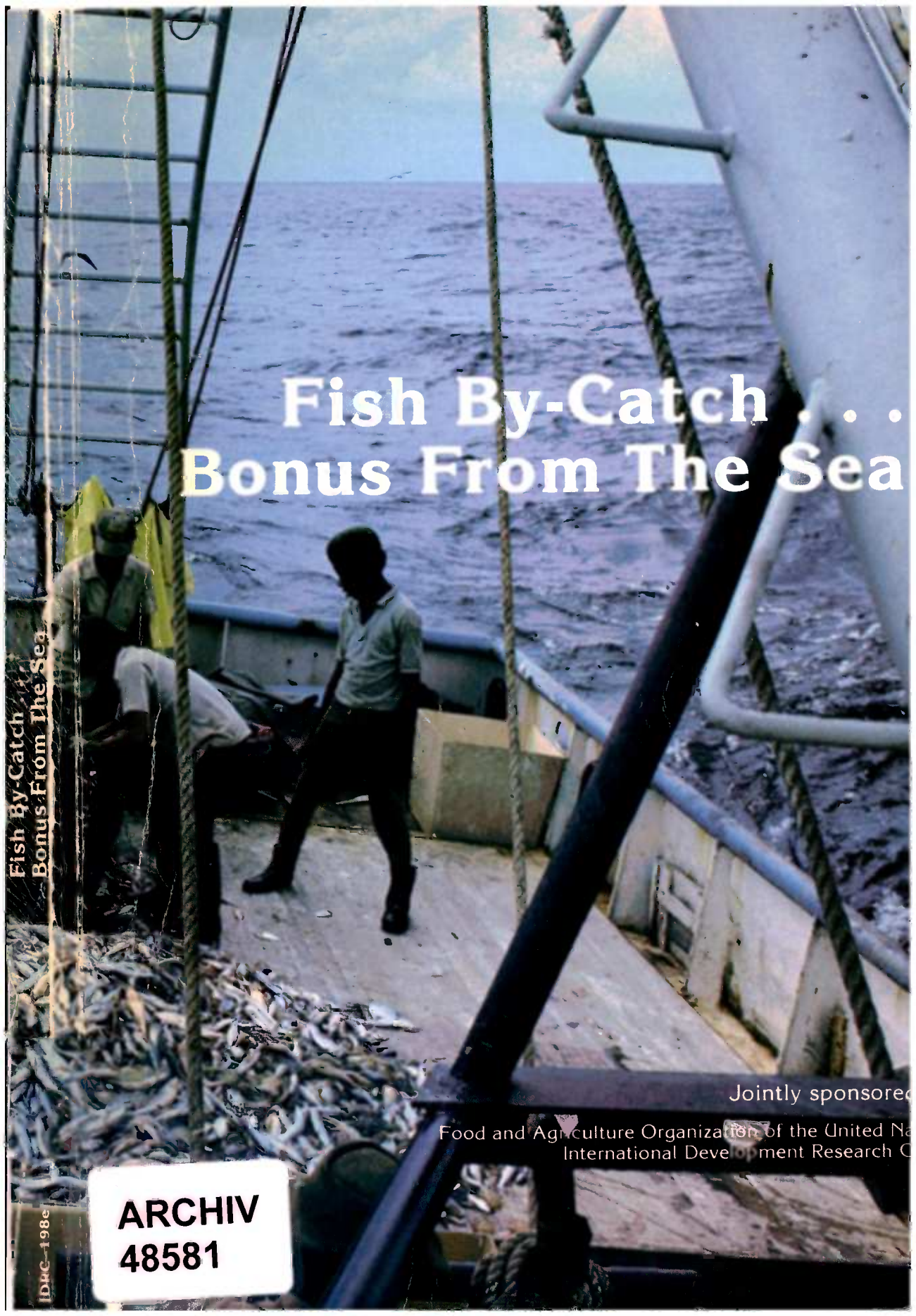


A photograph of a fishing boat deck. Two men are visible: one in the foreground wearing a light-colored shirt and dark trousers, and another in the background wearing a light-colored shirt and dark trousers. A large pile of small fish is in the foreground. The background shows the ocean and a cloudy sky. The title "Fish By-Catch . . . Bonus From The Sea" is overlaid in white text.

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Report of a Technical Consultation
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Fish Discards from the Southeastern United States Shrimp Fishery

Gilmore Pellegrin Jr *U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Center, Mississippi Laboratories, Pascagoula, Mississippi, USA*

*Magnitude and species composition of fish by-catch are described for the Gulf of Mexico and south Atlantic shrimp fleets. By-catch estimates for the Gulf were 15 times those for the south Atlantic. Highest estimates occurred in the north-central and northwestern Gulf and in the south Atlantic off the North Carolina and Georgia coasts. Catch compositions varied at the species level; however, Sciaenidae was the dominant family for both the Gulf and the south Atlantic. Gulf fauna included estuarine-dependent species in subtropical environs and estuarine-independent species in tropical environs. Dominant species included Atlantic croaker (*Micropogon undulatus*), spot (*Leiostomus xanthurus*), and sand seatrout (*Cynoscion arenarius*). Compositions were relatively similar throughout the south Atlantic, with spot, Atlantic croaker, and weakfish (*Cynoscion regalis*) making major contributions.*

The shrimp industry is one of the most important fisheries in the United States. Shrimp ranked first in value and either second or third in volume of all U.S. fisheries between 1971 and 1975. The Gulf of Mexico and south Atlantic regions play a significant role in the nation's shrimp industry, accounting for approximately 53.0% and 7.1% of the total landings, respectively. Three species provide the majority of landings in both regions. Catch for the Gulf region includes brown

shrimp (*Penaeus aztecus*) 55%, white shrimp (*P. setiferus*) 30%, and pink shrimp (*P. duorarum*) 13%. For the south Atlantic region, the figures are white shrimp 63%, brown shrimp 30%, and pink shrimp 6%.

The primary gear used in the Gulf and south Atlantic shrimp fisheries is the otter trawl, a nonselective bottom net that incidentally catches numerous fish and other invertebrates. Although edible-sized fish are retained for food, the majority of the by-catch, which consists of fish weighing less than 0.25 kg, is discarded at sea. Most discards probably do not survive long after the stress inflicted during trawling and the time on deck during sorting.

Finfish mortalities induced by the Gulf and south Atlantic shrimp fleets have recently gained increased attention. Representatives of the red snapper and groundfish fisheries are concerned about the effects of this waste on the ability of the stocks to rebuild. In 1972, the Pascagoula Laboratory initiated a shrimp fleet by-catch program with objectives to estimate the magnitude and species composition of the finfish by-catch of the northern Gulf of Mexico shrimp fleet. In this paper, I briefly summarize findings of that program and, through a literature review, provide similar estimates for the south Atlantic fleet.

Methods

The shrimp fleet by-catch program acquired data from samples of commercial catches and from analysis of information collected by research vessels. Sampling of the commercial catches was performed by contractors who placed observers aboard the shrimp vessels. The data from the research vessels R/V *George M. Bowers* and FRS *Oregon II* were for stations where commercial shrimp concentrations occurred; the stations were selected by a method described elsewhere (Pellegrin et al., in preparation).

Samples equal to at least 10% of the total catch were taken from each trawl station, sorted by species and identified, counted, and weighed. Mean fish/shrimp ratios were computed by area (Fig. 1) and multiplied by estimates of annual shrimp landings (averaged from data for 1971–75) for the respective areas. Species compositions were computed as percents by weight. Percentages of 10 dominant fish species were multiplied by the

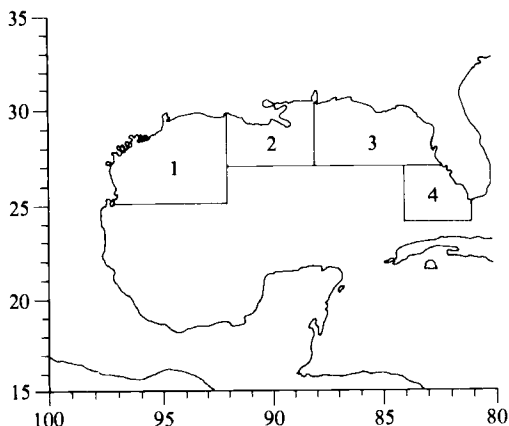


Fig. 1. Four geographical subareas of the Gulf of Mexico region.

total by-catch estimates as a calculation of the total by-catch of the individual species.

Catch compositions, fish/shrimp ratios, and total-landing estimates for the south Atlantic either were taken directly from the literature or were modified from the literature so that they conformed with the format used in this study.

Results

Keiser (1977b), in a report on the incidental catch by commercial shrimp trawlers of the south Atlantic states, used fish/shrimp ratios from published and unpublished reports for estimates of by-catch. Because of the variability of data, he used median values that were multiplied by total shrimp landings to estimate total fish by-catch (Table 1).

Estimates of species compositions off North

Carolina were taken from Wolff (1972, cited by Keiser 1977b) and were converted to percent by weight of the total by-catch (including invertebrates other than crabs). Catch compositions of Wolff's data were approximately 82.4% fish, 15.7% shrimp, and 1.9% other invertebrates.

Species compositions by weight for the total by-catch for South Carolina are given by Keiser (1977b). However, only species of the fish by-catch are listed by him (1976) in his report on the incidental catch of the South Carolina shrimp fishery. I estimated by-catch for individual fish species by multiplying percent compositions from the Keiser 1976 report by the estimated total fish by-catch for South Carolina (Table 2). Keiser (1977b) cites species compositions of Georgia shrimp-trawl samples from Knowlton (1972). I determined by-catch estimates for 10 dominant fish species by multiplying Knowlton's percent compositions by the estimated annual fish by-catch for the Georgia coast. Species composition data from by-catch samples on a weight basis were unavailable for the Florida northeast coast shrimp fishery. Keiser (1977b) does, however, list species compositions (from Anderson 1968) as percents by number.

My colleagues and I (Pellegrin et al., in preparation) divided the northern Gulf of Mexico into four study areas (Fig. 1) and computed mean fish/shrimp ratios and fish species compositions for the respective areas. These areas were defined on the basis of fish and shrimp densities. Area 1 was characterized by relatively low fish and high shrimp concentrations, and area 2 by both high fish and high shrimp concentrations. Moore et al. (1970) found fish densities to be two to five times

Table 1. Estimated annual fish by-catch for south Atlantic (Keiser 1977b) and Gulf of Mexico (Pellegrin et al., in preparation).

Area	Fish/heads-on shrimp ratios	Number of samples	Mean annual shrimp	
			landings (t, heads-on)	Estimated annual fish by-catch (t)
South Atlantic				
North Carolina coast	4.0:1	59	2883	11532
South Carolina coast	1.6:1	280	3935	6296
Georgia coast	2.6:1	184	3600	9360
Northeastern Florida coast	3.8:1	(unknown)	1647	6259
Gulf of Mexico				
1	6.3:1	478	28118	177143
2	14.4:1	824	17782	256061
3	15.9:1	29	2864	45538
4	4.2:1	146	7150	30030

Table 2. Comparison of fish species compositions in the by-catch (t) for the south Atlantic and Gulf of Mexico regions.^a

Species	South Atlantic coast			Gulf of Mexico ^e			
	South Carolina ^b	Georgia ^c	North Carolina ^d	Area 1	Area 2	Area 3	Area 4
<i>Micropogon undulatus</i>	2791	356	1956	35077	115953	3233	—
<i>Leiostomus xanthurus</i>	4463	2253	2620	5876	17701	15483	—
<i>Cynoscion arenarius</i>	—	—	—	8547	16674	1821	—
Nonfood fish flounders	357	—	—	15847	—	911	2093
<i>Cynoscion nothus</i>	—	—	—	11573	5643	—	—
<i>Synodus foetens</i>	230	—	—	9437	6670	—	777
<i>Calamus</i> sp., <i>Stenotomus</i> sp.	196	—	—	—	13339	—	—
<i>Diplectrum</i> sp.	—	—	—	5520	—	2368	4546
<i>Prionotus rubio</i>	—	—	—	—	10518	—	—
<i>Trichiurus lepturus</i>	—	—	262	—	8722	—	—
<i>Arius felis</i>	—	143	309	—	8466	—	—
<i>Polydactylus octonemus</i>	—	—	—	8724	—	—	—
<i>Peprilus burti</i>	—	—	—	6410	—	1048	—
<i>Lagodon rhomboides</i>	322	—	—	—	—	—	5952
<i>Trachurus lathami</i>	—	—	—	4986	—	—	—
<i>Prionotus scitulus</i>	—	—	—	—	—	3416	1526
<i>Orthopristis chrysoptera</i>	969	—	—	—	—	2231	747
<i>Chloroscombrus chrysurus</i>	—	—	—	—	3078	—	—
<i>Haemulon aurolineatum</i>	—	—	—	—	—	—	1764
<i>Alutera schoepfi</i>	—	—	—	—	—	1048	599
<i>Cynoscion regalis</i>	450	137	646	—	—	—	—
<i>Brevoortia tyrannus</i>	—	574	655	—	—	—	—
<i>Menticirrhus</i> sp.	161	231	833	—	—	—	—
<i>Eucinostomus gula</i>	—	—	—	—	—	—	1107
<i>Anchoa hepsetus</i>	—	—	—	—	—	775	—
<i>Stellifer lanceolatus</i>	—	275	431	—	—	—	—
Skates and rays	—	325	336	—	—	—	—
<i>Paralichthys</i> sp.	462	—	—	—	—	—	—
<i>Urophycis regius</i>	—	343	—	—	—	—	—
<i>Larimus fasciatus</i>	—	—	299	—	—	—	—

^aAbsence of data indicates species did not occur in top 10 for respective localities.^bKeiser 1976 and 1977b.^cKnowlton 1972.^dWolff 1972.^ePellegrin et al. in preparation.

greater off the Louisiana coast (approximately area 2) than off the Texas coast (area 1). Louisiana and Texas also annually lead the Gulf states in volume of shrimp landed. Area 3 was characterized by both low fish and low shrimp concentrations. Gutherz and Thompson (1977) noted that sciaenids (the dominant groundfish family by weight in the northern Gulf) decreased greatly east of Mobile Bay, Alabama. Much of area 3 is considered un-trawlable; therefore, shrimp landings for area 3 were lower than the landings for areas 1, 2, and 4. Area 4 was characterized by greater shrimp landings than area 3 but lower fish densities. The faunal composition also changes in area 4 from semitropical, as found in areas 1 through 3, to tropical. The overall

fish/shrimp ratio in the by-catch of the Gulf is 9.1 : 1, and the total estimated by-catch is 5.1×10^5 t.

Discussion

The two largest annual fish by-catches of the south Atlantic region occurred off the North Carolina and Georgia coasts where an estimated 1.1×10^4 t and 9.4×10^3 t were taken, respectively. By-catch estimates were much lower for northeast Florida and South Carolina where 6.259×10^3 t and 6.296×10^3 t were taken, respectively.

Species compositions were relatively similar throughout the south Atlantic region

(Table 2); sciaenids dominated, with several species making significant contributions. Spot ranked number one for three states, whereas Atlantic croaker ranked either second or third. Other sciaenids included weakfish, kingfish (*Menticirrhus* sp.), star drum (*Stellifer lanceolatus*), and banded drum (*Larimus fasciatus*). Atlantic menhaden (*Brevoortia tyrannus*) contributed significantly off the coasts of South Carolina and Georgia where it ranked second and fourth, respectively.

For the entire south Atlantic region, an estimated 3.3×10^4 t of fish by-catch were harvested annually by the shrimp fleet. Five of the top 10 fish species were sciaenids, constituting 53.1% of the total fish by-catch. Dominant sciaenids included spot, Atlantic croaker, and weakfish. Other dominant species included Atlantic menhaden and pigfish (*Orthopristis chrysoptera*). The fish/shrimp ratio for the region was 2.8 : 1.

The two largest annual fish by-catches in the Gulf of Mexico occurred in areas 1 and 2. Fish captures were significantly smaller in areas 3 and 4.

Species compositions changed markedly across the Gulf region (Table 2). Sciaenids dominated in areas 1 through 3 but did not occur in the top 10 species of area 4. An estimated 6.1×10^4 t of sciaenid by-catch were harvested annually in area 1. Atlantic croaker dominated the catch, followed by shoal flounder (*Syacium gunteri*) and silver seatrout.

The centre of the northern Gulf of Mexico sciaenid population appears to occur in area 2, as an estimated 1.6×10^5 t were harvested annually (equal to about 60.8% of the total fish by-catch). Sciaenids were represented by

the top three species in this area, with Atlantic croaker exerting the greatest influence.

Although sciaenids dominated the species composition of area 3, they were not as abundant as in areas 1 and 2. Spot replaced Atlantic croaker as the most dominant species, with leopard searobin (*Prionotus scitulus*) also contributing significantly to the catch.

The annual estimate of total fish by-catch for the Gulf region was more than 15 times that of the south Atlantic region. This probably reflects the vast estuarine complex of the Gulf of Mexico centred on the Mississippi River delta. Gunter (1967) described the area as being one of the largest estuarine regions of the North American continent and one of the most productive fishery areas of the world. Gulf-wide, about 90% of the commercial catch and 70% of the recreational catch are made up of estuarine-dependent species (Lindall and Saloman 1977). Inspecting the species compositions of the by-catch for the Gulf region reveals that most species are indeed estuarine-dependent. This extensive estuarine environment would explain the overall greater productivity of the Gulf region in terms of both fish and shrimp.

Although sciaenids dominated the species compositions of both regions (53.1% of the south Atlantic and 43.4% of the Gulf), individual species components varied greatly. Spot dominated the south Atlantic region followed by Atlantic croaker and weakfish. Other dominant species included Atlantic menhaden and kingfish.

In the Gulf region, Atlantic croaker dominated the catch, followed by spot and sand seatrout. Inshore lizardfish (*Synodus foetens*) and longspine porgy (*Stenotomus caprinus*) also made major contributions.