The Northern Gulf of Mexico Groundfish Fishery, Including a Brief Life History of the Croaker (*Micropogon undulatus*)

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ABSTRACT

The northern Gulf of Mexico groundfish fishery is discussed, including a description of vessels, fishing gear, the grounds occupied, fishing tactics, and processing of the catch. Distribution and species composition of the groundfish stocks are presented, and a brief life history of the Gulf of Mexico croaker, *Micropogon undulatus*, is given.

INTRODUCTION

Croaker (*Micropogon undulatus*) are primarily exploited by the industrial bottomfish and foodfish fisheries in the northern Gulf of Mexico. The industrial groundfish fishery between Mobile Bay, Ala. and Trinity Shoals, La. currently lands about 50,000 tons annually (Fig. 1). Croaker represent about 70% of these landings and are utilized for pet food, fish meal, and bait. The fishery was described by Roithmayr (1965) and Gutherz et al. (1975). The foodfish fishery lands about 5,000 tons of large croaker (Fig. 2). They are marketed in Atlantic coast states from Georgia to New Jersey, with limited quantities sold in the midwest and along the Gulf coast. In addition to these landings it is estimated that more than 200,000 tons of industrial bottomfish are discarded at sea by shrimp fishermen. Sport fishermen and hook-and-line commercial fishermen catch numerous croaker near offshore oil platforms and in inside waters of sounds, bays, and rivers. Tabulations are not available for total landings by sportsmen within the defined commercial fishing area; however, Deuel (1973) listed 31,397 tons of croaker taken by sports fishermen from Florida to Texas. Population and catch data suggest that croaker stocks have the potential for further expansion with the development of new product technology.

Croaker represent about 50% of the total biomass on the northern Gulf industrial fishing grounds. Because the dynamics of the bottomfish fishery is controlled by croaker, general aspects of its life history and a brief description of the fisheries are described in this paper.

BIOLOGY OF CROAKER

The life history pattern of croaker is depicted in Figure 3. Spawning takes place primarily near shore during fall and early winter. Larvae move into the estuary on tidal or wind-generated currents and remain there to overwinter and grow. In the late spring or early summer, juvenile croaker migrate from the estuary into the near-shore environment and enter the fishery. This migration is

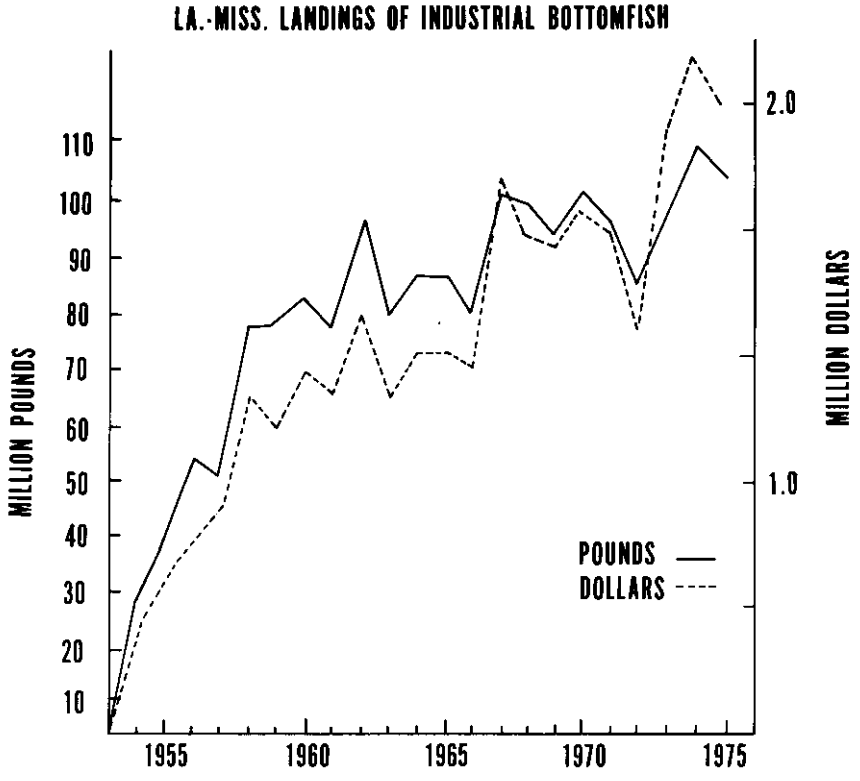

Fig. 1. Commercial landings of industrial bottomfish and their dollar values for the combined La.-Miss. landings between 1953 and 1975.

seen both east and west of the Mississippi River Delta; however, it can occur somewhat later east of the Delta. Croaker range from Massachusetts to Texas in the contiguous waters of the United States though they ordinarily are not numerous north of Chesapeake Bay. Similar life histories are noted throughout their range; however, spawning may commence earlier in the more northerly latitudes.

Reproduction

Gulf of Mexico croaker have a protracted spawning period extending from September to May. The primary spawning period is from October through December, with a secondary peak in early spring. Initiation of spawning is variable, but the primary spawning period is usually completed by the end of January.

Some spawning takes place throughout the offshore areas out to depths of about 80 m (40 fm), but major spawning occurs in depths of 20 m (10 fm) or less in the proximity of tidal passes. The larvae are then transported through these passes into the estuarine nursery grounds.

Eggs and larvae of croaker have been described by Hildebrand and Cable (1930) and Middaugh and Yoakum (1974). Developing eggs are pelagic and range in diameter from 0.6 to 0.7 mm, with mean length at emergence about 1.2 mm. Time from fertilization to emergence is 30 h 40 min (Middaugh and Yoakum, 1974). Croaker larvae about 5 mm TL first occur in the Mississippi Sound in October. Entrance into the estuary is variable depending on initiation of spawning. Immigration into the estuary continues throughout the spawning season with larvae generally collected no later than April. Croaker larvae and

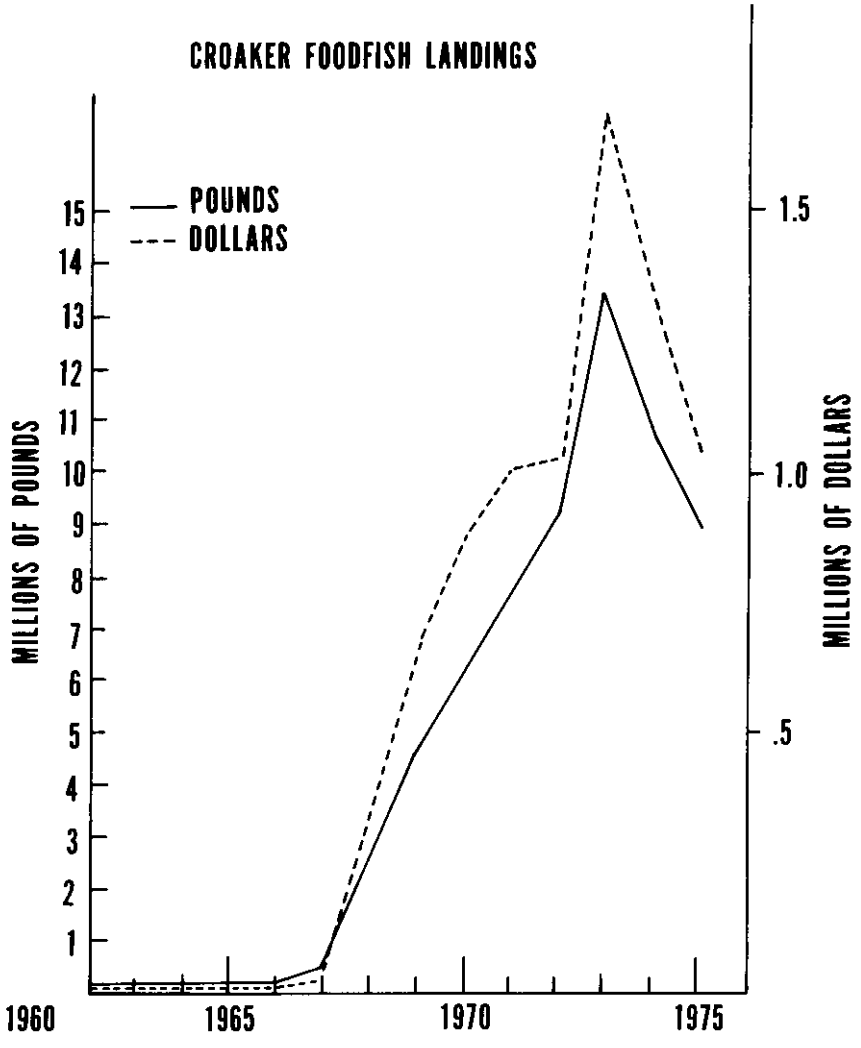

Fig. 2. Foodfish landings of croaker in Ala. and their dollar value from 1967 to 1975.

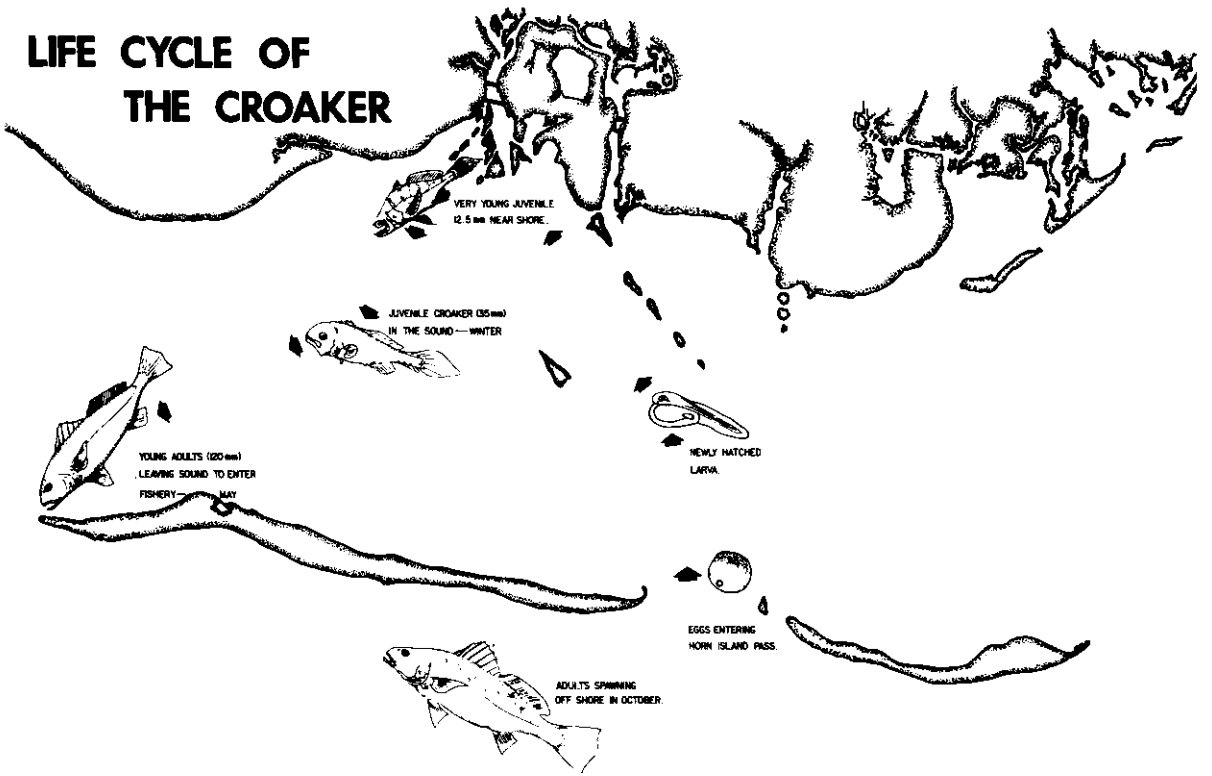

Fig. 3. Overview of the general life history pattern of croaker, *Micropogon undulatus*.

juveniles tolerate broad ranges of temperature and salinity, thereby increasing their survival rate as they overwinter in the estuary (Hildebrand and Cable, 1930; Bearden, 1964).

Fecundity of croaker in the Gulf of Mexico has not been established; however, Hildebrand and Schroeder (1928) reported a 15.5 in (39 cm) specimen with 180,000 uniformly sized eggs in the ovary. Uniformity of egg size infers that once spawning starts it is continuous until the ovary is empty.

Growth

Croaker are estuarine dependent and utilize the extensive estuarine system of the north central Gulf coast. Each estuary is an independent entity and has its own specific chemical, geological, hydrological, and biological characteristics. The growth rate of croaker may be slightly different between these areas, but general growth rates are similar.

The extended spawning season and varying time of estuarine emigration and immigration make age determinations from length frequencies difficult; however, it appears that three age groups are definable. The first two age classes are readily identified (Fig. 4) with respective mean lengths of 6.7 and 8.7 in (17 and 22 cm) TL. Considerable overlap is noted between all age groups. Age-1 croaker range from 4.7 to 9.1 in (12 to 23 cm) TL, age-2 from 5.9 to 11.4 in (15 to 29 cm) TL, and age-3 from 8.3 to 14.2 in (21 to 36 cm) TL (Bennie A. Rohr, National Marine Fisheries Service, Pascagoula Laboratory, Pascagoula, Miss. 39567, pers. comm.). This overlap in length between age groups results from the extended spawning period. By age 3 approximately 97% of the population has been lost to fishing or natural mortality. Predation on large croaker is probably minimal with longevity extending to 6 or 7 years. The largest reported croaker measured 26.1 in (66 cm) TL and weighed 8 lb gutted (Rivas and Roithmayr, 1970).

Sport or commercial snapper fishermen using hook-and-line consistently catch larger croaker in the vicinity of offshore platforms than those caught in trawls.

A sample of 80 croaker taken from a commercial snapper fishing vessel ranged from 10.2 to 18.9 in, average 16.1 inches (26 to 48 cm) TL, and 0.5 to 3.0 lb, average 2.1 lb (225 to 1352 g). A trawl catch in the same general area at the same time produced a sample of 95 croaker ranging from 5.5 to 15.7 in, average 9.5 in (14 to 40 cm) TL, and 0.1 to 1.9 lb, average 0.5 lb (34 to 851 g) (Bennie A. Rohr pers. comm.). Trawl caught large croaker have not exceeded 20.5 in (52 cm) TL, and they are seldom larger than 15.7 in (40 cm) TL.

Movement

Seasonal inshore-offshore movements of croaker have been described by Hildebrand and Schroeder, 1928; Gunter, 1945; and Bearden, 1964. Water temperature appears to influence these spring-fall (inshore-offshore) movements in South Carolina (Bearden, 1964) and the Gulf of Mexico (Franks et al., 1972). Gulf of Mexico inshore bottom temperatures during the spring have a similar

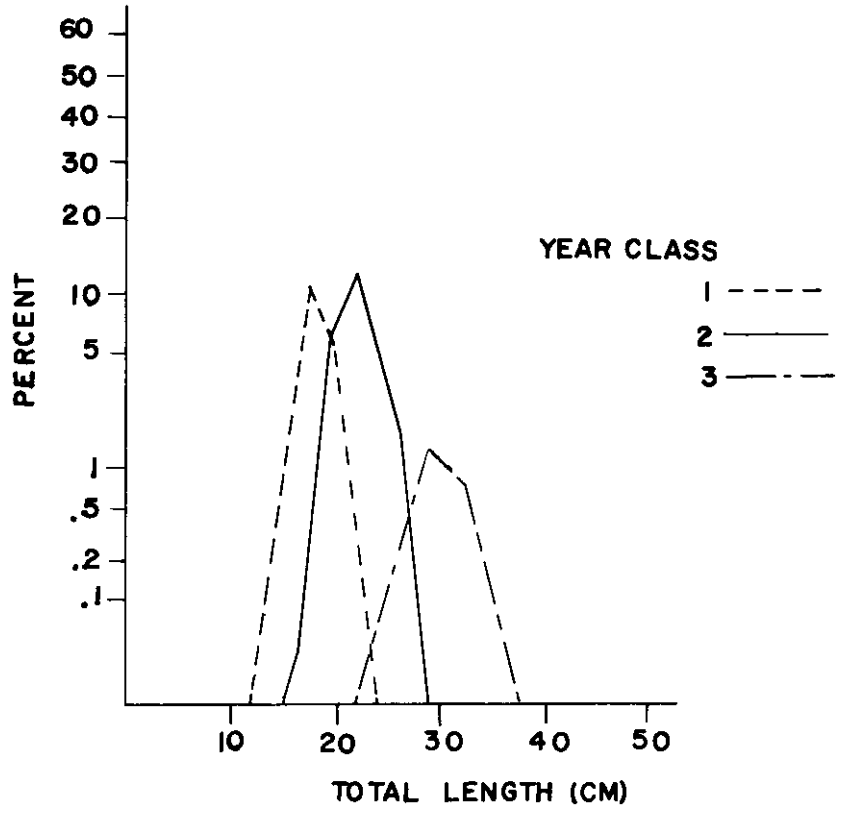

Fig. 4. Length frequency of croaker, *Micropogon undulatus*, showing two distinct age classes at 6.7 and 8.7 inches TL (17 and 22 cm).

range to that seen in the offshore areas during the fall (Perry A. Thompson, National Marine Fisheries Service, Pascagoula Laboratory, Pascagoula, Miss. 39567, pers. comm.). The change in these bottom temperatures coincides with the movements of croaker, i.e., they move offshore in the fall and inshore during the spring apparently to seek preferred water temperatures.

Croaker larvae move into the upper reaches of the estuary shortly after hatching. This movement continues throughout the spawning period with the highest number of larvae noted between October and January. During the ensuing winter and spring months croaker are found throughout the estuarine system, and they are probably the most abundant finfish species in the estuary.

Larvae that entered the estuary in early fall are ready to migrate into the open Gulf of Mexico between April and July. Actual time of migration is somewhat variable depending on growth rate and environmental conditions. The mechanisms controlling time of migration are unknown, but can be partly related to size because juvenile croaker caught in trawls are of uniform size.

Young croaker remain inshore and seldom venture beyond 10 m (5 fm). Movement into the open Gulf may continue as late as September-October due to the protracted spawning. During summer months young croaker usually remain in depths less than 20 m. With the onset of cold weather in late fall–early winter and the accompanying changes in bottom temperatures, croaker move into the deeper warmer offshore areas. During winter and early spring months few croaker are found in depths less than 20 m with most caught between 20 and 60 m (10 and 30 fm).

Size of individual croakers is generally related to depth. Throughout the year the largest croaker are commonly found around the mouth of the Mississippi River or in the proximity of offshore platforms in depths exceeding 40 m (20 fm). Smaller croaker are caught throughout the area in shallower depths.

Croaker school throughout their lives, but schools are poorly defined during winter and spring. Density of winter-spring schools is reflected in the lower catch per unit effort (CPUE) and schools show a greater divergence in size groups. Summer and fall schools are large and well defined with the resultant higher CPUE. At times summer and fall schools are extensive, producing 10 to 20 tons of fish in 15 to 20 min of fishing. These schools generally consist of fish of a uniform size, suggesting that once the school is formed it maintains itself through spawning until offshore migration.

Number of croaker on the fishing grounds is highest during the summer months when new recruits enter the fishery; however, mortality is highest at this time.

Croaker biomass estimates as a function of weight are highest during the fall, then decline continuously to a spring low just before the new recruits enter the fishery (Fig. 5). Throughout recruitment, population weight continues to increase. During the time of increasing weight, growth exceeds the population losses due to fishing and natural mortality. The remainder of the year when population weight decreases, mortality exceeds population growth.

Croaker Distribution

Croaker distribution on the industrial bottomfish grounds in the northern Gulf of Mexico is dependent on water temperature, season, and bottom type. Croaker prefer a muddy bottom and are generally not found in depths exceeding 120 m (60 fm). Few croaker or other sciaenid fishes are caught on a sand-dead shell bottom. During late spring, summer, and early fall when inshore water temperatures are high, heavy concentrations of finfish are found inside 20 m. When inshore bottom temperatures drop during late fall, winter, and early spring, finfish move offshore and the heaviest concentrations are found between 20 and 60 m.

Species Composition

A list of species taken on the northern Gulf groundfish grounds was compiled by Roithmayr (1965); however, only about 20 species are major components of the industrial trawl fishery (Table 1). Sciaenids, specifically croaker, dominate

the species composition. Seven other significant finfish are: spot (*Leiostomus xanthurus*), sea trout (*Cynoscion nothus* and *C. arenarius*), Atlantic cutlassfish (*Trichiurus lepturus*), catfish (*Arius felis*), longspine porgy (*Stenotomus caprinus*), bumper (*Chloroscombrus chrysurus*), and Gulf butterfish (*Peprilus burti*). Animals highly prized for their value as food items are also taken in variable quantities. Shrimp (*Penaeus*), pompano (*Trachinotus*), and bulldozer lobster (*Scyllarides nodifer*) are sometimes taken in quantities which have significant dollar value to the commercial fishermen.

INDUSTRIAL BOTTOMFISH FISHERY

Vessels and Gear

Vessels and gear have changed considerably since the inception of the fishery in 1952. An average-sized boat was about 50-ft TL (15.3 m) with a 165-hp engine and towed a single 65-ft (19.8 m) trawl. At that time there were approximately 50 boats fishing; some operated full time but most did not.

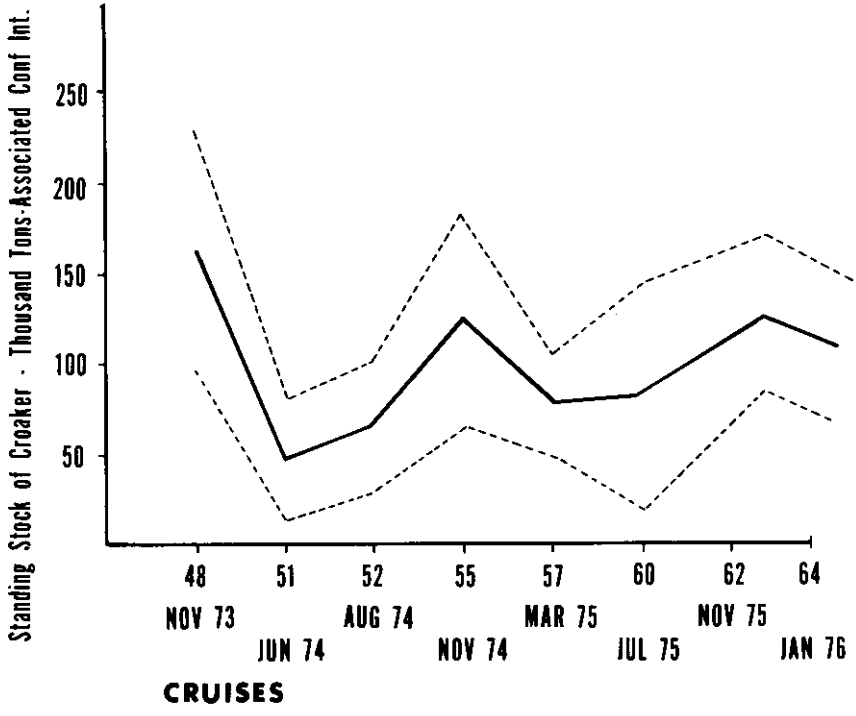

Fig. 5. Estimates of weight in tons and associated confidence intervals for croaker, *Micropogon undulatus*, during survey cruises to show population trends.

Table 1. List of finfish species contributing a significant portion to the bottomfish biomass on the northern Gulf of Mexico industrial bottomfish grounds

Family	Scientific Name	Common Name
Sciaenidae	*Cynoscion arenarius*	Sand seatrout
	Cynoscion nothus	Silver seatrout
	Larimus fasciatus	Banded croaker
	Leiostomus xanthurus	Spot
	Menticirrhus americanus	Southern kingfish
	Micropogon undulatus	Croaker
	Stellifer lanceolatus	Star drum
Carangidae	*Chloroscombrus chrysurus*	Bumper
	Trachurus lathami	Rough scad
	Vomer setapinnis	Atlantic moonfish
Ariidae	*Arius felis*	Sea catfish
Sparidae	*Stenotomus caprinus*	Longspine porgy
Stromateidae	*Peprilus burti*	Gulf butterfish
Trichiuridae	*Trichiurus lepturus*	Atlantic cutlassfish (Silvereel)
Clupeidae	*Harengula pensacolae*	Scaled sardine
	Sardinella anchovia	Spanish sardine
Synodontidae	*Synodus foetens*	Lizardfish
Triglidae	*Prionotus sp.*	Searobin

Presently there are 22 boats in the fishery, ranging from 75 to 145 ft (22.9 to 44.3 m) TL with 365- to 1000-hp engines, and towing two 70- to 110-ft (21.4 to 33.6 m) trawls. The carrying capacity of these trawlers ranges from 100 to 400 tons. A typical trawler is shown in Figure 6. Trawlers are constructed of steel, are double-rigged, and have a refrigerated seawater (RSW) tank for holding the catch.

Trawls are constructed from a basic design, differing only in size and placement of certain components. Leglines vary between 10 and 40 ft (3 to 12.2 m); mesh size is fairly uniform with 3 in (7.5 cm) in the wings and body, and 1.25 to 2 in (3 to 5 cm) in the throat and bag. Floats increase the vertical opening, and mud-rollers prevent the trawl from bogging in the mud. Doors are generally constructed of wood with chain bridles. Aluminum flotation tanks are sometimes used to increase the stability of the larger doors. Door size is variable, ranging from 10 ft x 50 inches to 15 ft x 72 in, with 12 ft x 60-inch doors most commonly used.

Fishing Grounds

The primary fishing area extends from Mobile Bay, Ala. (Long. 88°00'W) to just west of Ship Shoal, La. (Long. 91°30'W) to 100 m (50 fm, Fig. 7). These grounds are influenced by the extremely productive Mississippi River which annually deposits large quantities of sediments at its mouth creating a soft-mud bottom with a steep slope. East and west of this area, the bottom composition

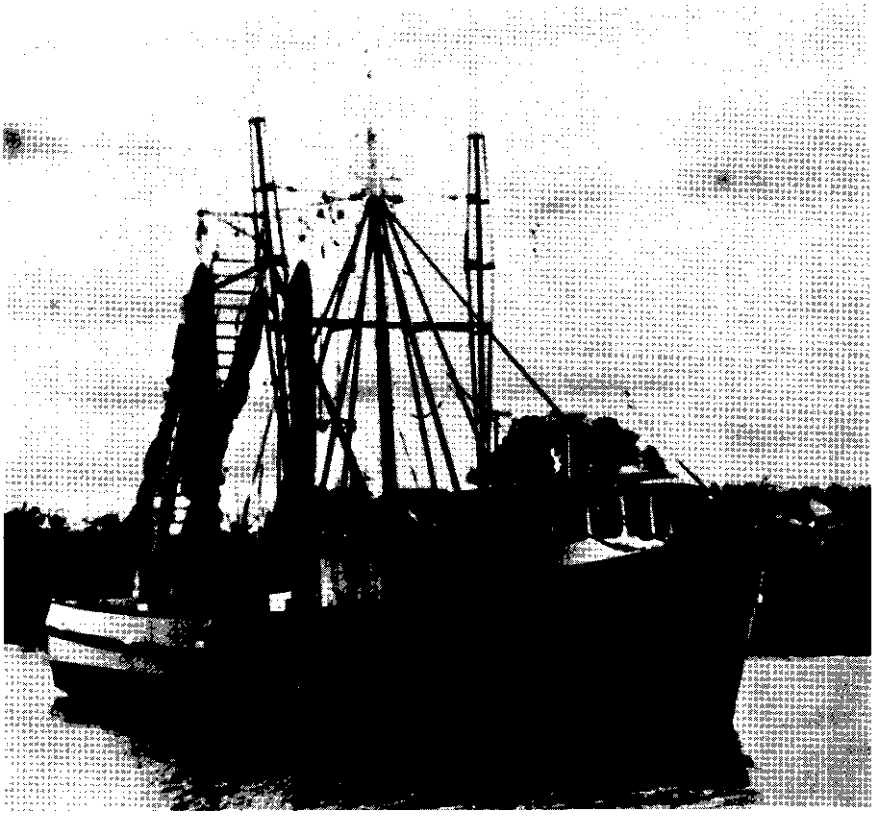

Fig. 6. Typical industrial bottomfish trawler operating in northern Gulf of Mexico.

changes from soft mud near the mouth of the river to a firm mud/sand, then to a sand-shell bottom where the shelf becomes broader and the rate of deposition decreases. Densities of fish are lower east and west of the primary fishing area. Fishing normally takes place inside 40 m; however, during the winter months it may extend seaward to 100 m.

Fishing Tactics

Fishing has evolved from single-rigged, small, wooden vessels to double-rigged, large, steel trawlers designed specifically for this fishery. All vessels employ a small trynet to locate commercial concentrations of fish and to monitor fishing activity. The trynet is hauled back each half-hour and the catch evaluated to determine whether to: (1) continue fishing, (2) change direction of tow, (3) move to a different area, or (4) set the large trawl. Evaluation criteria include species composition, number, condition, color, ratio of croaker to other finfish, and amount of undesirable material.

Trawling time varies from 10 min to 5 h, depending on density and availability of finfish, with longer tows producing low quality fish. Longer tows are generally made during the winter and spring months when fish are widely dispersed and the population is reduced. Fishing is continuous during periods of high catch rates, except for time lost due to gear changes, repairs, or unfavorable sea conditions. Fishing time averages about 14 h per day, depending on bottom type and regularity, gear damage, and density of fish. The catch is emptied into the chilled RSW solution through a grid which prevents sharks, rays, or large edible fish from entering the RSW tank.

Trip time varies from 3 to 10 days, with an annual average of about 7 days per trip. Summer and fall trips average about 3.5 days when catch rates are highest. Winter-spring trips average about 9 days because of decreased fish densities. Running time to the fishing grounds depends on the area fished and ranges from 4 h (east of the Delta off Pascagoula, Miss.) to 24 h (west of the Delta off Ship Shoal, La.) for vessels operating from Mississippi ports.

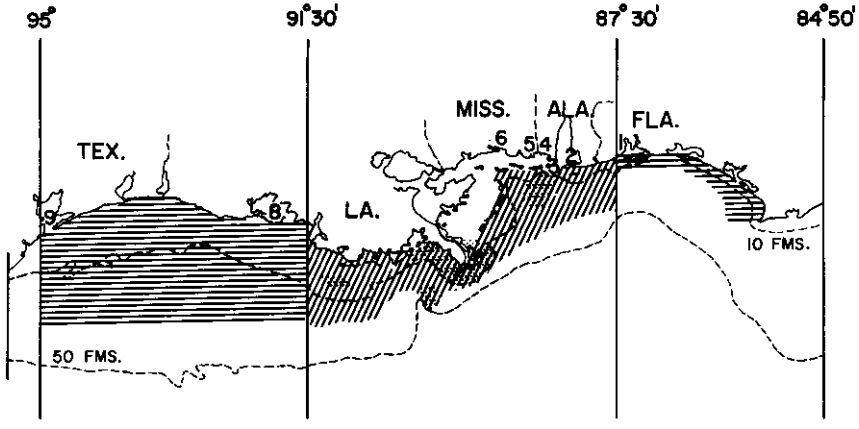

Fig. 7. Historical and traditional fishing grounds for industrial bottomfish and foodfish croaker in the northern Gulf of Mexico. Horizontal lines—historical grounds for industrial bottomfish, diagonal lines—present area fished by industrial bottomfish fleet, and the stippled area—area fished by foodfish croaker fleet. Specific locations referred to in the text are as follows: (1) Pensacola Bay, Fla. (2) Big Lagoon, Ala.; (3) Dauphin Island, Ala.; (4) Bayou La Batre, Ala.; (5) Pascagoula, Miss.; (6) Biloxi, Miss.; (7) Golden Meadow, La.; (8) Marsh Island, La.; (9) Galveston, Tex.

Processing

Vessels are offloaded with hydraulic fish pumps that transfer fish and RSW from the hold onto a conveyor belt leading into the plant (Fig. 8). Pump water is recycled back into the hold and repeatedly removed with fish by the pump system. Offloading time is variable depending on species composition and tonnage, with 100 tons taking 6 to 8 h. All marketable fish, crustaceans, and undesirable animals (i.e., those difficult to grind or harmful to the grinders) are removed from the conveyor belt as the catch proceeds into the plant. Marketable items are returned to the vessel crew and undesirable items are discarded.

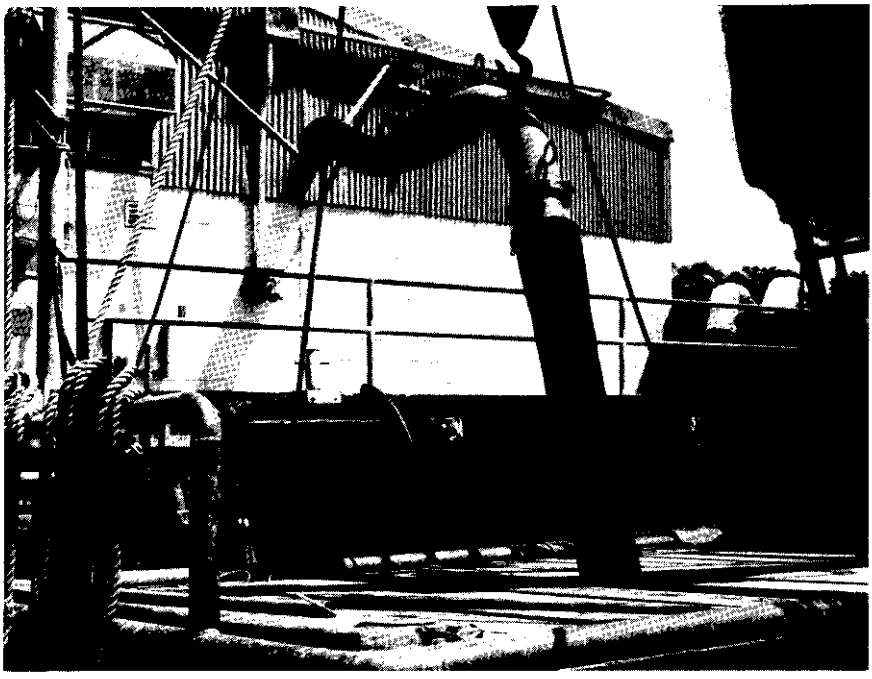

Fig. 8. Suction hose used to offload catch from industrial bottomfish trawler.

Desirable whole raw fish used for pet food enter the plant and are weighed, to determine payment for the catch, then ground and mixed with meal or other animal protein. Vitamins, minerals, and other products are added according to specified formulations. The product is then cooked, canned, sterilized in retorts, cooled, labeled, and readied for distribution. Fishmeal processing includes pressurized steam cooking, drying, and grinding. No oils or solubles are extracted in this process. Bait processing consists of freezing blocks of whole fish to a specified size with little regard to species composition.

FOODFISH CROAKER FISHERY

Vessels and Gear

Initially the foodfish fleet consisted of large shrimp boats, but as catches increased, vessel modifications were needed to deploy larger trawls and to increase the holding capacity. Vessels are generally constructed of steel and of a similar exterior design, though generally smaller than those operating in the industrial bottomfish fishery (Fig. 9). Ice rather than RSW is used to hold and insure the quality of the catch.

Trawls are of one basic design, but generally smaller than those used in the industrial bottomfish fleet. Placement and number of floats, mud rollers, and chain are variable, dependent on the individual captains. Mesh size is fairly uniform but wing depth ranges from 80 to 200 meshes depending on how high the net is to open. The most commonly used trawl doors measure 10 ft x 44 in (3 m x 11 cm) and are constructed of wood with chain bridles.

Fishing Grounds

The primary fishing area for foodfish croaker is between 4 and 80 m (2 and 40 fm) around Southwest and North Pass off the Mississippi River Delta. Limited fishing also takes place off Mobile Bay, Ala. (Fig. 7).

Fishing Tactics

Major differences between the foodfish and industrial bottomfish fisheries relate to the size of fish harvested and shipboard processing techniques. The foodfish industry requires iced fresh croaker longer than 9 in (23 cm). Fishing operations are similar to those described for the industrial bottomfish section of fishing tactics, except smaller trynets and fishing trawls are used.

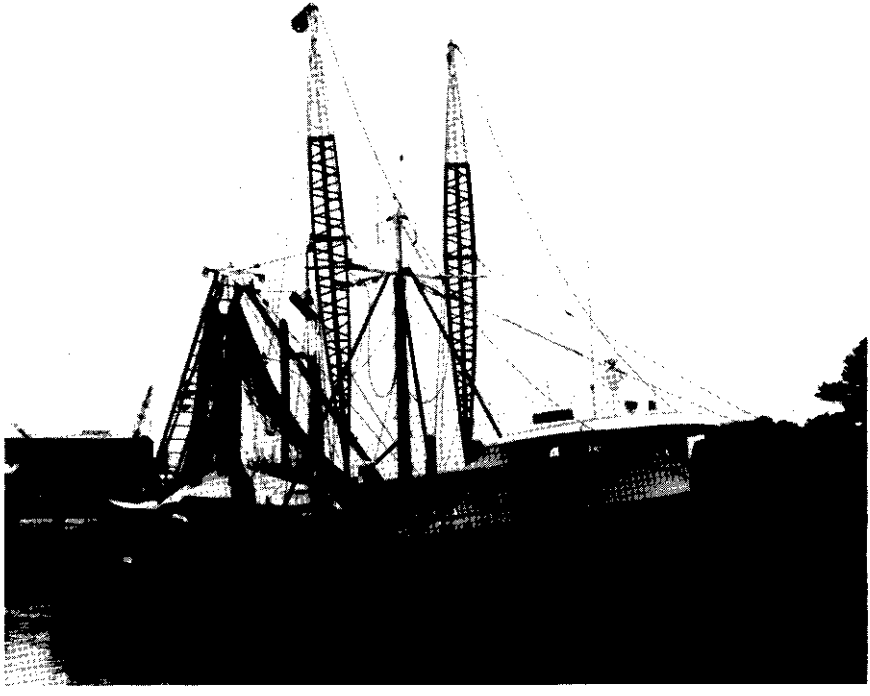

Fig. 9. Typical foodfish croaker trawler operating in the northern Gulf of Mexico.

Trawling time varies from 20 min to 3 h depending on concentrations of commercial sized croaker. Trawling is conducted only between sunrise and sunset because fishing the same limited grounds continuously disrupts the fish.

The catch is dumped on deck and sorted for edible croaker, other marketable finfish, and shrimp. Edible croaker are rough-sorted in size groups, placed in the hold, and iced. The remainder of the catch is discarded at sea.

Trip time ranges from 3 to 12 days depending on availability of fish and weather conditions. Average time is 6.5 days with 5 days spent fishing. Fishing time per day is about 13 h, less search and repair time.

Processing

Processing is restricted to offloading, grading, and boxing the catch. Vessels are offloaded with a bucket or suction hose and the catch is belt-conveyed into the plant. The catch is then hand sorted into the three size groups: large, greater than 1 lb (455 g) and longer than 12 in (30 cm); medium, between 0.75 and 1 lb (340-455 g) and longer than 10 in (25 cm); and small, between 0.5 and 0.75 lb (228-340 g) and longer than 9 in (22 cm). After grading, the sorted fish are boxed in the round, iced, and prepared for transport to the fresh-fish market.

Croaker offloaded from hook-and-line snapper boats are uniformly large and no sorting is necessary. The fish are boxed, iced, and taken to Bayou La Batre, Alabama for shipment to the fresh-fish markets.

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