A Survey of Bycatch in the Louisiana Gulf Menhaden Fishery

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Abstract: A survey was made of incidental catch in the Louisiana gulf menhaden (*Brevoortia patronus*) purse seine fishery. Samples were taken in 1980 and 1981 at plants located at Empire, Dulac, and Cameron. Overall the bycatch comprised 2.68% by number and 2.35% by weight of the catches sampled. The most abundant species were Atlantic croaker (*Micropogonias undulatus*), seatrout (*Cynoscion* spp.), threadfin shad (*Dorosoma petenense*), Atlantic bumper (*Chloroscombrus chrysurus*), hardhead catfish (*Arius felis*), and spot (*Leiostomus xanthurus*). Differences in species composition and abundance of bycatch among plants were found. The effects of the gulf menhaden fishery on other fisheries was considered insignificant.

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Gulf menhaden, the basic resource for a large fish meal and oil fishery extending from west Florida to east Texas, are caught exclusively in purse seines. There are now 8 reduction plants in Louisiana—2 at Empire; 1 each at Dulac, Morgan City, and Intracoastal City; and 3 at Cameron. Approximately 80% of gulf menhaden landings from 1975–1979 were processed in Louisiana. This fishery is the largest in Louisiana in terms of volume, and ranks second only to shrimp in value.

The impact of the menhaden fishery on other species has long been a point of argument. Postulated effects include destruction of spawning grounds of fish and shrimp, the depletion of the forage base (i.e., gulf menhaden) for some predators, and direct destruction of incidental species captured in purse seines. The first 2 assertions have been shown to be of little or no consequence (Baughman 1950, Knapp 1950, Gunter 1963, Oviatt 1977). The latter charge, concerning incidental catch, has been proven to be unfounded

several times (Christmas and Etzold 1977). However, the industry continues to be criticized on this issue.

Additional study was justified for several reasons. First, most studies took place over 20 years ago and a more current appraisal was needed. Second, some studies were restricted in scope, of short duration, and/or limited geographically. Our study was conducted over a 2-year period (1980–81) in 3 localities. Our objectives were to determine species composition and abundance of bycatch in the gulf menhaden fishery of Louisiana.

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Methods

Fishing Methods

A brief overview of fishing gear will be presented; for more detail consult Robas (1959), June (1963), and Christmas and Etzold (1977). Purse seines average about 425 m long and 20 or more m deep, and have a mesh size of not less than 1.6-cm bar; this net set in a perfect circle surrounds 1 ha. The top is kept afloat with cork floats while the bottom is weighted with stainless steel rings and a heavy lead "tom" weight of 180–215 kg. After the purse seine surrounds the school of menhaden, the net is pursed using a heavy rope running through rings on the bottom of the net and through the tom weight.

Plant Sampling

Sampling was conducted during 1980 to 1981 fishing seasons at 3 plants located along the Louisiana coast. These plants will be referred to as the Empire, Dulac, and Cameron plants. Boats from these plants generally fish different areas along the coast, although there is some overlap between adjacent plants. The menhaden season begins on the third Monday in April and ends on the first Friday after the second Tuesday in October. A total of 10 trips were scheduled at each plant for each year. The sampling sched-

ule was divided into 3-week increments in April–May and September–October, and into 2-week increments in June–August. The shorter time frames coincided with the peak harvest period in the fishery (Christmas and Etzold 1977). Samples were taken any time during each time frame. The actual number of sampling trips completed in 1980 and 1981, respectively, are as follows: Empire, 10 and 9; Dulac, 8 and 5; Cameron, 6 and 4. Twenty-three different boats were sampled.

Samples were taken by randomly scooping fish with a heavy-duty dip net as the catch was conveyed or dumped into "counting boxes" located inside each reduction plant. On each sampling trip 5 replicates (i.e., a 31.8 kg shrimp basket full of fish) were taken. Each basket replicate was weighed in total and a bucket subsample (approximately 5 kg) of gulf menhaden from the first basket was weighed in the aggregate and counted. The subsample weight and number of gulf menhaden was used to estimate total number of gulf menhaden per basket. In each basket sample all incidental species were separated, identified, counted, weighed, and measured. Because there was some initial confusion in the identification of sand seatrout (*Cynoscion arenarius*) and silver seatrout (*Cynoscion nothus*) by some samplers, it was impossible to correctly assign these early identifications. All specimens recorded as either sand seatrout or silver seatrout were regarded as *Cynoscion* spp.

Results and Discussion

Quantity of Bycatch

Considerable variation in bycatch values existed among sampling trips and between years (Table 1). Bycatch was highest at Empire and lowest at Cameron by number and weight. Percent weight of bycatch was usually lower than percent number because of the small size of many incidental species.

Several studies have been conducted on incidental bycatch in the gulf menhaden fishery. Dunham (1972) found that bycatch comprised 0.05% by number of the total catch in 1971 and 1.59% by weight in 1972. The latter figure did not include Atlantic thread herring (*Opisthonema oglinum*) which represented 2.33% by weight. Christmas et al. (1960) found incidental catch to comprise 3.90% by number and 2.80% by weight in the Mississippi menhaden fishery. An investigation by the Texas Game and Fish Commission (Knapp 1950, Miles and Simmons 1950) of boats operating out of Port Arthur revealed an incidental catch of 0.06% and 0.14% by number in 1948 and 1949. In general, bycatch data in the literature, as well as our data, show that menhaden landings from eastern Louisiana/Mississippi con-

Table 1. Bycatch Percentages in Gulf Menhaden Landed at Cameron, Dulac, and Empire during the 1980–81 Fishing Seasons

Year		Cameron		Dulac		Empire		Total	
		No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.
1980	Mean	1.35	1.37	1.11	0.81	4.72	2.61	2.39	1.60
	Range	0.11–4.78	0.22–3.61	0.00– 6.72	0.00–3.58	0.16–14.45	0.12– 5.69	0.00–14.45	0.00– 5.69
1981	Mean	1.29	1.03	3.13	1.70	4.47	6.58	2.96	3.10
	Range	0.23–3.92	0.42–2.39	0.19–12.20	0.44–4.20	0.11–14.77	0.04–10.46	0.11–14.77	0.04–10.46
1980–81	Mean	1.32	1.20	2.12	1.26	4.60	4.60	2.68	2.35
	Range	0.11–4.78	0.22–3.61	0.00–12.20	0.00–4.20	0.16–14.77	0.04–10.46	0.00–14.77	0.00–10.46

tain a greater volume of bycatch than landings from western Louisiana/Texas. The generally shallower purse seine sets in eastern Louisiana, including many in estuarine-like Chandaleur/Breton Sounds, may be the contributing factor for increased volume of bycatch in this area.

Empire data were separated because this location was distinctly different from Cameron/Dulac with respect to bycatch volume. At Cameron/Dulac approximately 86% and 77% of the samples contained less than 2% bycatch by number and weight, respectively. Most samples contained less than 5% bycatch by weight. No bycatch was recorded from 2 sampling trips at Dulac during 1980. Only 1 sample from either Cameron or Dulac produced high bycatch percentages; the first sampling trip at Dulac in 1981 resulted in 12.2% and 4.2% bycatch by number and weight, respectively. At Empire only 33% and 55% of samples contained less than 2% bycatch by number and weight, respectively. Two-thirds of the samples contained less than 5% bycatch for both number and weight. Two samples had 14–15% bycatch by number and 1 contained 24.8% bycatch by weight.

Our data indicate that most menhaden catches are very clean with respect to bycatch; however, very dirty catches are occasionally taken, especially at Empire. Christmas et al. (1960) also reported considerable variation in bycatch. They showed that 60% of seine sets produced less than 2.0% bycatch by number and that 12–14% of the sets yielded 5–10% bycatch. One set in 1957 contained 54.1% incidental catch.

Species Composition

A total of 35 fish and 6 invertebrate incidental species were taken during the study (Table 2) from the 3 reduction plants. The most abundant species of fish by number included Atlantic croaker (25.2%), *Cynoscion* spp. (19.7%), threadfin shad (13.2%), Atlantic bumper (12.6%), hardhead catfish (8.3%), and spot (5.8%). These 6 species comprised approximately 85% of the total weight of bycatch.

Invertebrate species, including squid (*Lolliguncula brevis*), oyster drill (*Thais haemastoma*), blue crab (*Callinectes sapidus*), *Callinectes similis,* white shrimp (*Penaeus setiferus*), and brown shrimp (*Penaeus aztecus*) were relatively insignificant in bycatch volume; only blue crab and brown shrimp were greater than 0.5% of bycatch by number.

Species composition, number of species, and abundance of bycatch differed among the 3 areas. More species were taken at Empire (35) than at either Dulac (17) or Cameron (19). Although sampling effort was greater at Empire than either Dulac or Cameron, variation in number of samples probably did not contribute significantly to the observed pattern in number of species. The composite Dulac/Cameron sampling effort exceeded Empire samples, but the pooled number of Dulac/Cameron species (25) was still

Table 2. Percentage Composition by Number and Weight of Individual Species in the Total Bycatch

	Empire		Dulac		Cameron		Total	
	% No.	% Wt.	% No.	% Wt.	% No.	% Wt.	% No.	% Wt.
Atlantic croaker (*Micropogonias undulatus*)	36.8	15.8	10.2	10.3	6.2	2.0	25.2	13.1
Cynoscion spp.	24.1	25.5	8.5	17.1	19.4	19.7	19.7	24.2
Threadfin shad (*Dorosoma petenense*)			63.9	26.2			13.2	4.3
Atlantic bumper (*Chloroscombrus chrysurus*)	2.6	1.2	4.9	5.2	53.9	35.3	12.6	8.1
Hardhead catfish (*Arius felius*)	12.8	30.5	1.0	5.7	2.7	11.0	8.3	24.2
Spot (*Leiostomus xanthurus*)	7.4	4.6	4.9	8.0	2.3	1.7	5.8	1.7
Star drum (*Stellifer lanceolatus*)	3.8	1.8			0.4	0.1	2.4	1.3
Spotted seatrout (*Cynoscion nebulosus*)	0.7	1.3					2.2	0.4
Harvestfish (*Peprilus alepidotus*)	0.7	0.7	2.7	4.4	3.1	2.3	1.6	1.6
Atlantic cutlassfish (*Trichiurus lepturus*)	1.5	1.1			2.3	1.6	1.3	1.1
Gafftopsail catfish (*Bagre marinus*)	1.3	5.3	0.5	7.1	1.2	12.5	1.1	7.1
Spanish mackerel (*Scomberomorus maculatus*)	1.3	3.2	0.7	2.3	0.4	0.1	1.0	2.6
Brown shrimp (*Panaeus aztecus*)	0.5	0.1					1.0	0.1
Blue crab (*Callinectes sapidus*)	1.0	1.1	0.2	0.9	1.2	1.2	0.8	0.2
Atlantic thread herring (*Opisthenema oglinum*)	0.8	0.9					0.5	0.6
Shark sp.	0.1	0.8	0.2	1.1	1.6	7.6	0.4	2.1
Bluefish (*Pomatomus saltatrix*)	0.2	0.8	0.7	5.7	0.4	1.6	0.4	1.8
Ladyfish (*Elops saurus*)	0.5	0.9					0.3	0.6
Squid (*Lolliguncula brevis*)	0.3	0.1			0.8	0.3	0.3	0.1
White shrimp (*Penaeus setiferus*)	1.0	0.3					0.3	0.1
Silver perch (*Bairdiella chrysura*)	0.5	0.2					0.3	0.1
Crevalle jack (*Caranx hippos*)	0.2	0.7	0.5	0.7			0.2	1.6
Southern kingfish (*Menticirrhus americannus*)	0.2	0.3	0.2	0.5			0.2	0.3
Butterfish (*Peprilus burti*)	0.2	0.1	0.2	0.3			0.2	0.1
Sheepshead (*Archosargus probatocephalus*)			0.2	4.1			0.1	0.7

Table 2. Continued

	Empire		Dulac		Cameron		Total	
	% No.	% Wt.	% No.	% Wt.	% No.	% Wt.	% No.	% Wt.
Cownose ray (*Rhinoptera bonasus*)	0.1	0.6					0.1	0.4
King mackerel (*Scomberomorus cavalla*)					0.4	1.8	0.1	0.3
Atlantic stingray (*Dasyatis sabina*)	0.1	0.4					0.1	0.2
Bay whiff (*Citharichthys spilopterus*)	0.1	0.1					0.1	0.1
Blackcheek tonguefish (*Symphurus plagiusa*)	0.1	0.1					0.1	0.1
Unidentified fish	0.1	0.1					0.1	0.1
Pinfish (*Lagodon rhomboides*)	0.1	0.1					0.1	0.1
Lookdown (*Selene vomer*)					0.4	0.1	0.1	0.1
Florida pompano (*Trachinotus carolinus*)	0.1	0.1					0.1	0.1
Skipjack herring (*Alosa chrysochloris*)			0.2	0.4			0.1	0.1
Gizzard shad (*Dorosoma cepedianum*)	0.1	0.1					0.1	0.1
Banded drum (*Larimus fasciatus*)	0.1	0.1					0.1	0.1
Scaled sardine (*Harengula pensacolae*)	0.1	0.1					0.1	0.1
Atlantic spadefish (*Chaetodipterus faber*)					0.4	0.1	0.1	0.1
Striped mullet (*Mugil cephalus*)					0.8	0.3	0.1	0.1
Callinectes similis	0.1	0.1					0.1	0.1
Oyster drill (*Thais haemastoma*)	0.1	0.1					0.1	0.1

lower than those from Empire. Our data thus implies that Empire menhaden landings contain more incidental species than either Dulac or Cameron. *Cynoscion* spp., Atlantic croaker, star drum (*Stellifer lanceolatus*), and spot, and hardhead catfish dominated the bycatch at Empire (Table 2). Sciaenids (especially *Cynoscion* spp. and Atlantic croaker) were also common at Dulac and Cameron, but were outnumbered by threadfin shad at the former and by Atlantic bumper at the latter plant (Table 2). Threadfin shad were present in only 1 sampling trip (May 1981) at Dulac, but still dominated Dulac landings because of large numbers (262) in that sample.

Literature on bycatch in the menhaden fishery generally supports our observations on spatial variations in dominant species and in number of species. Dunham (1972) listed 27 fish species in samples from Louisiana menhaden plants. The major species, in order of abundance, included hardhead catfish, cownose ray (*Rhinoptera bonasus*), gafftopsail catfish (*Bagre marinus*), spot, sand seatrout, and Spanish mackerel (*Scomberomorus maculatus*). Knapp (1950) found 15 species and 2 groups (shark and clupeids) in samples taken off western Louisiana/Texas in 1948. Clupeids (other than gulf menhaden) comprised approximately 80% of the bycatch by number; sharks, sand seatrout, spot, Spanish mackerel, and bluefish (*Pomatomus saltatrix*) each totaled from 2.5–5.0% numerically. In the same general area, Miles and Simmons (1950) reported 43 species in the 1949 incidental catch survey; Atlantic bumper and Atlantic thread herring accounted for 50.4% and 20.3% of the bycatch by number, respectively. Christmas et al. (1960) collected 62 incidental fish species in the fishery of Mississippi/eastern Louisiana with the following 10 species, in order of abundance, comprising over 90% of the total bycatch: striped mullet (*Mugil cephalus*), Atlantic croaker, spot, threadfin shad, gafftopsail catfish, hardhead catfish, sand seatrout, harvestfish (*Peprilus alepidotus*), *Cynoscion* spp., and pinfish (*Lagodon rhomboides*).

In summary, more species have been taken in bycatch studies in Mississippi/eastern Louisiana than in western Louisiana/Texas. Also, striped mullet and sciaenids were more common in the former, whereas clupeids and Atlantic bumper were more common in the latter area. These patterns are probably related in part, as in bycatch volume, to differences in fishing habitats.

The last sampling trip at the Empire plant in 1980 was interesting in that no menhaden were taken. Instead, the purse seine was set on a school of Atlantic thread herring which comprised 97.2% by number of the total catch. This data was separated from other samples because of its unique character. Other species captured included crevalle jack (*Caranx hippos*), gafftopsail catfish, hardhead catfish, Atlantic bumper, and Spanish mackerel. Atlantic thread herring are desirable catches in the menhaden fishery because

they contain a high body oil content, are of satisfactory quality for reduction to fish meal, oil and solubles, and are economically profitable under normal market conditions (Butler 1967).

The only sport species common in the bycatch were *Cynoscion* spp. and Atlantic croaker; however, specimens of these species were all small. Assuming a harvestable size of 300 mm for *Cynoscion* spp. and 200 mm for Atlantic croaker, no harvestable specimen was represented in our samples. Spotted seatrout were uncommon in incidental catch and confined to Empire; in addition, all were below harvestable size. The remaining sport species, bluefish, Florida pompano (*Trachinotus carolinus*), southern kingfish (*Menticirrhus americanus*), king mackerel (*Scomberomorus cavalla*), and Spanish mackerel were rarely observed and below harvestable size.

We feel our data are representative of bycatch found in the Louisiana menhaden fishery. One exception, however, is probably the underestimation of certain large fish species in our samples. To prevent damage to the suction pumps, some large specimens of shark, crevalle jacks, etc. are removed from the catch during harvesting or unloading. Some fish may also be removed from the catch by harvesting or unloading crews for personal consumption; however, such removals are probably insignificant because of the tight work schedule during harvest operations and the often very poor quality of fish unloaded at reduction plants.

Size of Bycatch

Most of the incidental catch collected in our study was small. The only species that averaged over 225 grams included sheepshead (*Archosargus probatocephalus*), cownose ray, shark sp., gafftopsail catfish, Atlantic stingray (*Dasyatis sabina*), bluefish, and crevalle jack. Length frequency histograms of the 2 most abundant species or species groups (*Cynoscion* spp., Atlantic croaker) were plotted (Fig. 1) to further illustrate the size of fish caught in the purse seines. Modal size groups were 170–179 mm for *Cynoscion* spp. and 120–129 mm for Atlantic croaker; maximum length groups were 280–289 mm for the former and 150–160 mm for the latter.

Conclusions

The menhaden fishery utilizes techniques and gear that is very efficient in capturing menhaden with a relatively small amount of incidental catch. Menhaden aggregate in dense schools and generally strike horizontally toward the sun rather than vertically when frightened. Both fishing gear and techniques have evolved to capitalize on these behavioral characteristics of menhaden. Consequently, purse seines are selective against most other species. For example, large predators (sharks, jacks, mackerel, etc.) that

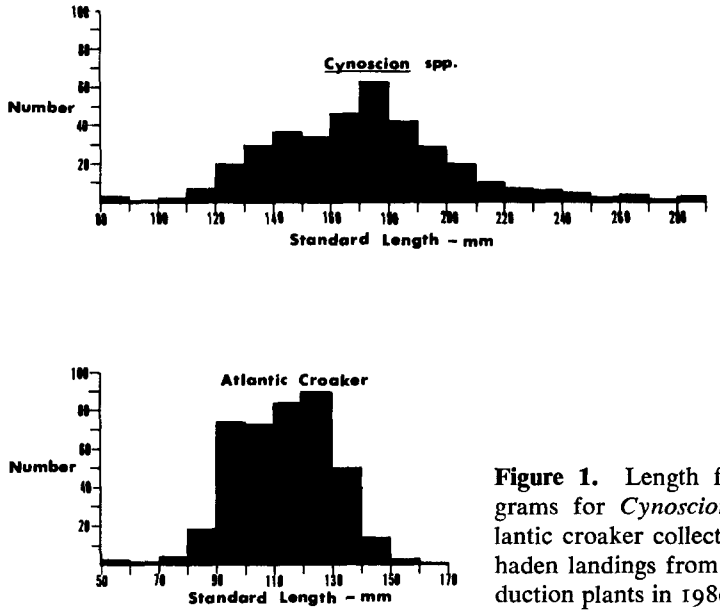

Figure 1. Length frequency histograms for *Cynoscion* spp. and Atlantic croaker collected in gulf menhaden landings from 3 Louisiana reduction plants in 1980–81.

frequent the fringe of menhaden schools are such powerful swimmers that they usually escape. In addition, as the seine is pursed, the bottom may be lifted up so that bottom dwelling and/or vertically-striking species may escape from the net.

From our data it would appear that no appreciable damage to fish populations, including sport fish, can be attributed to the Louisiana menhaden fishery. The industry appears compatible with other commercial and/or sport fisheries and charges brought against the industry with respect to bycatch have no reasonable basis. Incidental catch is fairly low; using our bycatch to gulf menhaden ratios and average menhaden landings for the period 1970–1975, an average annual bycatch of 14.6 million kg for the entire Gulf of Mexico menhaden fishery was computed. A comparison of total bycatch volume in the menhaden and shrimp fisheries provides an interesting contrast and indicates the relatively insignificant impact of the menhaden fishery. Using known fish to shrimp ratios (Siedel 1975) and shrimp landings for 1970–1975 (Van Lopik et al. 1980), an average fish bycatch of 683.2 million kg was taken in the Gulf of Mexico commercial shrimp fishery during these years. The menhaden bycatch during the same time period was thus only about 2.1% of the shrimp bycatch. This disparity would probably have been much greater had recreational catches of shrimp been considered. The area subjected to purse seine sets is also much lower than

areas utilized by the shrimp fishery. Christmas (1980) noted that in the record 1978 season only about 1.03% of the bottom in the fishing grounds might have been disturbed once by menhaden nets. No estimates exist on the bottom coverage by trawlers over an entire season; however, most trawlable bottoms (especially in Louisiana) are dragged many times over the duration of the season. In addition, bycatch taken in the menhaden fishery is not wasted like in the shrimp fishery; all bycatch is processed along with the menhaden in the reduction plants.

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