CROAKER WORKSHOP REPORT AND SOCIO-ECONOMIC PROFILE

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CROAKER WORKSHOP REPORT

AND

SOCIO-ECONOMIC PROFILE

by

C. Bruce Austin
J. Connor Davis
Robert D. Brugger
Joan A. Browder

Results of a workshop and socio-economic profile of the fisheries for Atlantic croaker and associated groundfish in the northern Gulf of Mexico

Sponsored by

National Marine Fisheries Service
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Rosenstiel School of Marine and Atmospheric Science
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BIO-SOCIO-ECONOMIC PROFILE OF THE CROAKER FISHERIES

BACKGROUND ON THE SOCIO-ECONOMIC FISHERY PROFILE WORKSHOPS

C. Bruce Austin, Principal Investigator

Sponsor

The workshops were sponsored by the Southeast Region, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, Department of Commerce, under Contract No. 03-6-042-35137.

Objectives and Scope

The purpose of the workshops was to obtain necessary, but presently unavailable descriptive and quantitative socio-economic information for systems modeling, through workshops comprised of people directly working "in" the fisheries (e.g., fishermen and processors) as well as from those working "on" the fisheries (scientists and administrators).

Choice of Fisheries and Workshop Participants

The choice of fisheries was determined by mailing a questionnaire to people knowledgeable about fisheries in the southeast region. The questionnaire recorded why these people considered the fisheries they selected to be the most appropriate for such workshops.

Northern Gulf croaker (*Micropogon undulatus*) and mackerels (king, *Scomberomorus cavalla*, and Spanish, *Scomberomorus maculatus*) were chosen after discussions with National Marine Fisheries Service and State officials. These species ranked near the top of the questionnaire recommendation list, had minimum overlaps with other studies, encompassed a wide range of issues, and are economically important.

Those that responded to the questionnaire also recommended individuals working "in" and "on" the fisheries whom they believed would be the most knowledgeable about general fishery, biological, and economic factors. Persons were categorized according to: fishermen, processors, scientists, and administrators. Utilizing these names as a starting point, workshop participants were selected on the basis of providing information on all the important aspects of the fisheries (general, biological, socio-economic) and as representing specific interest groups.

Croaker Workshop Participants

Mark Chittenden, biologist, population dynamics, Texas A&M University, College Station, Texas.

John Christiansen, Manager, Quaker Oats (processes croaker into pet food), Pascagoula, Mississippi.

Albert Jones, biologist/administrator, fishery management plans, Southeast Fisheries Center, NMFS, Virginia Key, Florida

Jimmie Martin, industrial (pet food) croaker trawl fisherman, Pascagoula, Mississippi.

Charles Roithmayr, biologist/administrator, general fishery information, Pascagoula Laboratory, NMFS, Pascagoula, Mississippi.

Grady Seamen, food croaker trawl fisherman, Bayou La Batre, Alabama.

Kent Seamen, Seamen Seafood (handles fresh and frozen food croaker), Bayou La Batre, Alabama.

Charles Sebastian, charterboat captain, Grand Isle, Louisiana.

David Summersgill, Summersgill Enterprises (freezes croaker for crab bait, and animal food), Golden Meadows, Louisiana.

Mackerel Workshop Participants

Donald Allen, biologist/administrator, general fishery information, Southeast Fisheries Center, NMFS, Virginia Key, Florida.

Al Arnitt, gillnet king mackerel fisherman, Vice President, Organized Fishermen of Florida, Summerland Key, Florida.

Dale Beaumariage, biologist/administrator, general fishery information, migration, landings, Florida Department of Natural Resources, Tallahassee, Florida.

Frank Breig, handline king mackerel fisherman, Treasure Coast Cooperative, Ft. Pierce, Florida.

Harold Busher, biologist/administrator, recreational fisheries information, Panama City Laboratory, NMFS, Panama City, Florida.

Charles Carter, gillnet king mackerel fisherman, Key West, Florida.

James Cato, economist, cost and returns, marketing margins, University of Florida, Gainesville, Florida.

Leo Cooper, fish house operator (Angelo's Seafood), Marathon, Florida.

Tim Daniels, gillnet king mackerel fisherman, President of Middle Keys Chapter of Organized Fishermen of Florida, Marathon, Florida.

Roger Farlow, Vice President, Treasure Coast Cooperative, Ft. Pierce, Florida.

Gary Graves, fish house operator (Keys Fishery), Marathon, Florida.

Edward Houde, biologist, observer, University of Miami, Miami, Florida.

Albert Jones, biologist/administrator, fishery management plans, Southeast Fisheries Center, NMFS, Virginia Key, Florida.

Charles Manooch, biologist/administrator, general fishery information, mackerel literature, Beaufort Laboratory, NMFS, Beaufort, North Carolina.

Eugene Nakamura, biologist/administrator, general fishery information, mackerel literature, Panama City Laboratory, NMFS, Panama City, Florida.

Fred Prochasha, economist, cost and returns, marketing margins, University of Florida, Gainesville, Florida.

Curtis Ryan, charter boat captain, President of Charterboat Association, Key West, Florida.

Deborah Shaw, general Keys fishery information, natural history, Key West Cooperative Extension Service, Key West, Florida.

Elemer Stokes, gillnet Spanish mackerel fisherman, Leesburg, Florida.

Tony Storemont, gillnet Spanish mackerel fisherman, Treasure Coast Cooperative, Ft. Pierce, Florida.

Walter Thompson, gillnet king mackerel fisherman, Marathon, Florida.

The number of workshop participants was restricted for two reasons. First, it was believed that a small, broadly representative group of people would communicate most effectively to yield the most socio-economic information. A major task of the participants was to verify or correct the workshop staff's impressions of the fisheries, as presented in the background papers. These background papers explained methods, outlined the purpose and tasks of the workshops, and served as the primary resource documents.

A second reason for restricting participants was that some self-employed participants could only attend if they were reimbursed for their travel and lodging expenses. Participants employed with public agencies (State or Federal) or large businesses were more able to have their employer cover their travel and lodging expenses.

Workshop Staff

Preparation of background material, logistic support for the workshops, and final reports, were team efforts by the following persons.

C. Bruce Austin, Marine Resource Economist, Assistant Professor, Department of Economics School of Business and Division of Biology and Living Resources, Rosenstiel School of Marine and Atmospheric Science, University of Miami. Principal Investigator.

Joan A. Browder, Systems Ecologist, Consultant (now Assistant Research Professor, Division of Biology and Living Resources, Rosenstiel School of Marine and Atmospheric Science). Primary responsibility: preparation of the mackerel background material.

Robert D. Brugger, Economic Research Assistant, Division of Biology and Living Resources, Rosenstiel School of Marine and Atmospheric Science, University of Miami. Primary responsibility: workshop coordinator, logistic support.

J. Connor Davis, Biology Research Assistant, Division of Biology and Living Resources, Rosenstiel School of Marine and Atmospheric Science, University of Miami. Primary responsibility: preparation of the croaker background material.

James B. Higman, Fisheries Biologist, Research Assistant Professor, Division of Biology and Living Resources, Rosenstiel School of Marine and Atmospheric Science, University of Miami. Primary responsibility: review and edit final workshop reports.

David Kittrel, Graduate Student Research Assistant, Department of Economics, University of Miami. Primary responsibility: assist in preparation of croaker and mackerel background material.

Mark C. Ward, Graduate Student Research Assistant, Department of Economics, University of Miami. Primary responsibility: assist in systems modeling.

Special Contributors to the Croaker Workshop

Charles Roithmayr, biologist, Pascagoula Laboratory, NMFS, Pascagoula, Mississippi. Presented an overview of the Gulf croaker fisheries.

Mark Chittenden, Assistant Professor, Department of Wildlife and Fisheries Science, Texas A&M University, College Station, Texas. Presented an overview of the Gulf croaker stocks.

Special Contributors to the Mackerels Workshop

Deborah Shaw, Key West Cooperative Extension Service, Key West Florida. Presented an overview of the natural history and Florida Keys fisheries for mackerels.

Dale Beaumariage, Chief, Bureau of Marine Science and Technology, Florida Department of Natural Resources, Tallahassee Florida. Presented an overview of the biological work (primarily tagging) done on mackerels by the Florida Department of Natural Resources.

Eugene Nakamura, Officer in Charge, NMFS Panama City Laboratory, Panama City, Florida. Presented a summary of a recently compiled bibliography on mackerel.

Fred J. Prochaska and James C. Cato, economists, Florida Sea Grant Program, Gainesville, Florida. Presented a paper on costs and returns, marketing margins in the mackerel fisheries (printed in the final workshop report).

Jeffrery A. Fisher, Extension Agent, Florida Cooperative Extension Service, Panama City, Florida. Submitted a report on recreational (private and charter) fishing for king mackerel in Northwest Florida (printed in final workshop report).

Harold A. Busher, Lee Trent, and Mark L. Williams, Panama City Laboratory, NMFS, Panama City, Florida. Submitted a paper on recreational fishing for king mackerel in Bay County, Florida (1975) (printed in final workshop report).

Kevin I. Allen, Kenneth T. Ellington, and Henry R. McAvoy, Market Research, NMFS, Gloucester, Massachusetts. Submitted paper on domestic zoo and aquarium purchases of mackerel (printed in the final report).

Pre-Workshop Preparations

Besides selecting fisheries and participants and arranging logistic support for the workshops, the primary effort of the staff was the preparation of background papers on the chosen fisheries (croaker and mackerels). The first task was a literature search. This was more complete for croaker than mackerels because the literature search for croaker was also part of another NMFS contract (croaker socio-economic profile, Contract No. 03-6-042-35137). As was expected, much more biological information was available than socio-economic or general fishery information.

After completing the literature search, Connor Davis conducted a field trip from Miami to Mississippi and return by car for pre-arranged interviews with croaker fishery people and to observe croaker fishing, processing handling, etc.

A trip to Pensacola by Joan Browder was made for the purpose of gathering information on the croaker fishery. Joan Browder also conducted field trips from Key West to Sebastian and to Naples for the mackerel (king and Spanish) fisheries.

These field trips served two purposes. They were planned to search out information that was not available in the literature. Little additional written or quantitative information was uncovered, however, industry people provided considerable descriptive socio-economic information that was valuable if it could be organized. This was a task of the workshops. The field trips also offered the opportunity to select workshop participants after initial field interviews determined their ability and desire to articulate and record what they knew about the fisheries.

Background Papers

The information that was assimilated from the literature search and the field trips was brought together into separate croaker and mackerel workshop background papers. These papers presented the staff's initial "impressions" of the fisheries. They did not purport to be wholly accurate and were not for publication or quotation. When important facts were not known, we sometimes speculated. The purpose of the papers was to provide a starting point for workshop discussions.

Workshops

The croaker workshop was conducted 31 March and 1 April 1977 at the University of Miami Rosenstiel School of Marine and Atmospheric Science on Virginia Key, Miami, Florida. The mackerel workshop was conducted 28-29 April 1977 at the National Marine Fisheries Service Southeast Fishery Center on Virginia Key, Miami, Florida.

Post Workshop Analysis and Final Workshop Reports

The workshop sessions were taped. These tapes were the basis for revising the background papers which are the final workshop reports. These reports were then reviewed by workshop participants. The remainder of this document is the workshop's final bio-socio-economic profile on the croaker fisheries. After the profile are written statements by some workshop staff and participants.

The workshop's final report on mackerels is published as a separate University of Miami Sea Grant document.

BIO-SOCIO-ECONOMIC PROFILE OF THE CROAKER FISHERIES

Assimilated from existing data and

information provided by workshop participants

J. Connor Davis

C. Bruce Austin

DESCRIPTION OF THE CROAKER STOCK

Life Cycle

The Atlantic croaker has a short life cycle characterized by rapid growth, high mortality rate, and dependence on the estuary during its juvenile stage. These characteristics are shared by many species which inhabit the shallow (less than 50 fathoms) soft bottom areas of the North Central Gulf of Mexico (Chittenden, 1977). The major portion of the croaker stock in the Gulf is found between the mouth of Mobile Bay and Ship Shoal, Louisiana, out to 30 fathoms.

Croaker spawn in the Gulf of Mexico near the estuaries. Peak spawning occurs during fall, probably in October (White and Chittenden, 1976) or November (Juhl et al., 1975), although some spawning may take place from September through March (White and Chittenden, 1976; Welsh and Breder, 1923). Larvae immigrate into the estuaries, where they grow rapidly until the following spring. In May and June, the juveniles begin to move out of the estuary (Hansen, 1969) when they are approximately 110–129 mm TL (4.3–5.1 inches) (Parker, 1971; Hansen, 1969). They remain close to shore, in such areas as Mississippi Sound, for 1-2 months, then move out and join the stock of older fish. Young of the year appear in the commercial catch in June at a length of 120 mm TL (4.7 inches) (Juhl et al., 1975). At this time, the majority of the stock is in shallow water, less than 7 fathoms. They remain in shallow water until October or November, then begin to move offshore to areas between 10 and 30 fathoms (Gutherz, 1977). This offshore movement is probably in response to decreasing water temperatures. The fish remain offshore until the following spring, when they begin to move inshore.

Fish older than one year are seldom abundant inside estuaries. An interesting exception to this was the presence of large numbers of adult croaker in the Pensacola Bay estuary. Gillnet fishermen in the area reported very good catches of croaker from 1968 through 1975. These fish were present in the bay as late as January. The average size of the fish increased during the 8 year period. During the first years of the fishery, 80% of the fish were "mediums" (3/4-1 pound) and 20% were "large" (over 1 pound). During the last few years, 20% were mediums and 80% were large (Austin Smith, per. comm.).[1] These fish did not reappear in 1976.

Standing Stock

Estimates of croaker standing stock in 5 50 fathoms are available (Table 1) for three months in 1974 (June, August, and November) and in 1975 (March, August, and November). For the area between 2 and 5 fathoms, biomass estimates are available for June, 1974 and June, 1975 (Juhl, et al., 1975, 1976).

Table 1. Standing stock of croaker in the north central Gulf of Mexico (short tons).

	1974			1975			
Date	June	Aug	Nov	March	June	Aug	Nov
5-50 fathoms	46,859	65,194	123,016	92,965		78,926	130,415
2-5 fathoms	88,359				60,985		
TOTAL	135,218	65,194	123,016	92,965	60,985	78,926	130,415

*Juhl, et al., 1975, 1976.

In the area 5-50 fathoms, biomass is at its lowest in June, before the entry of young of the year into that area. Total biomass estimates in that area are higher in August and November and then decrease. This gives the appearance that during the summer months the biomass is increasing. This likely represents immigration into the 5-50 fathom area from closer inshore. By June, the majority of the young of the year have moved out of the estuaries, but remain in waters less than 5 fathoms. Most of the stock of older fish is also found in less than 7 fathoms. If the June biomass estimate for 2-5 fathoms is included, the biomass in the area available to the fishermen (3.5 fathoms and deeper) is largest in June. Most of the croaker stock is found within 5-50 fathoms from November through May. Biomass estimates in November and March show a consistent decline from June estimates.

Age, Growth and Mortality

There is considerable variation in estimates of growth and mortality (Table 2). Differences can be a result of differing sampling techniques, sampling bias in gear, or actual differences in the growth and mortality rates in different areas. Estimates of age and growth utilized in this report are based on Juhl (1975, 76) but there is considerable disagreement over what are the best estimates.

INDUSTRIAL FISHERY

Trawl Fleet and Fishermen

Small croaker (predominantly 115-200 mm) are exploited primarily by what is referred to as the "industrial fleet." The catch is processed into canned petfood, frozen crab bait, and fish meal (used primarily for poultry feed).

Table 2. Estimates of length at age and mortality rates of Atlantic croaker. Total length[1] mm (inches).

Author	Age I		Age II		Age III		Mortality Rates
Juhl, *et al.*, 1975	160	(6.3)	220	(8.7)	290	(11.4)	
Juhl, *et al.*, 1976	162.5	(6.4)	238.2	(9.4)	275.8	(10.9)	97% in 3 years
Herke, 1971	250	(9.8)					
White and Chittenden, 1976	160	(6.3)	270	(10.6)			96% per year
Pearson, 1929			220	(8.7)			
Welsh and Breder, 1924	150	(5.9)	220	(8.7)	265	(10.4)	
Gunter, 1945	103–173	(4.1–6.8)					
Roithmoyr, 1965 b	127	(5.0)	178	(7.0)			
Nelson, 1969	115–120	(4.5–4.7)					

[1] SL converted to TL by $\frac{SL}{.8} = TL$

The vessels which began the industrial fishery in 1953 were designed for shrimp fishing. They were primarily "Biloxi lugger" side trawlers, characterized by an engine room and pilot house located near the stern of the vessel. Some boats fished shrimp and bottom fish simultaneously. The catch on these boats was preserved on ice. Vessels were small, approximately 50 feet, hold capacity about 30 tons, and a pulled single 65 foot net (Gutherz, et al., 1975). The trend towards larger more efficient vessels began immediately (1954) when two converted menhaden boats with capacities up to 125 tons entered the fishery. These vessels used refrigerated seawater to preserve the catch (Roithmayr, 1965A). This method is now used by all the vessels. Presently all but two vessels in the fleet are specially designed for the industrial trawl fishery. They are double rigged, designed to fish two nets simultaneously, one from each side of the vessel. In 1974, vessels varied in size from 75 to 121 feet with carring capacities from 72 to 300 tons (Gutherz, et al., 1975). Today the largest vessel is 145 feet with 400 tons capacity. The typical net has an 85 foot head rope; net size varies with the size of the vessel. Electronic equipment generally includes CB and VHF radios, autopilot, depth recorder, loran, and radar. Crew size varies from 2-4, with most vessels carrying 3 including the captain.

While the size of individual boats and their production capabilities have been increasing, the number of vessels and fishermen has steadily declined. In the late 1950's there were approximately 50 vessels in the fishery (Roithmayr, 1965A). In 1974, there were 16 vessels in Mississippi and 5 in Louisiana (Gutherz, et al., 1975). In January, 1978, there were 11 vessels in Mississippi and 4-5 in Louisiana.

The cost of industrial trawlers has increased rapidly in recent years. One owner estimated the 1977 replacement cost of his 85-foot vessel at

$500,000 plus nets and electronics which is twice its cost ($250,000) seven years ago. Replacement cost of larger vessels exceed one million dollars. This is nearly double the cost of a shrimp trawler of equivalent size. The industrial trawler's high cost is due to the heavier construction necessary to handle the heavy loads of its trawls and to the cost of the refrigerated seawater system.

Loans are available from two primary sources, commercial banks and federally insured boat loans. Bank loans are the most common. They will lend with low down payments but at relatively high interest rates. Bank loans are usually six month open notes. Banks often establish maximum debt limits. If a fisherman wants to own more than one boat, he may not be able to obtain sufficient credit. Federal insured boat loans have no debt limit, and offer lower fixed interest rates. However, they require a 25% down-payment, and involve substantial red tape. It is difficult to acquire the down payment and the red tape is unattractive to fishermen.

Juhl (1974) estimated an annual income of $19,319 to the owner of an "optimum vessel" (90 feet) with a replacement cost of $250,000. This was based on estimates before the sharp increase in fuel costs. Since that time, vessel operating costs have risen almost 300% (Jimmie Martin, per. comm.) while ex-vessels prices have increased approximately 26% during the same period. At the present price and production levels, vessels which are already amotorized can make a profit. However, it is difficult to earn enough income to amotorize a new vessel. Reluctance of the independent owners to replace their vessels could result in greater vertical integration as processors purchase boats to assure their fish supply. This has been the trend in the past in the case of Mavar Shrimp and Oyster Company.

The industrial fleet is large in terms of landings and dockside value, but small in terms of the number of people employed. This is because the fleet is very capital intensive. There are approximately 50 fishermen (crews and captains) actively engaged in industrial fishing operations in Louisiana and Mississippi, as of January, 1978. Most of these fishermen have been in the fishery for a long time and are related to fishing families who originally fished shrimp. There is little labor mobility in or out of the fishery, although crew members frequently move among vessels.

Entry into the fishery as a crew member is difficult because of the declining number of crew positions. Those seeking employment without close personal connections, either family or friends in the fishery, have little chance of securing work except as a last minute replacement for an absent regular crewman.

Many crewmen believe they could earn higher incomes fishing shrimp, but are willing to accept lower pay croaker fishing for two reasons. First, it is not necessary to hand sort the catch. Second, croaker boats make shorter trips and return to the same port.

The captain and the crew are paid individually on the basis of tons of fish landed. An additional source of income to the crew is the incidental catch of food fish and shrimp, all of which goes to the crew. These bring relatively low prices because the preservation in refrigerated seawater results in a poor quality product relative to ice preserved fish and shrimp. Even so, this represents a significant source of income. Juhl (1974) estimated an additional income of $23,375 for the entire crew of an optimum vessel. This represented 23% of the crew's net income. One captain estimated his crew received 10-15% of their income from the incidental catch. The annual income of a crewman on an industrial trawler varies from $12,000 to approximately $19,000 dependent on the vessel, the captain's skill, and the amount per ton that owners pay the crew. Crews on independent vessels make more than those on processor-owned vessels but that income is less reliable.

Fishing Grounds

The industrial fishery grounds extend from just west of Ship Shoal, Louisiana to the entrance of Mobile Bay between the depths of 3.5-50 fathoms, (Figure 1). Most trawling is done in less than 20 fathoms. The grounds may be separated into two areas, east and west of the Mississippi River delta, with the dividing line at the South Pass of the Mississippi River. On the east delta grounds, no trawling is done inside of the barrier islands of the Mississippi Sound although some vessels may operate in Breton Sound for short periods.

In the early years of the fishery, most of the fishing effort was east of the delta (Roithmayr, 1965A). As effort has increased, more fishing activity has been directed west of the delta. By 1972, effort and catch were divided evenly between east and west delta grounds. This probably reflects an inability of the east delta grounds to supply the quantities of fish being harvested (Gutherz, et al., 1975).

Catch Composition and Landings

Approximately 70 percent of the catch is Atlantic croaker (Micropogon undulatus). Four other species comprise most of the remainder of the catch; spot (Leiostomus xanthurus), silver seatrout (Cynoscion nothus), sand sea trout (C. areanarius) and Atlantic cutlassfish or silvereel (Trichiurus lepturus). The size of individual fish which can be used by the processing equipment in the pet food plants is limited. For croaker, the maximum size is 8 inches (Gutherz, et al., 1975). The petfood plants prefer croaker to other groundfish, therefore, the industrial trawlers fish specifically for croaker.

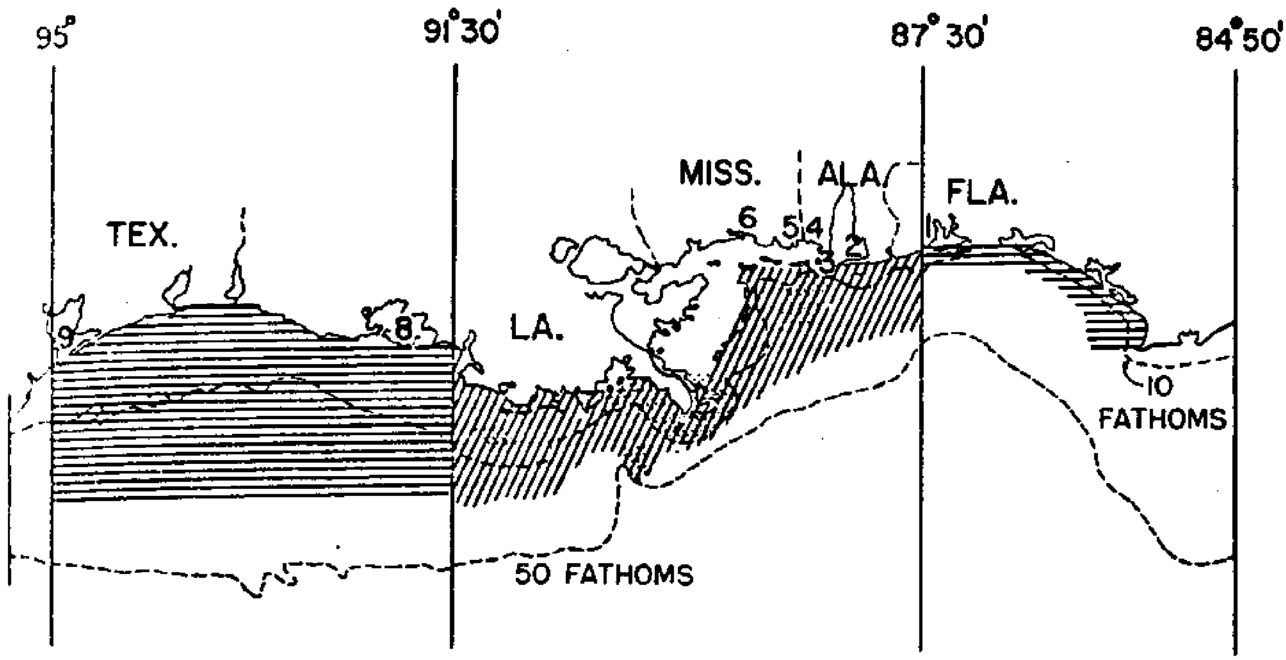


Figure 1. Fishing grounds for industrial bottomfish and foodfish croaker in the northern Gulf of Mexico. Horizontal lines indicate historical grounds for industrial bottomfish, while diagonal lines show the present area fished by industrial bottomfish fleet and the stippled area is that fished by the foodfish croaker fleet. adapted from Gutherz et al., 1975

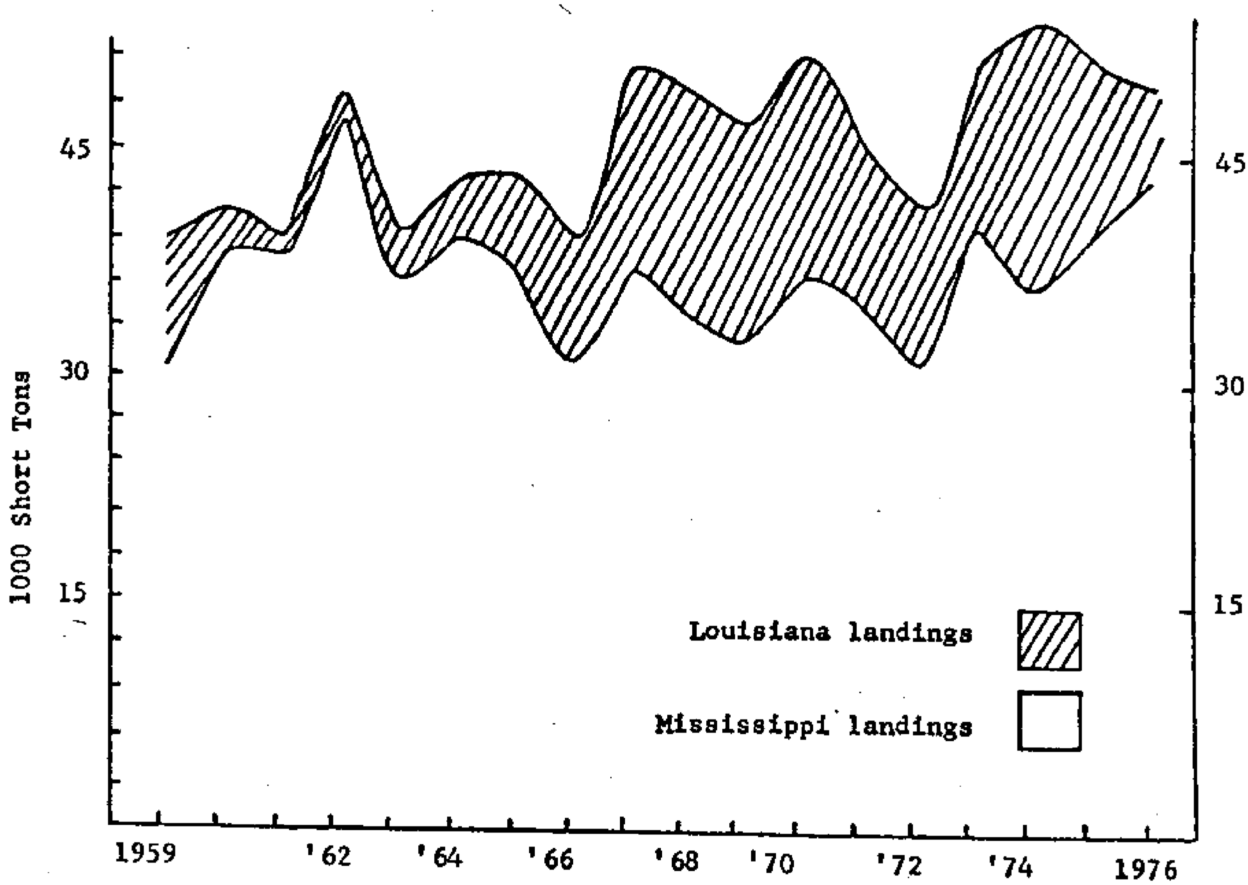
The skill with which vessel captains select for croaker has increased significantly. From 1959 through 1963, croaker were 56 percent of total landings (Roithmayr, 1965A). In 1974 the proportion of the catch that was croaker had increased to 72 percent (Juhl, et al., 1975) and 75% in 1976 (Charles Roithmayr, per. comm.). The increase in 1976 may be related to a change in fishing grounds. Also, part of the increase since 1959 may be due to better net design.

From 1952 to 1958, the industry rapidly expanded increasing both the number and capacity of vessels and processors (Roithmayr, 1965A). From 1958 to 1966 production remained stable at approximately 41,000 tons. In 1967 production rose to 50,300 tons (Juhl, et al., 1975). This resulted primarily from the opening of the Lipton pet food cannery at Golden Meadows, Louisiana. Since 1967, catches have fluctuated around 50,000 tons, except for two years of low stock abundance, 1971 and especially 1972. Landings in Mississippi have remained failry stable since the early 1960's. Landings in Louisiana fluctuate greatly from year to year (Figure 2).

Seasonal Fluctuations of Croaker Concentrations and Fishing Effort

There are two distinct seasons in the fishery, summer–fall and winter-spring. The croaker stock has an onshore-offshore movement correlated with water temperature. Seasonal differences are found in total effort, catch per unit effort, areas fished, length of tow, and size classes of fish in the catch.

In the summer and fall, most fishing is carried out inside of 7 fathoms (Roithmayr, 1965B). In the late spring the fish move into shallow water and begin to concentrate. Catch rates rise to approximately 2-4 tons per hour. Two year classes are evident, I^{+} and II^{+}, with the bulk of the catch most often



Source: Drummand, *et al.*, 1977

Figure 2. Annual Mississippi and Louisiana landings of industrial groundfish.

most often from I^+, depending on year class strength. Usually in June, young of the year, age approximately 9 months and length 12 cm (4.7 inches) are recruited into the fishery. Catch rates rise to a mean of 4-6 tons per hour (Juhl, et al., 1975). Very dense schools of croaker can be found and catches of 20 tons in 15 minutes have been reported (Gutherz, et al., 1975). Most fishing effort is expended on the nearshore grounds east of the river mouth. At that time, the catch is primarily from age I^+ with young of the year fish comprising a large portion of the catch in certain areas. The processors limit landings at this time of year, sometimes as early as May, when the catch begins to exceed processing capacity. Low stock abundance has resulted in little or no limitation of landings since 1976. During the rest of the summer and fall, availability of the fish and catch per unit effort fall slowly. Fishing effort remains inshore but is extended west of the delta when the catch is not sufficient from the grounds east of the delta. By August, most effort is west of the delta. In the fall, catch rotes begin to increase east of the delta (Charles Roithmayr, pers. comm.).

With decreasing water temperatures, the fish move offshore and disperse. The fishermen follow; most trawling occurring outside 7 fathoms from November to April (Roithmayr, 1965B). Catch rates drop to approximately 1 ton per hour. Catch rates generally remain low until late spring when the inshore movement of croaker begins.

Estimated Catch Per Unit Effort

Catch per unit effort (CPUE) and effort statistics are computed for two periods, 1959-1963 and 1973-1976. Effort and CPUE for the two periods are not comparable. There have been too many changes in the fishery. Nets are larger and better designed for ground fish and boats are larger and more powerful. The distribution of effort on the fishing grounds has also changed.

CPUE expressed as tons per hour dragging a standard 65-foot net increased slightly from 1959 to 1963. Mean values for the four-year period increased from .438 in 1959 to .556 in 1963. There appeared to be no evidence that the stock was being overfished at that time (Roithmayr, 1965A).

In 1973, the National Marine Fisheries Service again began monitoring the fishery at the request of industry representatives. This was the result of poor catches in 1972, and fear by the industry that the stock was being over-exploited.

Low catch rates in 1972 were apparently the result of temporary fluctuations in abundance. Landings recovered in 1973 and reached an all-time high in 1974. Catch rates improved from 1972 to 1973, but have been going down slowly since that time (Table 3). The sharpest drop in CPUE occurred in 1976. Biomass estimates from NMFS cruises in 1976 indicated a drop in abundance of industrial bottom fish, especially on the east delta grounds. A shift in effort by the fishermen to the west grounds supports those conclusions. Very few fish were caught east of the delta in 1976. Catch rates for the winter of 1976-77 and summer 1977 were low, reflecting continued lower biomass.

Some fishermen believe that CPUE based on drag time in the industrial fleet underestimates changes in abundance. As the stock declines fishermen spend more time searching for fish concentrations and less time actually dragging. They believe that if effort estimates included search as well as drag time the CPUE would show a significant declining trend since 1967 or 1968. One fisherman (Jimmie Martin) reports that his fuel consumption (in gallons) per load of fish has increased 50 percent since 1968. It is possible that in this situation fuel consumption is a more inclusive estimator of effort than drag time.

Pet Food Processors and Markets

The catch of the industrial fleet is processed into cat food, frozen crab bait, and, recently, surimi. Pet food processing began in 1952 with the establishment of a plant in Pascagoula, Mississippi (Roithmayr, 1965A). By 1959, there were two canneries and a freezer plant at Biloxi, Mississippi; a cannery, freezer plant, and reduction plant at Pascagoula; a cannery at Gulfport, Mississippi; and a freezer plant at Golden Meadows, Louisiana. Since that time, the number of processors has declined, although production has increased. Today there are only three processors of industrial bottom fish along the northern Gulf Coast (Table 4). Most of the landings are made in Mississippi to supply the two largest processors, Mavar and Quaker Oats.

Table 3. Estimated catch, effort, and CPUE in the industrial trawl fishery.

Year	Catch (Tons)	Effort (1000 hours)	CPUE
1973	50.8	26.80	187
1974	52.6	27.25	193
1975	51.0	29.55	173
1976	49.4	31.25	158

Table 4. Processors of croaker landed by the industrial fleet.

Name	Products	Location
Mavar Shrimp and Oyster Company, Ltd.	Pet food	Biloxi, Mississippi
Quaker Oats Company	Pet food	Pascagoula, Mississippi
Summersgill Enterprises, Inc.	Frozen bait, animal food, and surimi	Golden Meadows, Louisiana

Mavar produces canned cat food whose primary ingredient is industrial ground fish. Until recently Mavar did not use animal by products. However, because of the inability to obtain sufficient quantities of fish during the winter of 1976-77 they are now utilizing animal by products. Their standard product is a 15-ounce can marketed under the brand name of Kozy Kitten. Although other canners produce more pet food, the percentage of fish in Mavar's product is higher and they purchase the largest quantity of fish. Mavar does little advertising and their product has limited distribution within the southeast.

Quaker Oats is the largest producer of cat food using croaker, but is second to Mavar in the utilization of Gulf bottom fish. They use large amounts of animal by products (primarily chicken and some beef parts) and produced a wide variety of products. Their cat food is marketed nationally under the brand name of Puss'N Boots in 15.25 and 6.5 ounce cans. This plant also produces dog food which does not contain fish.

Frozen Animal Food and Bait Processor and Markets

Summersgill Enterprises freezes croaker (round weight) primarily for shipment to the west coast tuna catfood canneries. Apparently croaker contains some ingredient not present in tuna which is important for formulating a complete diet. Some of their production is also sold for crab bait.

Much frozen fish was once sent to mink farms in the Midwest. This market is now closed. Horse meat, a better food for mink, is again available to mink ranchers.

Processor Work Force

There are approximately 300 persons directly employed by the industrial groundfish processors, 35 in Louisinana and 265 in Mississippi. In addition to these there are 140 employees at the Continental Can factory in Pascagoula. Approximately 80% of the can production is utilized by Quaker Oats (John Christiansen).

The type of employment and employee varies with the processor. At Quaker Oats, employees are permanent and work full time whether or not the plant is processing fish. At times when fish are not available, the production line is converted to other pet food products. Quaker Oats is a highly mechanized plant. Its production per employee and its wage scales are relatively high.

In the past, Mavar Fish and Oyster Company operated only when fish was available. Employees were laid off when the plant was not operating. This may change as the Company begins to use animal by products. In summer, when fish is very abundant, Mavar runs two shifts. The plant is not highly automated. Production per employee and wage scales are relatively low.

At Summersgill most employees are permanent and full-time.

Catch and Effort Control Mechanisms

The fleet-processor operations have substantial vertical integration. Approximately 6 boats fish regularly for Mavar, three are processor owned. Five boats fished for Quaker Oats, all are independently owned. All the boats that fish for Summersgill are owned by the processor.

There is horizontal integration in the fleet but not in processing. That is, more than one boat is owned by an individual fisherman or non-fishing owner, but not more than one processing plant is owned by the same company.

Processors have substantial control over ex-vessel prices, fishing effort, and total landings. Ex-vessel prices in January, 1978, varied from $63 to $80 per ton. Prices have risen approximately $2 per ton per year. While fishermen are not officially organized (e.g., unions or cooperatives), they have at times acted in concert to increase ex-vessel prices by threats to stop fishing.

Pet food processors are in a favorable position to set ex-vessel prices for two reasons. First, some processors own substantial proportions of the fleet. Processors found it necessary to own boats in order to assure a supply of fish for their processing operations. Second, fish is only one ingredient, along with animal by products and cereals, utilized for the production of cat food. There are opportunities to substitute animal by products for fish.

It is not clear according to what criteria pet food processors set ex-vessel prices. It undoubtedly includes a consideration of animal by product (e.g., chicken) prices. It also seems likely that, since processors own boats, they have an accurate estimate of fishing costs and would attempt to set ex-vessel prices sufficiently high to keep independent boats actively engaged in fishing.

It is important for the processor and the fleet to be able to regulate total catch so that during periods of high croaker concentrations when catches are larger the landings do not exceed processing capacity. Similarly, in periods of low concentrations, processors want to assure enough fishing effort to maintain the necessary catch to supply processing operations.

Regulation of catch is accomplished by processors assigning days for boats to bring their catch to the plant. The schedule is based on the expected catch (capacity) of each boat. When fishermen are given a landing date they plan their fishing schedules accordingly. They depart long enough in advance of the landing date to catch a full load. If fishing is not as good as anticipated they return with less than capacity on their landing date. If fishing is better than expected they may return early and wait several days to unload the catch. Processors can also control vessels entering the industrial fishing fleet because they are the only purchasers of small croaker.

There are constraints on the processors' control of the fishermen. Ideally, the processor would like to have enough boats to supply his maximum demand even in periods when fish are scarce. However, if there are too many boats, then trip limits must be enforced that may restrict the income of the individual fishermen to a point that they leave for other fisheries, usually shrimp. This is particularly true of the captains who do not own their boats (the majority). Skilled captains are not common and the lack of a captain effectively removes the vessel from the active fleet.

Processors who own their boats have experienced shortages of skilled crewmen. They attributed these shortages to high wages and labor demand in both the shrimp fishery and offshore oil industry (David Summersgill).

Uncertainty Affecting Supply and Demand in the Pet Food Industry

Processors require steady supplies of raw material to keep their plants and employees working and to supply the demand for their finished products. As in most fisheries, weather and variations in fish availability make the supply of fish uncertain, particularly on a day to day basis. Because fresh fish cannot be inventoried, continuous production of fish based petfood is sometimes difficult. In the case of Mavar, lack of fish idles the plant. Other petfood processors (Quaker Oats) can switch to other types of petfood which do not contain fish, but this interrupts production and increases costs.

The uncertainty of fish supply reduces the processor's demand for fish by increasing their use of animal by-products. Animal by-products are more expensive than fish, but the supply is reliable. By allowing continuous production and long range planning, the reliable supply of animal byproducts is considered worth the greater cost. This is particularly true for Quaker Oats.

There is a complex relation between supply and demand for the finished product in the petfood industry. The uncertainty of the industrial fish supply prevents the processors from fully exploiting the potential demand for their products through advertising. If a processor feels certain of a continued supply of fish he may initiate advertising campaigns at both the wholesale and retail levels. To a limited extent, sales can be made to follow supply. However, this is considered a risky business practice if there is a chance fish will not be available such that production cannot meet the promoted demand.

Expansion of the Fleet

Vessel construction and operating costs have increased more rapidly than revenue. Unless a large new market, such as surimi, is developed, it is unlikely that the fleet will expand because: (1) prevailing ex-vessel prices (2) rapidly increasing vessel construction and operating costs, and (3) difficulty of arranging credit for the required larger loans.

While costs are obviously important, the history of the expansion of the fishery is a history of finding markets for the catch. It appears unlikely the industrial fishery will expand unless new markets that can support higher ex-vessel prices are developed. There is disagreement over the maximum sustainable yield of the fishery, but little disagreement over the likelihood of significantly higher landings if new markets are not developed. Since expansion is primarily viewed as a "market problem," the market potentials are discussed.

Future Pet Food Markets

Canned catfood made from industrial fish has four major competitors; canned foods using other fish (primarily tuna), canned foods using animal by products, dry foods, and semi-moist foods. The primary factors which affect sales of these pet foods are product image, convenience, price, and attractiveness to the animal.

Canned foods are expensive and less convenient for the owner than other types of food, but have a high product image and are very attractive to the animal. Within the canned food category, catfood made from tuna or other high value fish has a competitive edge through association with the human equivalent. Cat foods made from animal by-products have, through intensive advertising, developed a high image. It is questionable if any of the canned products are much more or less attractive to the animal.

In recent years, a trend has begun towards smaller cans, 6.5 ounces compared with the standard 15 ounce can, containing specially flavored products such as liver flavor, chicken, beef stew and egg. These have been advertised as the feline equivalent of gourmet food. They are also somewhat easier for the housewife to handle. Prices average approximately double an equal weight of food in the 15 ounce cans. Although most of the extra cost is in the can, the profit margin on gourmet packs is greater than on standard cans. In most of these products, fish, if present, is not used as the main food source, but as flavoring. These "gourmet products" have become a major portion of the canned cat food market.

Dry foods are more convenient to the owner and are lower priced than canned foods, but they have a lower product image and less appeal to the animal. Advertising has improved their image in recent years, and their market share has been increasing. National economic conditions have probably assisted the sale of the lower priced dry foods.

Semi-moist foods are relatively new and highly competitive. They are more expensive than canned foods, but are extremely convenient for the owner and apparently almost as attractive to the animal as the canned products. They are easy to store, require no refrigeration, are less messy and have less odor than canned food. Intensive advertising has promoted semi-moist products. They have become a serious competitor in the petfood market and their share of the market has been rapidly expanding.

The possibilities for expansion of canned pet food markets are probably limited. Although total production has increased slightly, canned foods' share of the market has decreased. Also, the trend towards using fish as flavoring instead of the main ingredient restricts the demand for fish production.

Future Frozen Markets

Existing frozen groundfish markets are presently dependent on California canned tuna pet food production and the blue crab fishery. An expansion of canned tuna pet food production is not expected. The demand for frozen crab bait is substantial but the existence of low cost substitutes makes the demand for groundfish very price elastic.

Future Fish Meal Markets

The price of Peruvian fish meal has been increasing since May and June of 1976. If this trend continues the resumption of meal production from groundfish is possible. This could provide a large market, perhaps 15-20 thousand tons, which would be a 40% increase in existing landings (Charles Roithmayr). Increased fishing and processing could occur quickly because the fleet and processing capacity (presently underutilized)) already exist.

Future Minced Fish Markets

Minced fish processed into convenience foods such as fish sticks, may have potential; Gulf groundfish would make an acceptable product. The size fish which could be used is limited by the minimum size which machines can head and gut (six inches). Minced fish must be made with fish from which the head and viscera have been removed. Presently approximately 30% of the groundfish landed by the industrial fleet is larger than six inches. For domestic consumption, there are two problems which must be resolved. At the present time competition from minced cod makes minced croaker uneconomical. There is also a problem with the FDA. In a minced fish product, the percent species composition must be listed on the package. The species composition of the industrial catch varies with season and area. It would necessitate considerable sorting and storage expenses to maintain a constant species composition. This could be circumvented if only croaker were used and other uses found for the rest of the catch.

A minced fish product called "fishshrimp" was produced in Bayou la Batre. The product was a breaded mixture of minced croaker and shrimp, formed to resemble a shrimp. Sales were apparently good. Unfortunately the company experienced quality control problems and the FDA forced the product off the market.

Future Surimi Markets

One possibility for a substantial increase in demand for croaker is surimi production. Similar to minced fish, presently the size of fish is limited by existing machine requirements for heading and gutting. (six inches or larger). Surimi is an intermediate product which is used in the manufacture of Japanese products such as fish cakes and kamaboko. The best surimi is made from black marlin or sciaenids, particularly croaker, (Okada, *et al.*, 1973).

A pilot plant in Golden Meadow is being operated by Summersgill. This is to be expanded to a total capacity of 75 tons per day of croaker larger then seven inches. (David Summersgill, pers. comm.). Another, smaller pilot surimi plant in Bayou la Batre will soon be operating.

Opinions of people in the fishery on the possibilities of surimi production are mixed. Many doubt that it will occur, siting that it has been discussed for years without much action by the Japanese. Most agree that the ex-vessel price that could be obtained for Gulf groundfish used in surimi production would be substantially higher than the price paid for croaker used for pet food, frozen animal food or bait, or fish meal. Independent fishermen see this as an opportunity for higher income. Existing processors visualize this as a potential threat to their fish supplies. All agree that it would result in substantially increased fishing effort. All industry people are concerned about the sustainability of potentially doubling the existing annual catch.

FOOD CROAKER FISHERY

Exploited Stock

The fishery for croaker for human consumption exploits larger fish from the same stock exploited by the industrial fleet. The minimum length croaker acceptable in the food fish market is 9 inches (229 mm). There are three market size classes: small, medium, and large. Small croaker are those 9 inches or longer and weighing between .5 and .75 pounds (227-341g). Medium-sized croaker are longer than 10 inches (254 mm) and between .75 and 1.0 pounds (341-454g). Large croaker are longer than 12 inches (305.3 mm), and weigh more than one pound (Gutherz, *et al.*, 1975).

Snapper Boat Landings

Snapper boats catch croaker incidentally while fishing for red snapper and also fish specifically for large croaker around oil rigs when snapper fishing is poor. An estimate of the snapper boat catch is unavailable, but much of the landings reported from Mississippi, Texas, and Florida are from snapper boats (Table 5). As the abundance of red snapper has declined, effort directed at croaker has increased. Most of these fish are marketed locally.

Table 5. Food fish croaker landings in the Gulf of Mexico (1000's of pounds).*

Date	Fla. West Coast	Alabama	Mississippi	Louisiana	Texas	Total
1966						
1967	87	104	389	56	134	770
1968	147	1566	1431	90	139	3373
1969	410	3687	647	427	84	5255
1970	936	5691	332	369	107	7435
1971	1004	8384	498	294	54	10,234
1972	1588	9444	484	308	58	11,882
1973	2357	13,300	453	377	122	16,609
1974	1943	10,554	1514	421	172	14,604
1975	2184	9065	1004	484	116	12,853
1976+	935	6313	427	343	113	8,231

* Source: Commercial Fishery Statistics, NMFS

\+ Preliminary, Ernie Snell, NMFS, Miami, Florida, personal communication

Trammel and Gill Netting

A small trammel net fishery once took 10-20 thousand pounds of croaker anually from Big Lagoon, Alabama (Gutherz, et al., 1975). This fishery is apparently no longer in operation. From 1968 through 1975 croaker of medium and large sizes were caught by gill net fishermen in Pensacola Bay (Karen Smith). These fish did not appear in 1976. During that period, croaker were the most important source of income for those fishermen.

Trawl Fishery

The food trawl fishery began in 1967 in response to demand from well-established east coast (Georgia to New York) markets that could not be supplied by declining Atlantic coast croaker landings. It is suspected that reduced east coast catches were related more to environmental conditions than fishing mortality (Joseph, 1972).

Small amounts of large croaker had been landed by shrimp boats and snapper boats before the trawl food fishery began in 1967. It has been suggested that these larger fish were always present, but that fishermen were not aware of their presence. There are reasons to believe that this is unlikely. Prior to 1966 croaker larger than .75 pounds were very rare in the shrimpers' incidental catch. Shrimp fishermen reported a sudden appearance of large croaker (one pound and larger) just prior to the beginning of sale of large croaker (1966). In addition, large croaker appeared in Pensacola Bay at the same time (Karen Smith). Sport fishermen began to catch croaker around oil rigs off Louisiana at about the same time. However, prior to 1968 sport fishermen had not actively sought croaker at those sites. It appears that larger croaker became abundant coincidentally at the same time that the demand for croaker on the east coast could not be supplied by Atlantic coast landings (1966-1968).

Vessels

Approximately 75% of food fish landings are made by the trawl fleet (Gutherz, et al., 1975). The vessels are large shrimp boats, some of which have been modified to handle larger and heavier nets, and have increased hold capacity. They are double rigged side trawlers varying in length from 65 to 86 feet with capacities from 52 to 101 tons. The nets range in head rope size from 35 to 71 feet, dependent on vessel size. The catch is preserved in refrigerated ice (Gutherz, et al., 1975). Crew and captain usually number 2-3. All the vessels in the fleet fish shrimp as well as croaker.

The nets range in headrope size from 40 to 71 feet, dependent on vessel size. The nets used were once standard shrimp trawls, but today are designed specially to catch croaker. They are very similar to industrial vessel nets, but smaller.

In 1977, many vessels in the shrimp fleet and in the food croaker fleet began switching from double to twin rigged trawls (Grady Seaman, pers. comm.). The twin rig consists of four nets. Two are towed from each outrigger. Headrope width is typically 35 feet. The twin rig covers more area than the double rig. it is also lighter, and therefore can be towed faster, or if desired, it can be towed at the same speed, with lower fuel consumption. Increasing the area covered and the towing speed results in considerable increases in catch per hour. Exactly how much increase is obtained seems to vary considerably. Grady Seaman (pers. comm.) reported approximately 20 percent increase in catches of both shrimp and croaker.

The number of vessels fishing croaker at any time is regulated by the ability of fish houses to market the catch and the price and abundance of shrimp. When it is more profitable to catch shrimp, the vessels switch to shrimp fishing. At times a vessel will fish croaker at the end of the unsuccessful shrimp trip. Juhl (1974) reported 40 part-time vessels in the fleet. Drummond et al., (1977) report 26 vessels. Shrimp have been abundant in 1977 and 1978, causing a decline in vessels fishing for croaker. In January, 1978, only 2 or 3 vessels from Bayou la Batre were fishing primarily for croaker (Grady Seaman, pers. comm.). Many shrimp vessels land small quantities of croaker.

Fishing Grounds

The main fishing grounds for the trawlers are around Southwest Pass of the Mississippi River in depths of 5 to 40 fathoms. This appears to be the only area in the Gulf where very large croaker are abundant and not associated with structures such as oil rigs or oyster reefs. Snapper boats may catch croaker on almost any oil rig in the Gulf, but most production comes from structures near the Mississippi River mouth.

Catch Composition and Landings

Landings of foodfish croaker in the Gulf of Mexico increased from 770,000 pound in 1967 to 16,609,000 pound in 1973, then decreased to 12,853,000 pound in 1975. The decrease from 1973 to the present is the result of reduced markets because of increased landings of east coast croaker as stocks there have recovered. This has had the greatest effect on Alabama landings, where production has decreased by 50%. Landings have remained low, partially because of the high availability of shrimp.

The size composition of trawler-caught croaker (by weight) is large, 18.2%, medium, 29.2%, small, 25.5%, discards, 27.1% (Juhl, 1974). Croaker caught by snapper boats are consistently larger than trawl landed croaker.

Food Fish Processors and Markets

Whenever trawlers catch food size croaker (target catch or incidentally with shrimp) they are sold to local fish houses. Most fisheries in Bayou la Batre handle at least some croaker, but it is a product of minor importance. Fish houses are to a certain degree obligated to buy what the boats that fish for them land. Many fish houses prefer not to handle croaker, but they will purchase limited quantities to satisfy their fishermen (independent fleet) and assure their supply of shrimp (Grady Seamen, pers. comm.).

Little processing is involved, croaker are iced and shipped to markets fresh, round weight. Until recently, one fish house (Seaman Seafood) was marketing 30 percent of their croaker frozen (headed and gutted). The market for frozen croaker was developed as a side line during the processor's market expansion for frozen shrimp and more expensive food fish such as flounder. Seaman Seafood discontinued handling frozen croaker and recently went out of business. Frozen croaker had been marketed along with flounder and seatrouts in large supermarket chains, such as A & P, in Tennessee and Kentucky.

The traditional market for food croaker extends from the Carolinas to New York, primarily along the coast. At one time most croaker were marketed through large wholesale markets such as Fulton's Fish Market in New York City. This market channel is not much used today, because the price is highly variable. Some processors suffered losses in the past when the price of croaker dropped significantly before the trucked catch reached the market.

Today, processors market the catch through a variety of pathways. Some processors own their trucks and ship direct to retail outlets. Others sell to truckers who have orders from retail markets. A typical delivery route may extend from Mobile to Atlanta, with numerous stops. Larger fish brokers may buy several thousand pounds at a time to distribute with their own trucks or through independent truckers.

Croaker is sold, fresh, in small fish markets, primarily to lower income groups. The market is presently limited and easily saturated by lower priced fish from Chesapeake Bay.

Catch and Effort Control Mechanisms

The catch and effort levels in the food trawl fleet are not as well regulated as in the industrial fleet. Food croaker are a "second choice" for the trawl fishermen who prefer to catch shrimp and a minor, frequently undesirable, part of the fish house business. Landings are primarily influenced by conditions in the shrimp fishery.

Uncertainty Affecting Supply and Demand for Food Croaker

Fresh croaker cannot be inventoried and it is a small market with a highly elastic demand resulting in severe price fluctuations. Profit margins for fishermen and processors are low. From 1973-76, the average ex-vessel price of croaker declined slightly. In 1973 the ex-vessel prices for the three size grades (small, medium, large) were 7, 18, and 22 cents per pound (Juhl, 1974). In 1976 the average ex-vessel prices were 7, 15, and 18 cents per pound (Ken Odum, pers. comm.). Fishermen do not know ex-vessel prices until the catch is sold. It is not uncommon for vessels to start croaker trips when prices are relatively high, but when they return ex-vessel prices do not cover production costs. The same situation frequently applies to the fish houses.

Expansion of the Trawl Fleet

While ex-vessel prices declined slightly from 1973-76, operating expenses nearly tripled, primarily due to fuel and ice costs. One fisherman (Grady Seamen) reported his average trip expenses (fuel, ice, groceries) increased from $850. to $2,500.

The increasing cost of vessels indirectly affects the food croaker fleet because the vessels are built primarily for the shrimp fishery. Therefore, vessel costs are considered in relation to the economics of shrimp fishing, not croaker. The costs of conversion from shrimp to croaker fishing are minimal.

It is unlikely the food croaker fishery will expand as a target catch, but incidental catches associated with shrimp fishing may increase with the expanding shrimp fleet.

Expansion of the food fleet, like expansion of the industrial fleet, is primarily a "market problem."

Future Markets for Food Croaker

Croaker has a poor "image" and is considered a "lower grade" food fish in most areas of the country. If the name could be changed for marketing purposes new markets might develop. However, FDA regulations make this extremely unlikely.

Severe price fluctuations will probably continue unless the catch can be marketed in some form (other than fresh) that can be inventoried.

Increases in demand for food croaker on the domestic market seems unlikely. The croaker landings on the east coast, although they have greatly increased, are seasonal, primarily from April to August. Gulf coast croaker cannot compete either in price or quality with east coast fish during that time, but can still supply the market during the remainder of the year. However, there are indications that the fishing season for east coast croaker has been growing longer. If this continues, the Gulf coast share of the market may decline.

INCIDENTAL CATCH OF CROAKER

Commercial Shrimp Fleet

There is a substantial incidental catch of bottomfish by shrimp trawlers. The fish are discarded (dead) because the shrimpers do not have methods or facilities to handle or store the fish. Blomo, et al. (1974) estimated the by-catch from Texas waters at 210 million pounds, using a 4:1 ratio of fish to shrimp. Bryan and Cody (1975) found that 34-45 percent of the Texas brown shrimp fishery catch was finfish. Probably the best data available is Juhl, et al. (1976). For 1975, they estimated the total finfish by-catch in the Gulf at 200.08 million kg (220,000 short tons), of which 85.90 million kg (94,490 short tons) was Atlantic croaker. In the area which encompasses the croaker fishing grounds plus the estuarine nursery areas of Louisiana, an estimated 161.62 million kg (177,780 short tons) of bottom fish were discarded. Of this, 72.10 million kg (79,310 short tons) was croaker. This is approximately double the total commercial (industrial and food) catch of croaker.

Sport Trawl Shrimp Fleet

Another source of incidental catch mortality is the sport trawling fleet. These are primarily small boats using 10 to 16 foot otter trawls. They operate primarily in estuaries. The magnitude of this activity is unknown. Swingle, et al. (1976) conducted a creel census of recreational trawlers in Alabama. An estimated 4,751 gear units fished 73,804 hours and caught 290,541 pounds of shrimp in 1974. If the by-catch ratio 3.4:1 as estimated by Juhl, et al. (1976) for inland Louisiana waters is used, then 987,839 pounds of bottom fish were discarded in Alabama alone. Probably 40 percent of this was croaker (Nelson, 1969). On the basis of estuarine area available to sport trawlers, it is likely that the sport by-catch in Louisiana and Texas is several times larger than in Alabama, and is at least as large in Mississippi.

Food Croaker Trawl Fleet

Croaker smaller than 9 inches are discarded by the food fleet. Using Juhl's (1974) data on annual production, a discard ratio for croaker discarded to croaker landed of .37:1 can be computed. By this estimate the 1975 croaker discard by Alabama trawlers was 3,350,000 pounds. Another discard estimate of 66,000,000 pounds per year was made by Drummond et al. (1976) which included all bottomfish species.

One commercial food fisherman estimated that 75% of his total catch was discarded, half of which was croaker (Grady Seamen). This is equivalent to a 1.5:1 croaker discarded to croaker landed ratio. Apparently the discard rate and composition vary greatly by area and season.

Expected Increase in Incidental Catches

In the past, mortality of finfish as a shrimp by-catch was not considered to have significant affects on finfish abundance (Gunter, 1956). However, there is now some evidence that this may no longer be the case. Thomas, et al. (1971) reported a sharp decrease in finfish biomass from 2.20 grams/square meter to 0.39 grams/square meter following the opening of shrimp season in a Louisiana estuary. There are some indications that bottomfish biomass in the north central Gulf of Mexico declined in 1976. This decline correlates with an increase in shrimp trawling in the same area (Charles M. Roithmayr). Total shrimp trawling effort in the northern Gulf of Mexico is increasing and expected to continue to increase. Vessels are being constructed and existing vessels excluded from Mexican waters are expected to redirect their effort in the Gulf. In addition, the incidental catch of groundfish for a given amount of effort has increased. Because of the high value of shrimp, it has become profitable for shrimp fishermen to trawl in areas where groundfish biomass is very high. Formerly, the expense of sorting was too great to justify the catch in these areas. The twin trawl (4 nets) is also increasing the catch per hour of both shrimp and finfish.

Sport trawling effort will probably also increase as recreational boating grows and as the price of shrimp rises.

RECREATIONAL CROAKER FISHERY

Atlantic croaker is not usually considered a highly sought sport fish. However, they are relatively abundant, easy to catch, and good to eat. Large numbers are caught and kept by sport fishermen, only some of whom are fishing specifically for croaker.

Deuel (1973) estimated the 1970 sport catch of croaker in Gulf of Mexico at 49.296×10^6 fish, total weight, 62.794×10^6 pounds. The mean weight was 1.26 pounds. This estimated weight seems somewhat high. Mean weight that was reported by the fishermen may have been overestimated. Seventy-seven percent of the estimated catch was made inside the estuaries. Very few fish found in surveys of estuaries have exceeded one pound. However, even if the mean weight were only one half Deuel's estimate (.63 pounds), closer to the mean weights reported in Clark (1962), Deuel and Clark (1968) and Simmons (1961), the total sport catch would still be triple the commercial food fish landings.

Some studies of sport fishing have been made in selected areas on the Gulf coast. Jackson (1972) estimated the croaker catch from Biloxi Bay, Mississippi at 76,103 fish during a six-month period in 1971. Croaker were the second most common fish, comprising 27.81% of the total catch. Simmons

(1962), conducted a creel census during the summer of 1960 in the Laguna Madre of Texas. Atlantic croaker were second in number caught and third in weight. More (1965) conducted a creel census in Galveston and Trinity Bays, Texas for nine months in 1963 and 1964. Atlantic croaker was 51% of the total catch by sport fishermen operating from small boats. Mean weight was .49 pounds. In a creel census that covered most of the bays of Texas, Hefferman _et al_. (1976) found croaker was 9.6% of the total catch by weight. By numbers of fish, croaker were first in Galveston Bay, second in Upper Laguna Madre, seventh in San Antonio Bay, and eighth in Aransas Bay. Mean weight varied from .41-.67 pounds.

In none of these studies were croaker a highly sought species. It appears that croaker fill the fisherman's box when highly sought species are not available. Such is the case for grunts, family _Pomadasyidae_, in south Florida (Austin _et al_., 1977). Charterboat operators in Louisiana are now fishing for croaker when red snapper are unavailable (Charles Sebastian pers. comm.). Some "sport" fishermen fish for croaker around oil rigs and sell much of their catch to New Orleans restaurants (Charles Roithmayr pers. comm.).

In the past, croaker has had a poor image among sport fishermen. This is changing as more fishermen discover the food qualities of the fish. It is likely that as sport fishing grows in the northern Gulf of Mexico, the relative importance of croaker to sport fishermen will continue to increase.

SUMMARY AND CONCLUSIONS OF THE WORKSHOP STAFF

The summary and conclusions are in the form of short statements and represent the opinions of the workshop staff. Concurring or divergent opinions by workshop participants are presented in the following section.

Industrial Fishery (Small Croaker)

1. The industrial fleet is relatively small in terms of number of boats (approximately 15-16 in January, 1978) and number of people employed (approximately 50). However, it is a capital intensive fishery with relatively large annual landings (50,000 tons).
2. There are three processors of small croaker directly employing approximately 300 persons.
3. Small croaker is a low value high volume product (ex-vessel price $63-$80 per ton in January, 1978) utilized primarily for cat food.
4. Catch, fleet, markets, and prices are relatively stable with no significant changes expected. Profits are not high enough to attract new boats to enter the fleet. More likely, as boats retire or leave the fleet processors will be required to build and operate their own boats which will result in further vertical integration of the fleet-processor industry.
5. Market demand is the primary expansion constraint on the fishery. Croaker based canned cat food has a substantial but declining share of the cat food market. It is not expected that croaker based cat food sales will increase stock. A period of low abundance began in 1976 and still persists.
6. There is no indication of overfishing although there have been fluctuations in apparent abundance (1971, 1972).
7. Catch per unit effort in the industrial fleet has shown a slow decline. This does not necessarily signify overfishing in the classical sense.
8. While pet food production is not expected to increase, there is the possibility of resumed and greatly expanded production of fish meal. This is dependent on fish meal prices that are determined by the Peruvian

anchovy fishery. There is existing fleet and processing capacity that could facilitate the immediate production of fish meal on a large scale if it was profitable.

9. There is also the possibility of surimi production which could utilize significant quantities of croaker.

General Conclusion about the Industrial Fishery:

Without new markets the fishery can be expected to continue production near existing levels which does not represent overfishing. Fishing effort or catch do not need to be regulated at this time. However, if one of the new major markets (meal or surimi) were to develop; effort, catch, and processing could rapidly increase. This could place severe pressure on the stocks unless the incidental catch of croaker, primarily by shrimp trawlers, is reduced.

Food Fishery (Large Croaker)

1. The trawl food fishery is a secondary activity of the shrimp fleet that partly developed as a result of reduced landings of food croaker on the East Coast.
2. Food croaker are of minor importance to fish houses, most of which would prefer not to handle croaker.
3. Fishing effort, catch, markets, and prices fluctuate widely, particularly for fresh fish which cannot be inventoried.
4. Market demand and price fluctuations are the primary constraints on the fishery. Unless new markets involving products that can be inventoried (e.g., frozen croaker or convenience foods) are developed it is unlikely the fishery will expand. Market expansion in the South is difficult because croaker have a low "image" as a food fish.
5. There is no indication of overfishing, although there are indications

that apparent abundance has significantly declined in heavily fished areas.

6. There is a substantial incidental catch of small croaker that is discarded.

General Conclusion about the Food Fishery:

Without new markets the fishery can be expected to continue production near or below existing levels which does not represent overfishing. Fishing effort and catch do not need to be regulated at this time. However, now is the time to investigate ways to reduce small croaker discards and document if the apparent reduction in large croaker in heavily fished areas frequently occurs in areas that are normally fished by recreational line fishermen where future commercial-recreational conflicts may develop. Promote the food value of croaker.

Incidental Catch of Croaker

1. The commercial shrimp fleet has a very large incidental discard catch of croaker that has been estimated to be as much as twice the size of the total commercial (industrial and food) catch.
2. The incidental catch and species composition vary greatly by area and season.
3. There is presently no satisfactory technology to reduce incidental catches by the shrimp fleet. Opening flaps in the top of shrimp nets substantially reduces incidental catches but also allows approximately 10 percent of the shrimp catch to escape which is the profit margin in the shrimp fishery.
4. There is a substantial incidental catch of croaker by small inshore recreational shrimp trawlers.

5. There is a substantial discard of small croaker by the food trawl fleet that is expected to be 1 to 1.5 times the food croaker landings.
6. The incidental catch by shrimp trawlers is expected to increase as anticipated shrimp fishing increases. Furthermore, if shrimp prices continue to increase then it will be profitable to fish shrimp in areas of higher croaker concentrations which will result in increased incidental catch rates.

General Conclusions about Incidental Catches:

Incidental croaker discards which are of considerably more than the utilized catch have been tolerable because there has not been a significant expansion in the target catch of croaker. If the target croaker catch was to expand through the development of new markets, increased competition for croaker would make it difficult to justify such large incidental catches that are presently not utilized. Top priority should be assigned to gear modifications that would reduce incidental croaker catches in the shrimp fishery and/or facilitate ways to utilize the catch.

Recreational Fishery

1. The sport catch of croaker by private and charter boats has traditionally been a second choice "box filling" species when highly sought snappers and groupers were not available.
2. Croaker have become relatively more important as a target species with landings in the range of approximately three times the commercial food catch.
3. It is expected that sport fishing for croaker will continue to increase and be concentrated at popular inshore and offshore habitats such as oil rigs.

4. Some sport fishermen and charterboat operators believe that commercial trawling significantly reduces the catch rates for recreational line fishermen in specific areas such as around oil rigs.

General Conclusions about the Recreational Fishery:

Recreational fishing by private and charter boats will continue to expand, particularly at specific offshore sites such as oil rigs. There may develop more acute conflicts between commercial trawlers and recreational line fishermen at the more popular sport fishing sites. It should be determined if trawling significantly reduces recreational catch rates in specific areas.

A Survey of the Literature Relating to the Biology and Fisheries of the Atlantic Croaker (Micropogon undulatus) in the North Central Gulf of Mexico*

J. Connor Davis

This literature survey includes material pertaining to Atlantic croaker and its fisheries in the Gulf of Mexico since 1960. It is not intended to be a complete listing. Many papers with only minor references to croaker are not included. Also excluded are papers dealing with laboratory experiments on fish physiology or exposure to heavy metals. Major papers on other species involved in the industrial fishery, particularly spot (Leiostomus xanthurus), are included, as are those dealing with biology and fisheries of croaker on the Atlantic coast. Papers published prior to 1960 which are of major importance in any of the above categories are also included.

Appendix I is a list of pertinent bibliographies. Appendix II are additional references which were discovered after the bibliography was prepared. The journals and publications listed in Appendix III were searched back through 1960. Many additional papers prior to 1960 or from other publications were extracted from the bibliographies of papers found during the search.

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ANNOTATED BIBLIOGRAPHY

1. Adkins, Gerald and Philip Bowman. 1976. A study of the fauna in dredged canals of coastal Louisiana. Louisiana Wildl. Fish. Comm. Tech. Bull. 18: 1-71.

   A comparison is made of hydrology, species composition, abundance, and growth in altered and natural estuaries.

2. Arnold, E.L., Jr., S. Wheeler and K.N. Baxter. 1960. Observations on fishes and other biota of East Lagoon, Galveston Island. U.S. Fish Wildl. Serv., Spec. Scient. Rep. Fish., (344): 30 pp.

   Seasonal occurrence and abundance of larval fishes was determined through monthly plankton samples from November, 1953, through May, 1958. Clupeidae, Engraulidae, Sparidae, Sciaenidae, and Mugilidae were the most abundant families. Atlantic croaker was the most abundant sciaenid.

3. Arnoldi, David C., William H. Herke and Ellis J. Clairain, Jr. 1974. Estimate of growth rate and length of stay in a salt marsh nursery of juvenile Atlantic croaker, *Micropogon undulatus* (Linnaeus), "sandblasted" with fluorescent pigments. Proc. Gulf Caribb. Fish. Inst., 26: 158-172.

   Approximately 90,000 croaker, 10 to 40 mm SL were marked with fluorescent pigment. Sixty were recovered. Estimated growth rates are high, about 14 mm per month, suggesting that most croaker in the industrial fishery are less than one year old.

4. Blomo, Vito J. and John P. Nichols. 1974. Utilization of finfishes caught incidental to shrimp trawling in the western Gulf of Mexico. Part I: Evaluation of Markets. Texas A & M Univ. Sea Grant Publ. TAMU-SG-74-212, 85 pp.

   The potential volume of finfish bycatch is estimated. Potential markets are described, their products, economic structure, total production, and factors which most affect their price levels. Price flexabilities were computed for each market. The volume of additional trawl fish which could be absorbed by each market without depressing the price more than ten percent was calculated.

5. Breuer, J.P. 1962. An ecological survey of the lower Laguna Madre of Texas, 1953-1959. Publs. Inst. Mar. Sci., Univ. Tex., 8: 153-183.

   A description of the bay is given with its history, [illegible]ology and an annotated species list of flora and fauna.

6. Breuer, Joseph P., et al. 1964. Analysis of populations of sports and commercial fin-fish and of factors which affect these populations in the coastal bays of Texas. In: Coastal Fisheries Project Reports, 1963. Texas Parks Wildl. Dept., Austin, p. 231-479.

Continuation of work reported in reference 93.

7. Breuer, Joseph P. et al. 1965. Analysis of populations of sports and commercial fin-fish and factors which affect these populations in the coastal bays of Texas. In: Coastal Fisheries Project Reports, 1964. Texas Parks Wildl. Dept., Austin, p. 227-339.

Continuation of work described in reference 92. In addition, results of a survey of sport fishing boats in Galveston and Trinity Bays are presented. Atlantic croaker was the largest catch by numbers and total weight.

8. Bryan, C.E. and Terry J. Cody. 1975. A study of commercial shrimp, rock shrimp, and potentially commercial finfish 1973-1975. Texas Parks Wildl. Dept., Coastal Fisheries Branch, Austin. 78pp.

One of three sections deals with finfish discards during shrimp trawling operations on the brown shrimp grounds. Percent fish discards in samples taken the commercial fleet averaged 34% in 1973 and 43% in 1974. The two most abundant vertebrates were Gulf butterfish (Peprilus burti) and Atlantic croaker.

9. Bullis, H.R., Jr. and J.S. Carpenter. 1968. Latent fishery resources of the central west Atlantic region. In: The future of the fishing industry of the United States. D. W. Gilbert (editor), Univ. Wash. Publ. Fish., New Ser., IV: 61-64.

A short summary of the industrial fishery for bottom fish is given and a comparison of economic return from menhaden purse seiners and industrial trawlers is made.

10. Chittenden, Mark E. 1977. Simulations of the effects of fishing on the Atlantic croaker (Micropogonias undulatus). Proc. Gulf Caribb. Fish. Inst. Vol. 29.

Parameters of the von Bertalanffy and Beverton-Holt equations were estimated. Yield curves and yield isopleths are presented for a series of values of length at capture and natural mortality rates, M. Simulations suggest that the magnitude of MSY critically depends on M. Croaker simulations may be assumed as a first approximation for other species in the shrimp communities because they have similar population dynamics.

11. Chittenden, Mark E., Jr. and John D. McEachran. 1976. Composition, ecology, and dynamics of demersal fish communities on the northwestern Gulf of Mexico continental shelf, with a similar synopsis of the entire Gulf. Texas A & M Univ. Sea Grant Publ. TAMU-SG-76-208, 104 pp.

Using samples collected during commercial shrimp trawling operations, two distinct communities of demersal fishes are described and their community ecologies discussed. One community, dominated by the Atlantic croaker, is found on the white shrimp grounds. The other, dominated by the long spine porgy (Stenotomus caprinus), is found on the brown shrimp grounds. Finfish discard rates are computed. Life histories and population dynamics of major species are described.

12. Christmas, J.Y. and Richard S. Waller. 1973. Cooperative Gulf of Mexico estuarine inventory and study, Mississippi. Gulf Coast Res. Lab., Ocean Springs, Miss. 434 pp.

This publication was done in four sections, Area, Hydrology, Sedimentology and Biology. In the biology section, sampling procedures, using plankton nets, seines, and trawls, conformed to those used in other state estuarine inventories. Relative abundance, growth rate and distribution by season, area, temperature and salinity are presented for common species. The dominant vertebrates in order of abundance were bay anchovy (Anchoa mitchilli), Atlantic Menhaden (Brevoortia patronus), Atlantic croaker and spot.

13. Clairan, Joseph E., Jr. 1974. Correlations between environmental factors and emigration of juvenile Atlantic croaker, Micropogon undulatus, from a Louisiana marsh nursery. Masters Thesis, Louisiana State Univ., 87 pp.

Emmigration of juvenile Atlantic croaker in a Louisiana coastal marsh was determined using fish traps and trawls and compared to certain environmental changes, particularly temperature and salinity. Two major emigration periods were found, 15-24 May and 8-22 June. Emigration ended by 29 June. Sudden decreases in temperature or salinity were the principal stimuli to emigration.

14. Clark, John R. 1962. The 1960 salt-water angling survey. U.S. Fish Wildl. Serv. Circ. 153, 36 pp.

Estimates are given for the total number caught, total weight, fish and the number of fishermen for each species, area, and fishing method. An estimated 31,611,000 Atlantic croaker weighing 18,970,000 lb. were landed in the Gulf of Mexico.

15. Compton, Henry. 1966. A survey of fish populations in the inshore Gulf of Mexico off Texas. In: Coastal Fisheries Project Reports, 1965. Texas Parks Wildl. Dept., Austin, p. 55-71.

Results of trawl surveys in 1965 from waters off Port Aransas, Port Mansfield, Port Isabel and Galveston are presented and compared with data from 1964. Atlantic croaker and sand trout (Cynoscion nothus) were the two most abundant species. Data on relative size of fish are given.

16. Copeland, B.J. 1965. Fauna of the Aransas Pass Inlet, Texas. I: Emigration as shown by tide trap collections. Publs. Inst. mar. Sci., Univ. Tex. 10: 9–21.

Estimates of biomass are made for invertebrates and vertebrates exported from the estuarine system through Aransas Pass Inlet.

17. Darnell, Rezneat M. 1958. Food habits of fishes and larger invertebrates of Lake Pontchartrain, Louisiana, an estuarine community. Publ. Inst. mar. Sci., Univ. Texas, 5: 353-416.

Stomach analyses were carried out on 35 of the more important species present, wtih special attention directed to Atlantic croaker and spot. Although both species are bottom feeders, adult spot and croaker were not in competition for food due to differing feeding behavior and gill raker structure.

18. Darnell, R.M. 1962. Fishes of the Rio Tamesi and related coastal lagoons in east-central Mexico. Publs. Inst. mar. Sci., Univ. Tex. 8: 299-365.

A description of the history, geology, and hydrology of the area is given with an annotated list of species and discussion of zoogeography and salinity tolerances of fishes in that area.

19. Dawson, C.E. 1958. A study of the biology and life history of the spot, Leiostomus xanthurus Lacepede, with special reference to South Carolina. Contrib. Bears Bluff Lab. No. 28, 48 p.

A general life history for spot is presented with estimates of growth rate, spawning period, fecundity, inshore abundance and distribution, length frequency, and length-weight relationship. The economic importance of the commercial and sport fisheries are discussed. Some observations are made on food, predators, parasites, and sound production.

20. Dawson, C.E., Jr. 1965. Length-weight relationships of some Gulf of Mexico fishes. Trans. Amer. Fish. Soc., 94(3): 279–280.

Length-weight relations for seventeen species, including Atlantic croaker and spot, were calculated using the formula log(weight) = log C + n log (total length).

21. Dawson, C.E. 1967. Contribution to the biology of the cutlassfish (Trichiurus lepturus) in the northern Gulf of Mexico. Trans. Amer. Fish. Soc., 96(2): 117–121.

Monthly catch per unit effort and length frequency by depth are given with some estimates of growth. Data was collected in a two year trawl survey in 3.5-20 fms. off Grand Isle, La.

22. Deuel, David G. 1973. 1970 salt-water angling survey. Curr. Fish. Stat. 6200, 489 pp.

See reference no. 14.
An estimated 49,926,000 Atlantic croaker weighing 62,794,00 pounds were landed in the Gulf of Mexico.

23. Deuel, David G. and John R. Clark. 1968. The 1965 salt-water angling survey. U.S. Fish Wildl. Serv., Res. Publ. 67, 51 pp.

See reference no. 14.
An estimated 26,816,000 Atlantic croaker weighing 19,453,000 pounds were landed in the Gulf of Mexico.

24. Dovel, W.L. 1968. Predation by striped bass as a possible influence on population size of Atlantic croaker. Trans. Amer. Fish. Soc., 97(4): 313–319.

Predation during periods of low water temperature is suggested as a possible contributing factor to the decline of Atlantic croaker stocks on the Atlantic coast.

25. Dugas, Ronald J. 1975. Variation in day-night trawl catches in Vermilion Bay, Louisiana. Louisiana Wildl. Fish. Comm. Tech. Bull., 14: 1–13.

Differences in species composition in trawl samples are shown between day and night sampling. Little difference in croaker catches was noted.

26. Dunham, Fred. 1972. A study of commercially important estuarine-dependent industrial fishes. Louisiana Wildl. Fish. Comm. Tech. Bull., 4: 63 pp.

Egg and larval survey and trawl samples were made from July 1969 through July 1972. An analysis of movements of juvenile commercial fishes within an estuary and data on species composition and length frequency of the industrial fish catches in Louisiana is presented. The most abundant species in the trawl samples was the bay anchovy (Anchoa mitchilli). Atlantic croaker was the most abundant commercial species, over 65% of the industrial bottomfish catch.

27. Franks, James, J.Y. Christmas, W.L. Siler, R. Combs, R. Waller and C. Burns. 1972. A study of nektonic and benthic faunas of the shallow Gulf of Mexico off the state of Mississippi as related to some physical, chemical and geological factors. Gulf Res. Reps., 4(1): 1–148.

Six stations from 5 to 50 fathoms were sampled monthly for 29 months with a nekton net and 12 meter balloon trawl. Croaker were the most abundant species, 34.91% of the catch. Some data on seasonal variations in catch per unit effort are presented.

28. Ginsburg, Isaac. 1931. On the difference in the habitat and the size of Cynoscion arenarius and C. nothus. Copeia, 1931(3): 144.

The sand seatrout (Cynoscion arenarius) is larger and more abundant nearshore, while the silver seatrout (C. nothus) is more abundant offshore. C. nothus seldom exceeds ten inches.

29. Guest, William C. and Gordon Gunter. 1958. The sea trout or weakfishes (genus Cynoscion) of the Gulf of Mexico. Gulf States Mar. Fish. Comm., Tech. Summ. No. 1, 40 pp.

The life histories of 3 species are described as well as a summary of their commercial fisheries in the Gulf.

30. Gunter, Gordon. 1938. The relative numbers of species of marine fish of the Louisiana coast. Am. Nat., 72: 77–83.

The Atlantic croaker was the most abundant fish in the trawl survey. The anchovy, (Anchoviella epsetus), was probably more abundant, but the trawl used had too large a mesh to effectively capture that species.

31. Gunter, Gordon. 1945. Studies on marine fishes of Texas. Publs. Inst. mar. Sci., Univ. Tex. 1(1): 1–190.

A description of the physiography, hydrography and fauna of Texas bays and the adjacent Gulf of Mexico. Biological collections were made with otter trawls, beach seives, and trammel nets. Data on age, growth, habitat, seasonal abundance, sexual cycle, and food of major species, including Atlantic croaker and spot, are presented.

32. Gunter, Gordon. 1950. Correlation between temperature of water and size of marine fishes on the Atlantic and Gulf coasts of the United States. Copeia, 1950(4): 298–304.

The apparent relation between decreasing water temperature and increased maximum size of several fishes, including Atlantic croaker and spot, is discussed.

33. Gunter, Gordon. 1967. Some relationships of estuaries to the fisheries of the Gulf of Mexico. In: Estuaries. G.H. Lauff (editor), Amer. Assoc. Advan. Sci. Publ. No. 83, Washington, D.C., pp. 621–638.

A description is given of the geology, geography and hydrology of Gulf Coast estuaries and the organisms and fisheries they support. Man-made changes in the distribution of freshwater runoff from the Mississippi River and seasonal cycles of temperature and salinity are described and their effects on faunal distribution and estuarine productivity discussed.

34. Gunter, Gordon and Gordon E. Hall. 1963. Biological investigations of the St. Lucie estuary (Florida) in connection with Lake Okeechobee discharges through the St. Lucie canal. Gulf Res. Reps., 1(5): 189-307.

Collections of vertebrates and invertebrates and data on salinity and turbidity were taken during periods of no discharge, some discharge, and heavy discharge of fresh water into the estuary. Freshwater discharge had no detectable adverse effects. Atlantic croaker was the fourth most abundant species taken.

35. Gutherez, Elmer J. 1977. The northern Gulf of Mexico groundfish fishery, including a brief life history of the croaker (Micropogon undulatus). Proc. Gulf Caribb. Fish. Inst. Vol. 29.

A description is given of the vessels, gear, fishing grounds, tactics and processing of both industrial and foodfish trawl fisheries. Some data on spawning season, age and growth and seasonal movements of Atlantic croaker are given. An estimate of 97% total mortality for croaker by the end of the third year of life is given.

36. Gutherez, Elmer J., Gary M. Russell, Anthony F. Serra and Bennie A. Rohr. 1975. Synopsis of the northern Gulf of Mexico industrial and food fish industries. Mar. Fish. Rev., 37(7): 1–11.

An overview is given of the history, value, vessels, gear, processing, fishing grounds, and fishing tactics in both fisheries along with some information on species composition and finfish distribution in the northern Gulf of Mexico.

37. Hansen, David J. 1969. Food, growth, migration, reproduction and abundance of pinfish, Lagodon rhomboides, and Atlantic croaker, Micropogon undulatus, near Pensacola, Florida, 1963-1965. U.S. Fish. Bull., 68(1): 135–146.

The abundance, age and growth, food, migration, and reproduction of two species in the Pensacola estuary were studied by a trawling survey with two stations for each species. Scales were used for one estimate of growth in L. rhomboides. Two year classes of pinfish were found, but only one of Atlantic croaker. Croaker were found to mature at the end of the first year of life.

38. Haskell, Winthrop A. 1961. Gulf of Mexico trawl fishery for industrial species. Comml. Fish. Rev., 23(2): 1–6.

A description is presented of the fishery, species composition, fishing grounds, landings, processing, and fleet composition.

39. Hellier, Thomas R., Jr. 1962. Fish production and biomass studies in relation to photosynthesis in the Laguna Madre of Texas. Publ. Inst. mar. Sci., Univ. Tex. 8: 1-22.

Seasonal migration and growth of fish stocks was shown to be in phase with primary production. Age and growth determinations were made for Anchoa mitchelli, Mugil cephalus, Lagodon rhomboides, and Leiostomus xanthurus.

40. Herke, William H. 1971. Use of natural and semi-impounded Louisiana tidal marshes as nurseries. Ph.D. dissertation. Louisiana State University, 242 pp.

Data was collected using trawls in very shallow water. Factors affecting juvenile as examined. Growth rates estimates for

several species are much greater than other work using length frequency data and are attributed to biased sampling procedure in other studies. Estimated length at one year was 200 mm for Atlantic croaker and 180-200 mm for spot.

41. Hildebrand, Henry H. 1954. A study of the fauna of the brown shrimp (*Penaeus aztecus*, Ives) grounds in the western Gulf of Mexico. Publs. Inst. mar. Sci., Univ. Tex. 3(2): 229–366.

A species list and estimates of relative abundance were made for major species taken by shrimp trawlers on offshore grounds from the Mississippi River mouth to $24^{\circ}10'$ north on the Mexican coast and on the Campeche Banks.

42. Hildebrand, Samuel F. and W. C. Schroeder. 1928. The fishes of Chesapeake Bay. Bull. U.S. Bur. Fish. 33(I): 1–366.

A key to the species found in Chesapeake Bay is given. The larvae and adults of common species are described. Estimates of spawning cycles, relative and seasonal abundance, age, and growth rates are given. A detailed description of the fisheries for commercially important species, including Atlantic croaker and spot, is presented.

43. Hildebrand, Samuel F. and Louella E. Cable. 1930. Development and life history of fourteen teleostean fishes at Beaufort, N.C. Bull. U.S. Bur. Fish., 46: 383-488.

Atlantic croaker and spot were among the fishes studied. Spawning periods, growth estimates, description of the larvae, comparison of larval characters, and food and feeding habits of both species are given.

44. Hoese, H. D. and R. S. Jones. 1963. Seasonality of larger animals in a Texas turtle grass community. Publ. Inst. mar. Sci., Univ. Tex., 9: 37–47.

A drop net covering 118 m^2 was used to determine population levels of common vertebrates and macroinvertebrates over a one-year period. The pinfish, *Lagodon rhomboides* was the dominant vertebrate. Atlantic croaker were absent from this community. Spot were abundant during spring and fall and absent at other times.

45. Jackson, Gerry A. 1972. A sport fishing survey of Biloxi Bay and the adjacent Mississippi Sound. M.S. Thesis, Mississippi State Univ. 101 pp.

Fishing activity and total catch is estimated in the Biloxi Bay estuary for a six month period in 1971 using a roving creel census, boat counts and take home interviews. Four species composed 86.16% of total catch. They were sand seatrout (36.42%), Atlantic croaker (27.84%), spotted seatrout (14.88%), and ground mullet (7.02%). Spotted seatrout were the most sought. An estimated 10,295 fishing trips were made during the study period.

46. Joseph, E. B. 1972. The status of the sciaenid stocks of the middle Atlantic coast. Chesapeake Sci., 13(2): 87–100.

Population trends of Atlantic croaker, weakfish (Cynoscion regalis), and spot are examined from historical catch records. Decreases in croaker abundance are related to low winter water temperature.

47. Juhl, Rolf. 1966. Experimental fish trawling survey along the Florida west coast. Comml. Fish. Rev., 28(6): 1–5.

A trawling survey was conducted between Cape San Blas and the Dry Tortugas. Vermillion snapper were the most frequently taken snapper. Mean catch per tow for double trawls was 105 lb. No concentrations of industrial bottomfish were found.

48. Juhl, Rolf. 1974. Economics of Gulf of Mexico industrial and food fish trawlers. Mar. Fish. Rev., 36(11): 39–42.

Annual operating costs, effort, landings, and income are estimated for the "optimum vessel" in each fishery. The "optimum vessel" was subjectively determined, based on cost and performance of the top producers.

49. Juhl, Rolf, Elmer J. Gutherz, Shelby B. Drummand, Charles M. Roithmayr and Joseph A. Benigno. 1975. Oceanic resource surveys and assessment task, status report. Natl. Mar. Fish. Serv., S.E. Fish. Cntr., Pascagoula, Miss. 32 pp.

Summary of work done in 1974 in the north central Gulf of Mexico by ORSA personnel, including croaker biomass estimates, a review of the industrial and food fish trawl fishery, and estimates of finfish discards from shrimp boats.

50. Juhl, Rolf, Shelby B. Drummond, Elmer J. Gutherz, Charles M. Roithmayr, Joseph A. Benigno and John A. Butler. 1976. Oceanic resource surveys and assessment task, status report. Natl. Mar. Fish. Serv., S.E. Fish. Cntr., Pascagoula, Miss. 50 pp.

A summary is given of ORSA accomplishments in 1975. Included are estimates of croaker standing stock, age and growth of croaker, a summary of the industrial fishery landing and effort, estimates of finfish discards from shrimping operations, a hydro-acoustic survey of pelagic fish resources, an aerial survey of bluefin tuna, and results of LANDSAT-I satellite scanning of menhaden fishing grounds.

51. June, F. C. 1956. Condition of the middle Atlantic pound-net fishery. Comml. Fish. Rev., 18($): 1-5.

Factors causing the decline of the Atlantic coast pound net fishery are discussed. The primary cause was decline in yield of food fish especially Atlantic croaker and whiting.

52. Juneau, Conrad L., Jr. 1975. An inventory and study of the Vermilion Bay - Atchafalaya Bay complex. Phase II, Biology. Louisiana Wildl. Fish. Comm. Tech. Bull., 13: 20–76.

Areal and seasonal distribution of zooplankton, major vertebrates and invertebrates between April, 1972 and March, 1974. Spot were not abundant, Atlantic croaker was the second most abundant vertebrate.

53. Kjelson, Martin A. and George N. Johnson. 1976. Further observations of the feeding ecology of postlarval pinfish, Lagodon rhomboides, and spot, Leiostomus xanthurus. U.S. Fish. Bull., 74(2): 423–432.

Field and laboratory data indicated changes in feeding rates with species. Feeding rates and daily rations were estimated.

54. Kutkuhn, Joseph H. 1964. Industrial fishery program. U.S. Fish Wildl. Serv. Circ. 183: 38–40.

Short summary of the history and goals of the study of the industrial bottomfish fishery.

55. Loesh, Harold, James Bishop, Arthur Crowe, Robin Kuckyr, and Paul Wagner. 1976. Technique for estimating trawl efficiency in catching brown shrimp (Penaeus aztecus), Atlantic croaker (Micropogon undulatus) and spot (Leiostomus xanthurus). Gulf Res. Reps. 5(2): 29–34.

Mark-recapture experiments using fluorescent pigments and a 4.9 m otter trawl were conducted in a shallow estuarine lake. Trawl efficiency was estimated at 26.5%, Atlantic Croaker, 6% for spot and one third to one half for brown shrimp.

56. Loustaunau, Javier. 1971. Use of Gulf "trash" fish for production of human grade fish protein concentrate. M.S. Thesis, Louisiana State Univ., Baton Rouge. 43 pp.

The protein and fat content of bluegill sunfish, (Lepomis macrochirus), spadefish, (Chaetodipterus faber), threadfin shad, (Dorosoma petenense), and Atlantic croaker was determined. Croakers were highest in protein and lowest in fat content.

57. Massman, W. H. and A. L. Pacheco. 1960. Disappearance of young Atlantic croakers from the York River, Virginia. Trans. Amer. Fish. Soc., 89(2): 154–159.

Reduction in abundance of juvenile Atlantic croaker is related to low water temperature.

58. Matlock, Gary C., Rocco A. Marcello, Jr., and Kirk Strawn. 1975. Standard length-total length relationships of Gulf menhaden, Brevoortia patronus (Goode), bay anchovy, Anchoa mitchilli (Valenciennes), and Atlantic croaker, Micropogon undulatus (Linnaeus), from Galveston Bay. Trans. Amer. Fish. Soc., 104(2): 408–409.

Atlantic croaker standard length-total length relation given for 3 length classes 28-95 mm, 102-159 mm, and 168-255 mm.

59. McFarland, W. W. 1963. Seasonal change in the number and the biomass of fishes from the surf at Mustang Island, Texas. Publ. Inst. mar. Sci., Univ. Tex. 9: 91–105.

The standing crop of fish varied from 25.8 lb. per acre (winter) to 103.2 lb. (summer). By weight, Mugil cephalus was the most abundant species. Atlantic croaker were uncommon and spot were common only in summer.

60. McHugh, J. L. 1966. Management of Estuarine Fisheries. In: A symposium on estuarine fisheries (Smith, R.F., A.H. Swartz, and W.H. Massman, editors). Amer. Fish. Soc. Spec. Publ. No. 3: 133-154.

The author presents a wide ranging discussion on estuarine fisheries. The problems inherent in management of complex estuarine systems are discussed and a holistic approach to their solution is urged.

61. Miller, John M. 1965. A trawl survey of the shallow Gulf fishes near Port Aransas, Texas. Publs. Inst. mar. Sci., Univ. Tex. 10: 80–107.

Bi-monthly samples were taken over a depth range of 3-15 fathoms from February through July, 1964. Data include numbers, depth, dates, water temperature, and size range for 68 species including Atlantic croaker and spot.

62. Miyauchi, David, George Kudo, and Max Patashnik. 1973. Surimi - a semi-processed wet fish protein. Mar. Fish Rev. 35(12): 298-300.

Surimi manufacture is described. Surimi is an intermediate product from which fish cake and sausage are manufactured.

63. Moore, Donald. 1964. Abudance and distribution of western Gulf bottomfish resources. U.S. Fish Wildl. Serv. Circ. 183: 45-47.

Relative abundance of bottomfish and analysis of size vs. depth are presented. Greatest abundance was off central Louisiana in 0-10 fathoms. Most bottomfish, including Atlantic croaker, increased in weight with increasing depth.

64. Moore, Donald, Harold A. Brusher and Lee Trent. 1970. Relative abundance, seasonal distribution, and species composition of demersal fishes off Louisiana and Texas, 1962-1964. Contr. Mar. Sci., 15: 45–70.

A monthly trawl survey of demersal fishes was conducted between the Mississippi River delta and Mexico from 7 to 110 m depth. Relative abundance of important species was compared by depth, area, season, and time of day. Atlantic croaker was the most abundant fish off the Louisiana coast and the long spine porgy, (Stenotomus caprinus) was the most abundant off Texas.

65. Music, James L., Jr. 1974. Observations on the spot (Leiostomus xanthurus) in Georgia's estuarine and close inshore ocean waters. Georgia. Dept. Natl. Resour. Contrib. Ser. 28, 29 pp.

Data on abundance, seasonal trends, mortality and growth are presented for spot from 3 types of habitat creeks, bays, and nearshore. Three types of gear were used, seine, otter trawl, and gill net. Spawning was reported from close inshore ocean waters from October through March. Spot reach 5-6 inches in the first year. At least two age groups were found.

66. Nelson, Walter R. 1969. Studies on the croaker, Micropogon undulatus Linnaeus; and the spot, Leiostomus xanthurus Lacepede, in Mobile Bay, Alabama. J. Mar. Sci., 1(1): 1-92.

Data is presented for both species on spawning location, age, growth, movements, abundance, and distribution and their relation to salinity temperature, and depth.

67. Nichols, John P., Melvin Cross, Vito Blomo and Wade L. Griffin. 1976. Utilization of finfishes caught incidental to shrimp trawling in the western Gulf of Mexico, Part II: Evaluation of costs. Texas A & M Univ., Sea Grant Publ. TAMU-SG-76-203, 42 pp.

Costs of several schemes for recovery of finfish discards are analyzed and ex-vessel prices necessary to "break even" are computed. The most promising plan called for a tender vessel to collect discards for industrial use.

68. Okada, Minoru, David Miyauchi, and George Kudo. 1973. "Kamaboko" - the giant among Japanese processed fishery products. Mar. Fish. Rev. 35(12): 301-306.

An overview of the "kamaboko" market, its products, production, manufacture, preferred species, and quality characteristics. Croaker and black marlin are considered the best raw material.

69. Parker, Jack C. 1965. An annotated checklist of the fishes of the Galveston Bay system, Texas. Publs. Inst. mar. Sci., Univ. Tex. 10: 201-220.

Short comments on habitat and abundance and a list of references are given for each species found in Galveston Bay.

70. Parker, Jack Clark. 1971. The biology of the spot Leiostomus xanthurus Lacepede, and the Atlantic croaker, Micropogon undulatus (Linnaeus) in two Gulf of Mexico nursery areas. Texas A & M Univ., Sea Grant TAMU-SG-71-210, 182 pp.

The distribution of Atlantic croaker and spot in Lake Bornge, La. and Galveston Bay, Texas was determined in relation to temperature, salinity and certain hydrographic features. Length-weight relationships, condition, spawning periods, age and growth, and diets of each species were compared between the two areas.

71. Pearson, John C. 1929. Natural history and conservation of redfish and other commercial scianids on the Texas coast. Bull. U.S. Bur. Fish. (1928), 44: 129-214.

Description of the larvae, adults, spawning cycle, age and growth, seasonal distribution, food habits and commercial fisheries are given for five species, including Atlantic croaker and spot. Croaker were found to spawn during late fall in the Gulf of Mexico and reach 220 mm T.L. in two years.

72. Perez, Kenneth T. 1969. An orthokinetic response to rates of salinity change in two estuarine fishes. Ecology 50(3): 454-457.

A laboratory experiment was designed to test the hypothesis that distribution of estuarine species is controlled more by changes in salinity than by salinity, per se. Swimming speed of spot and Atlantic croaker increased when subjected to changing salinity.

73. Perret, William S. 1971. Phase IV, biology. In: Cooperative Gulf of Mexico estuarine inventory and study, Louisiana Louisiana Wildl. Life Fish. Comm., New Orleans, pp. 28-175.

Monthly samples were taken from April, 1968 through March, 1969 at 82 trawl, 12 seine, and 28 plankton net stations. Areal and seasonal distributions of major species are discussed.

Historical data are presented on commercial fisheries, including the industrial bottom fish industry.

74. Perret, William S., B. B. Barrett, W. R. Latapie, J. F. Pollard, W. R. Mock, G. B. Adkins, W. J. Gaidry and C. J. White. 1971. Phase I, Area description. In: Cooperative Gulf of Mexico estuarine inventory and study, Louisiana, Phase I and IV. Louisiana Wildl. Fish. Comm., New Orleans, pp. 1-27.

The estuarine area of the state is described and tabular data presented on water volume, vegetation, stream discharge, population, commercial fishery operations, drained and filled areas, and navigation channels.

75. Perret, William S. and Charles W. Caillouet, Jr. 1974. Abundance and size of fishes taken by trawling in Vermillion Bay, Louisiana. Bull. Mar. Sci. 24(1): 52-75.

Three stations were sampled over a 16 month period with a 4.9 m otter trawl. Salinity and temperature were taken. Four species dominated the catch: Atlantic croaker, spot, sand sea trout (Cynoscion arenarius), and Trinectes maculatus. Croaker was the most abundant. Length frequency distribution and relative abundance by month was presented for these species.

76. Ragan, J.G. 1963. Western Gulf bottomfish survey. U.S. Fish Wildl. Serv. Circ. 161, pp. 42-44.

Results are presented on species composition from a monthly trawl survey in 1961 at 11 stations between Cameron, La. and Freeport, Texas. The 2 most abundant fishes in order by weight were longspine porgy (Stenotomus caprinus) and Atlantic croaker. Longspine porgy dominated offshore stations while croaker and seatrouts dominated shallow water stations. Seasonal changes in distribution were noted.

77. Reid, G.K., Jr. 1956. Ecological investigations in a disturbed Texas coastal estuary. Tex. J. Sci. 8(3): 296-327.

78. Reid, G.K., Jr. 1957. Biological and hydrographic adjustment in a disturbed Gulf coast estuary. Limnol. Oceanogr. 2(3): 198-212.

Summary of results from three summer studies on the effects of the opening and subsequent partial closing of an inlet into an enclosed, low salinity, estuarine bay. Populations of Atlantic croaker, spot, sand sea trout (Cynoscion arenarius), and brown shrimp (Penaeus aztecus) declined in 1955, when the inlet was opened and partially recovered in 1956 when the inlet had partially closed. Populations of Atlantic menhaden (Brevoortia patronus), bay anchovy (Anchoa mitchilli diaphana), and white shrimp (Penaeus setiferus) increased when the pass was open and decreased when it partially closed.

79. Reid, George K. and Hinton D. Hoese. 1958. Size distribution of fishes in a Texas estuary. Copeia 3: 225-231.

The possible causes of size distribution of fishes within estuaries are discussed using length-frequency data for spot and Atlantic croaker from a brackish estuary which had been opened to the Gulf of Mexico. Salinity alone was not considered the cause.

80. Rivas, Louis R. and Charles M. Roithmayr. 1970. An unusually large Atlantic croaker, Micropogon undulatus, from the northern Gulf of Mexico. Copeia 1970(4): 771-772.

This croaker, caught in 35 fathoms by a snapper boat, is the largest reported to date, 668 mm, 3.6 kg (gutted).

81. Roelofs, E.W. 1954. Food studies of young sciaenid fishes, Micropogon and Leiostomus from North Carolina. Copeia 1954 (2): 151-153.

Feeding habits young spots and Atlantic croakers were examined through stomach analysis and observations of feeding behavior in aquaria. Annelid worms contributed 90% of the volume of stomach contents of croaker. Stomachs of young spot contained 50% copepods. Neither species consumed commercially valuable species of shrimp.

82. Roithmayr, Charles M. 1963. Industrial bottomfish fishery in the North Central Gulf of Mexico. U.S. Fish Wildl. Serv., Circ. 161, p. 39-41.

Summary of fishing 1960 and 1961. Lower catch in 1962 was due to decrease in effort dictated by a decrease in processing capacity. Trends in vessel size and catch rate are discussed. Monthly length frequency distribution indicates fishing is dependent largely on 1 and 2 year old fish.

83. Roithmayr, Charles M. 1964. Industrial bottomfish fishery of the north central Gulf of Mexico. U.S. Fish Wildl. Serv. Circ. 183: 41-44.

A summary is given on species composition, seasonal abundance, catch and effort in the fishery from 1959 to 1962. Disposition of the catch was petfood, 86%; fish meal, 18%; mink food and crab bait, 6%.

84. Roithmayr, Charles M. 1965A. Industrial bottomfish fishery of the northern Gulf of Mexico, 1959-1963. U.S. Fish Wildl. Serv., Spec. Scient. Rep., Fish. No. 518, 1-23.

A description is given of the fishery, its history, products, processors, vessels, gear, fishing tactics, fishing grounds, species composition, landings, and effort. Catch per unit effort is used to analyze trends in population size.

85. Roithmayr, Charles M. 1965B. Review of industrial bottomfish fishery in northern Gulf of Mexico,1959-1962. Comml. Fish. Rev. 27(1): 1-6.

Data is presented on catch, effort, and species composition. Length and weight distribution of Atlantic croaker with area and season are given. The fishing grounds are defined, and seasonal variation in mean catch per unit effort, fishing depth, and length of tow, is shown.

86. Rounsefell, G.A. 1964. Preconstruction study of the fisheries of the estuarine areas traversed by the Mississippi River-Gulf Outlet project. U.S. Fish. Bull. 63(2): 373-393.

The study provides base line data needed to assess environmental effects of the proposed channel. Hydrographic and biological data from April, 1959, through March, 1961, is presented. Little effect on ichthyofauna was expected, although increasing salinities might reduce the abundance of blue crabs.

87. Sabins, Dugan S. and Frank M. Truesdale. 1974. Diel studies of larval and juvenile fishes of Caminada Pass area, Louisiana. Proc. 28th Ann. Conf. S.E. Assoc. Game and Fish Comm. 1974. 161-171.

A small Renfro beam trawl was used to collect larval fish over a 15 month period at two stations in and near Caminada Pass. Spot were by far the most numerous species. Atlantic croaker were fifth, after several clupeid species. Two seasonal species assemblages were found, dependent on water temperature. Sciaenids dominated the cold water assemblage and clupeids the warm water. Distribution of the coldwater assemblage was more affected by tide than light level.

88. Schwartz, F.J. 1964. Effects of winter water conditions on fifteen species of captive marine fishes. Amer. Midl. Nat. 71(2): 434-444.

Observations are presented on the effect of low water temperatures on survival and behavior of estuarine fishes. For both Atlantic croaker and spot, death of adults occurred at higher temperatures than juveniles.

89. Simmons, Ernest G. 1961. Biological survey of the waters of region M-8. In: Coastal Fisheries Project Reports, 1960. Texas Parks Wildl. Dept., Austin. 11 pp.

Results of a tagging program and creel census in the Upper Laguna Madre, Texas. Tagging studies results were minimal due to the small number of fish tagged. The five most commonly taken fish were spotted seatrout, redfish, drum, Atlantic croaker, and flounder. Croaker were second in number and fourth in pounds landed. Data on economic value of fishing and origin of fishermen are presented.

90. Simmons, Ernest G. and H. Dickson Hoese. 1959. Studies on the hydrography and fish migrations of Cedar Bayou, a natural tidal inlet on the central Texas coast. Publs. Inst. mar. Sci., Univ. Tex. 6: 56-80, figs. 1-18.

Movements of fishes into and out of an inlet from January 1950, through July 1951, was studied using fish traps. Eighty-five percent of the fish captured were leaving the estuary. Atlantic croaker was the most abundant fish. Post larval croaker entered the bay in October and November. Many croaker less than 176 mm were leaving the bay in May and June. In September, larger gravid croaker, over 225 mm, were leaving the bay.

91. Springer, Victor G. and Jacques Pirson. 1958. Fluctuations in the relative abundance of sport fishes as indicated by the catch at Port Aransas, Texas. Publs. Inst. mar. Sci., Univ. Tex. 5: 169-185.

Total weekly catch of 16 sport fishes by organized anglers around Port Aransas was presented. Atlantic croaker catches were much greater in October and November than during the remainder of the year.

92. Springer, Victor G. and Kenneth D. Woodburn. 1960. An ecological study of the fishes of the Tampa Bay area. Fla. Bd. Conserv. Mar. Lab., Prof. Pop. Ser. No. 1, 104 pp.

A 13 month study of the ichthyofauna of the major habitats present was done with a roller frame trawl as the principal gear. Atlantic croaker were uncommon but length frequencies showed a rapid growth rate. Spot were abundant.

93. Stevens, James R., et. al. 1963. Analysis of populations of sport and commercial finfish and of factors which affect these populations in the coastal bays of Texas. In: Mar. Fish. Proj. Rept., 1961-1962, Texas Game Fish Comm., Proj. No. MF-R-4, 263 pp.

In each major bay system from Galveston Bay to the lower Laguna Madre, finfish populations were sampled monthly for two years. Hydrographic and meteorological data were taken concurrently. Variations in relative abundance of major species by area and time are examined. The effect of opening Port Mansfield Pass to the Lower Laguna Madre, results of a limited creel census, and a trawl survey of gulf fishes from 0-15 fathoms are discussed. Atlantic croaker was a major forage species in most areas. In the creel census it was third in numbers, and second in weight landed.

94. Sundararaj, B.I. 1960. Age and growth of the spot, <u>Leiostomus xanthurus</u> Lacepede. Tulane Stud. Zool. 8(2): 40-62.

Both scales and otoliths were used to determine age and growth. Estimates of length at age by the two methods coincided closely. At the end of their first three years of growth, spot averaged 153.3 mm, 212 mm, and 225 mm T.L., respectively.

95. Suttkus, Royal D. 1955. Seasonal movements and growth of the Atlantic croaker, (Micropogon undulatus) along the east Louisiana coast. Proc. Gulf Caribb. Fish. Inst. 7: 151-158.

Data from a trawl and seine survey in Lake Pontchartrain showed Atlantic croaker and southern bay anchovy (Anchoa mitchilli diaphana) to be the most abundant species. Croaker migrated from the lake during fall, in response to dropping water temperatures. Spawning occurred from October to January. Ageing by the scale method was difficult, but a length range for age group one was established.

96. Swingle, Hugh A. 1971. Biology of Alabama estuarine areas - cooperative Gulf of Mexico estuarine inventory, Alabama Mar. Resour. Bull. 5: 1-123.

Occurrence, relative abundance, and seasonal and aerial changes in distribution of fishes and macroinvertebrates are discussed, based on data from monthly samples at 20 trawl stations, 5 seine stations and 4 plankton stations between January 1968 and March 1969. Landing trends in major commerical fisheries are given. The three most numerous species were bay anchovy (Anchoa mitchilli), Atlantic croaker, and spot. Length frequencies by month are presented for each.

97. Swingle, Hugh A., Donald G. Bland, and Walter M. Tatum. 1976. Survey of the 16-foot trawl fishery of Alabama. Alabama Mar. Resour. Bull. 11: 51-57.

Data was collected through creel census at access points and by mail questionnaires. Estimates were made of trips per year, catch per trip, total catch, species composition, total effort and expenses for Mobile and Baldwin counties. In 1974, 290,541 lbs. of shrimp were caught, 25% of the commercial catch.

98. Swingle, Wayne E. 1976. Analysis of commercal fisheries catch data for Alabama. Alabama Mar. Resour. Bull. 11: 26-50.

A summary of the number of processers, employers, fishermen and gear units are presented. For each major fishery, catch statistics are given from 1964 to 1973. Trends in each fishery are discussed. In 1973, Atlantic croaker were one-third of total Alabama landings by weight.

99. Sykes, J.E. and J.H. Finucane. 1965. Occurrence in Tampa Bay, Florida, of immature species dominant in Gulf of Mexico commercial fisheries. U.S. Fish. Bull., 65(2): 369-379.

Biological collections showed that the five most important species in Florida's west coast commercial fisheries inhabit Tampa Bay and are dependent on such estuarine nursery areas. Atlantic croaker were not reported.

100. Tarver, Johnnie W. and L. Brandt Savoie. 1976. An inventory and study of the Lake Pontchartrain-Lake Maurepas estuarine complex. Louisiana Wildl. Fish. Comm.Tech. Bull. 19, 159 pp.

Vertebrate and macroinvertebrate populations were sampled with a 16 foot trawl and a 100 foot beach seine. Zooplankton and molluscan communities were determined. Hydrological and climatological data were collected at four stations. Sampling period was July 1972 through June 1973. Atlantic croaker was the most abundant commercial fish. Greatest abundance was reported in June.

101. Thompson, M. H. 1966. Proximate composition of Gulf of Mexico industrial fish. U.S. Fish Wildl. Serv., Fish. Ind. Res. 3(2): 29-67.

Monthly variation in oil, water, protein, and ash content of 17 species is presented. Results are discussed considering the influence of reproductive cycle, yearly variation, sex, food, size, activity and species. An equation for estimating the oil content of a mixed species load from its moisture content is given.

102. Trent, W. Lee, Edward J. Pullen, and Donald Moore. 1970. Ecology of western gulf estuaries. U.S. Fish Wildl. Serv. Circ. 343: 25-31.

Size and abundance of six major demersal species, including Atlantic croaker and spot, and oyster growth rates are compared between a natural marsh and dredged canals in a housing project. Atlantic croaker were more abundant and spot were less abundant in the canals.

103. White, Michael L. and Mark. E. Chittenden, Jr. 1976. Aspects of the life story of the Atlantic croaker, Micropogon undulatus. Texas A & M Univ., Sea Grant Publ. TAMU-SG-76-205, 54 pp.

Using trawl samples from inside a Texas estuary and samples of shrimp boat discards in the Gulf of Mexico, a validated scale method of age determination up to age I is described. Mean total lengths at ages I and II were 155-165 mm and 270-280 mm, respectively. An annual mortality rate of 96% was estimated. Maturation cycle is described and peak spawning reported in October. Differences in life history of croaker found north and south of Cape Hatteras, N.C. are discussed.

INDEX

APPENDIX I

OTHER BIBLIOGRAPHIES

Butler, Philip A. (Ed.) 1959. Annotated bibliography of unpublished estuarine research in the Gulf of Mexico 1925-1959. Gulf States Marine Fish. Comm., New Orleans, La. 51 pp.

Herbich, John B. and R. H. Snider. 1969. Bibliography on dredging. Texas A. and M. Univ. Sea Grant Publ. 203. 20 pp.

Crance, Johnie H. 1969. A selected bibliography of Alabama estuaries. Alabama Mar. Resour. Bull. 2. 21 pp.

APPENDIX II

REFERENCES FOUND AFTER THE BIBLIOGRAPHY WAS ASSEMBLED

A1. Chen, Lee Sea. 1976. Food habits of the Atlantic croaker, Micropogon undulatus (Linnaeus) and the spot, Leiostomus xanthurus (Lacepede) in the north central Gulf of Mexico. Master's Thesis, Dept. Biol., Univ. of S. Miss., Hattiesburg. 61 pp.

Variations in diet with size, season, and area were examined and the possibility of interspecific competition was discussed. In croaker and spot the most numerous food organisms were polychaetes. By volume, major foods were crustaceans in croaker and polychaetes in spot. In both species, the greatest volume of stomach contents was miscellaneous organic and inorganic debris.

A2. Heffernan, T.L., A.W. Green, L.W. McEachron, M.G. Weixelman, P.C. Weixelman, P.C. Hammerschmidt and R.A. Harrington. 1976. Survey of finfish harvest in selected Texas bays. Texas Parks and Wildl. Dept., PL88-309 project report no. 2-231-R-1, 116 p.

A3. Keiser, Richard K., Jr. 1976. Species composition, magnitude, and utilization of the incidental catch of the South Carolina shrimp fishery. South Carolina Mar. Res. Center, Tech. Rep. no. 16. 55 pp.

From samples of finfish discards of shrimp trawlers, species composition, relative abundance, catch per unit effort and fish:shrimp ratio's were calculated. Monthly mean fish:shrimp ratios ranged from 1:1 to 3:1. Scianids were 60.4% of the catch, by number. Spot and Atlantic croaker were first and third in abundance, respectively.

A4. Tarbox, Kenneth E. 1974. Seasonal occurrence, distribution, and relative abundance of juvenile fishes at Marsh Island, Louisiana. M.S. thesis Louisiana State University. 122 pp.

Juvenile fish populations were sampled for 11 months with a 15 m bag seine. Life history information for 74 species is presented. Maximum occupancy of nearshore waters occurred in spring. Sequential occupancy of estuarine waters by different species groups was documented. The most abundant species by number were bay anchovy (Anchoa mitchilli), menhaden (Brevoortia spp.) and Atlantic croaker. Short term effects of a hurricane are described.

A5. Thomas, Jim, Paul Wagner and Harold Loesch. 1971. Studies on the fishes of Barataria Bay, Louisiana, an estuarine community. Louisiana State Univ., Special Sea Grant Issue, Coast Stud. Bull. 6: 56-66.

From a trawl survey in two areas of the Bay, data is presented on species present, fish biomass, and feeding habits. Biomass data indicates a large reduction in biomass associated with shrimp trawling operations.

A6. Trent, Lee, Connie Arnold, and Ernest A. Anthony. 1976. Evaluation of the marine recreational fisheries in the northwestern Gulf of Mexico from Port Aransas to Port Isabel, Texas, 1975-76. Unpublished Report, Gulf Fisheries Center, Nat'l Mar. Fish. Serv. 14 pp.

Sport fishing economic value, catch and effort from shore and boats was estimated. Shore fishing represented 80.5% of total effort. Atlantic croaker was fifth in number caught by shore fishermen in most of the study area.

APPENDIX III

MAJOR PUBLICATIONS SEARCHED

Alabama Marine Resources Bulletin

Bulletin of Marine Science

Contributions in Marine Science

Copeia

Gulf Research Reports

Louisiana Wildlife and Fisheries Commission Technical Bulletin

Marine Fisheries Review

Proceedings of the Gulf and Caribbean Fisheries Institute

Professional Papers Series, Florida Board of Conservation

Texas A & M University, Sea Grant Publications

Texas Journal of Science

Tulane Studies in Zoology

University of Miami Sea Grant Publications

U.S. Fish and Wildlife Service Special Scientific Report, Fisheries

U.S. Fishery Bulletin

ADDITIONAL LITERATURE CITED

Austin, C.B., R. Brugger, J.C. Davis, and L.D. Siefert. 1977. Recreational Boating in Dade County, 1975-76. University of Miami Sea Grant Spec. Rep. No. 9, 143 pp.

Austin, C.B., J.C. Davis, J.A. Browder, and R. Brugger. 1978. Results of a workshop to examine the croaker fisheries from a systems viewpoint. Contract Report to NMFS.

Chittenden, Mark E.,Jr., and Donald Moore. 1976. Composition of the ichthyofauna inhabiting the 110-m bathymetric contour of the Gulf of Mexico, from the Mississippi River to the Rio Grande. Texas A & M Univ. Sea Grant Publ. TAMU-SG-76-210, 15 pp.

Drummond, Shelby B., Elmer J. Gutherz, Charles M. Roithmayr, and John A. Butler. 1977. Review of the groundfishes fishery management unit, Gulf of Mexico Fishery Management Council area. Prepared for verbal presentation at the Gulf of Mexico Management Council Meeting March 2-4, 1977.

Heffernan, T.L., A.W. Green, L.W. McEachron, M.G. Weixelman, P.C. Hammerschmidt, and R.A. Harrington. 1976. Survey of finfish harvest in selected Texas bays. Contract report to NMFS, Project No. 2-231-R-1, 116 pp.

More, B. 1965. Survey of saltwater sportsfishing in Galveston and Trinity bays. Texas Parks and Wildlife Dept., Coastal Fisheries Project Reports, 1964. pp. 231-250.

Wade, C.W. 1977. Survey of the Alabama marine recreational fishery. Ala. Mar. Res. Bull. 12: 1-22.

PAPERS CONTRIBUTED TO THE WORKSHOP BY STAFF

WAYS OF LOOKING AT FISHERIES*

C. Bruce Austin

In order to assimilate and interpret the phenomena associated with any complicated real world situation such as a fishery we must have a conceptual "window" through which we can filter the most important facts from the immensely complex world we observe. Care must be taken in selecting the window because it ultimately determines what questions we ask and then try to answer. Numerous disciplines (e.g., physic, biology, see Kuhn, 1962) have historically had significant changes in their "pardigms" (Kuhn's concept of the window).

How we view fisheries has also changed in recent years. For example, the recognition that "fisheries" are comprised of people (fishermen, processors, household consumers) as well as fish stocks requires us to include the economic and social considerations of people as well as biological considerations of fish populations. Such a perspective is particularly important with the assigned economic and social as well as biological responsibilities placed on newly formed Fisheries Management Councils through extended jurisdiction (Fishery Conservation and Management Act of 1976, P.L. 94-265).

Historical Ways of Viewing the Management at Fisheries

It is generally recognized that common property (non-owned) resources can be overexploited (Hardin, 1962; Schaefer, 1957). Fishery biologists have traditionally viewed the role of fishery management as that of obtaining the maximum sustainable yield (MSY) from the fish stock. When MSY is somewhere between a relatively low stock level and the largest stock sustainable by the

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environment, if a fishery was "underexploited" (stock too large for MSY) programs to intensify fishing were recommended. If a fishery was "overexploited" (stock too small for MSY) programs to reduce fishing were recommended.

These biological stock criteria policies have two shortcomings. From an ecological perspective, they do not include the impact of the recommended fishing effort level and resulting fish stock on other species that may be influenced because of connections through the food web or incidental catches.

The second shortcoming has been given substantial attention by economists, that is, MSY, nor any other strictly biological criteria, includes how people evaluate fishing or the catch. Fishing (commercial and recreational) occurs because of the benefits it provides to people. How people evaluate fishing and fish are necessary considerations to understand and predict the amount of fishing that will occur and determine the "optimum" amount of fishing and catch to be persued by a fishery management program. The ecological and economic shortcomings of MSY are addressed in the Fishery Management Act (P.L. 94-265). The term "optimum" with respect to the yield from a fishery means the amount of fish:

(A) which will provide the greatest overall benefit to the Nation, with particular reference to food production and recreational opportunities; and

(B) which is prescribed as such on the basis of the maximum sustainable yield from such a fishery, as modified by any relevant economic, social, or ecological factor.

This tells us that we must consider what is "relevant" but not exactly what are relevant factors or how relevant factors should be weighted in arriving at the optimum yield. Many people believe that "optimum yield" is not a useful concept because "optimum" can have more than one interpretation.

While this is true, it does not imply that optimum yield is not a useful concept. The concept is that of a process, not a solution. That is, it simply affirms that "optimum" must be based on multiple criteria. Legislating that social decisions are complex and there is no single evaluation method is not new. Cost-benefit analysis (Establishment of Principles and Standards for Planning, Federal Register, September 10, 1973) states that all the relevant costs and benefits of a Federal project must be considered.

It may seem unnecessary to many people to legislate that we must consider all the relevant factors. It sounds somewhat like trying to legislate common sense into decision making. Unfortunately, there is a real need to legislate common sense into the formulation of fishery management plans because those that have customarily studied fisheries (biologists and economists) are accustomed to formulating their anlaysis and presenting their results according to criteria that do not consider all the relevant factors that should be considered in formulating fishery management programs. This is one reason that biologists and economists seldom agree on the criteria for fishery management (Roedel, 1975). Biologists tend to think fishery management is for fish yield on the assumption that people fish for fish. Economists assume people fish for money or pleasure and frequently view fishing as just another sector of the economy that should be analyzed and managed in terms of its relative economic value to the whole economy.

Some economists have strongly advocated that their form of analysis is superior for deriving the "optimum" amount of fishery effort and catch (Crutchfield, 1975). Many biologist and others are not convinced. In the mean time, both groups continue to develop more sophisticated analytical models based on their separate assumptions. The economic models are more recent than biological ones. They began by "piggy-backing" basic population dynamics models (Schaefer, 1957). They have since developed primarily through utilizing continually more sophisticated analytical tools such as control theory (Smith, 1969; Clark, 1977).

Alternative Ways of Viewing the Management of Fisheries

The starting point for any fishery management program is the recognition that people do not "manage" fish, they manage other people. In the process of managing people that utilize fish they indirectly "manage" fish stocks. While it is not reasonable to expect that any singular criteria could satisfactorily derive an "optimum," it is not unreasonable to expect that people will try to formulate such criteria. If there is a value in the concept of "optimum yield" as articulated in the Fishery Management Act, it is that it legislates against grasping for singular criteria solutions to complex problems.

It is likely that fishery management decisions will be, like all other social decisions, some form of political compromise which must be made with or without "satisfactory" information. At this time in the development of fishery policies, perhaps the biggest mistake is to believe we must have a "complete" understanding of fisheries before we can manage them. This can lead to false conclusions that information must precede actions. In fact, actions will proceed with or without information. Those of us concerned with information must decide that for now we must do the best we can with the available information and hope that in the future information can keep pace with decisions.

Recognizing that: (1) fisheries are complex systems of interconnected biological and economic compartments, and (2) that decisions will be made now on the "best available information," perhaps we need some new tools of analysis. What we "know" is not necessarily how much data we have, but also our ability to organize the available data to draw inferences. Decisions can produce unexpected and unfavorable results because of the way we look at a fishery or our inability to follow complicated causal webs as well as from a lack of basic data.

Our (workshop staff) approach to fishery management is based on the premises that there are no "solutions" to optimum yield or other policies, only a range of alternatives. What is required is some method by which we can readily explore the results of different assumptions about fisheries (assumptions based on the best available information) when they are coupled with alternative management policies that might be contemplated. We believe that computer simulated numerical models are the most promising tools of analysis. They have been used with varying degrees of success in business (Forrester 1961, 1968), ecology (Odum, 1971A), engineering (Doebelin, 1972), and other disciplines through both analog and digital computers.

Computer simulated numerical models are capable of handling complex non-linear dynamic systems that more closely represent "real world" conditions than most analytical models. Since it is not possible to disrupt fisheries (people and fish) by directly experimenting with alternative policies, computer simulated models can (to a limited extent) act as surrogates for the "real thing" on which we can harmlessly experiment and perform various types of analysis.

The information we have thus far assimilated and the contributions of the workshop participants will not result in operational computer simulated numerical models. This is somewhere down the road, but we will organize what information we do have in a way that will attempt to outline the basic "structure" of the fisheries which will record the "compartments" of a fishery system and how they are interconnected. We believe this will be helpful to the Management Councils charged with developing management plans and be the beginning of our attempts to test the practicality of numerical modeling in the form of energetic systems.

An Energetic Systems Window Through Which to View Fisheries

As mentioned earlier, a conceptual window is a filter which helps us ask and then answer questions about complex phenomena. We have chosen an energetic systems paradigm that is a relatively new way of looking at things. Being "new" it is not easily definable in a concise set of principles. It draws on the thoughts of such diverse people as Forrester (business system dynamics, 1961, 1968), Georgescu-Rogen (economics, 1971, 1975), Odum (ecology, 1971A, 1971B), Lehninger (bio-chemistry, 1965), Kleiber (biology, 1961), and Slesser (engineering and economy, 1974). The basic concept that most of these people have in common is that life and all life processes (which include human economic activities) can be best understood in terms of an expanded interpretation of the entropy law (second law of thermodynamics).

For example, individual organisms ecosystems, business firms, industries, and national economics all have something in common in that they are "open" thermodynamic systems. The smallest unit of analysis is an energetic "compartment." In a fishery, examples would be a fish stock, fishing fleet ((commercial and/or recreational), processors/fish houses, or other businesses in the marketing chain. All compartments have three characteristics in common. First, they are identified as accumulations (stocks) of ordered matter (e.g., biomass of fish, numbers of people and boats in a fleet). The matter is ordered in a fashion that it can do "work" (transform energy in a thermodynamic sense).

Second, it takes energy and matter to order matter and to maintain ordered matter in its existing form (e.g., food to maintain biomass, fuel and materials to maintain machines).

Third, compartments do "work" to import energy and matter from outside sources. When importations are greater than maintenance requirements then a compartment can "grow" (increase or change it's form of ordered matter). Conversely, when maintenance requirements are larger than importations then a compartment "declines" (reduction in amount or form of ordered matter).

Fisheries as Energetic Systems Comprised of Connected Energetic Compartments

At the compartment level we are concerned with energy and matter importations and maintenance requirements and changes in ordered matter (growth or decline). Biological compartments such as fish stocks obtain their energy (food sources) and matter (non-organic materials) directly from their environment. As the fish stock (biomass) increases or declines it affects the availability of its energy and matter sources.

Most economic compartments (comprised of people and machines) obtain their energy (food for people, fuel for machines) and matter (already ordered in the form of boats and equipment) through money-commodity exchanges with other economic compartments in the economy. The size of an economic compartment (like a biological compartment) influences the availability of its sources of energy and matter. The most important and obvious connection is between the catch and the resulting size of the exploitable fish stock. Production can also influence the terms of exchange (e.g., ex-vessel prices of catch or cost of purchased energy or materials).

An energetic systems approach does not necessarily conflict with other more established ways of looking at fisheries. Unfortunately, much of the controversy over energetics has been related to it purportedly being an energy theory of human value (Odum, 1976; Gilliland, 1975; Huettner, 1976). In fact, it is a value theory of energy. Energetic systems (or any other form of analysis) will not explain what is of value to people. However, given what is of value to people, energetics offers a "holistic" way to analyze the implications of alternative choices. That is, it offers the only common denominator (energy) that conforms to a set of physical laws (thermodynamics) that can be analyzed at the compartment level (e.g., fish stock, fishing fleet) or system level (e.g., ecosystem, economy) in both biological and economic systems. Other physical units of measurement are not applicable to economic compartments and the most frequent common denominator for economic compartments (money) does not flow in biological systems.

While energetic systems analysis does not necessarily conflict with other forms of biological or economic analyses, it does require different data and methods of analyses. This workshop will be a start for us to assimilate the kinds of information that will be useful for energetic systems analyses. In the mean time, we believe this information, both descriptive and quantitative, will be very useful in formulating the fishery management plans for croaker and mackerels that will be undertaken in the coming year.

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EVALUATION OF THE WORKSHOPS

Workshop Staff

The term "workshop" is probably somewhat misleading. Information flow was primarily uni-directional from the participants to be assimilated and organized by the workshop staff. The purpose of the workshop was primarily to bring industry people together to "extract" as much useful socio-economic information as possible about the fisheries. The informaiton was to be used in two ways. First, to be organized into descriptive socio-economic profiles of the fisheries which are presented in the workshops final reports on croaker and mackerels. Second, the information was to be a first step in obtaining information that would be utilized in system modelling (dynamic numerical modelling through computer simulation).

Pre-Workshop Field Trips and Background Papers

The field trips by Connor Davis and Joan Browder to search out information and select workshop participants was necessary. Even _if_ we could have known who to invite to the workshops (which was greatly influenced by the field trips), these people would probably have declined to attend unless they had personally discussed the workshops with one of the workshop organizers. This illustrates a feature of socio-economic profiles that cannot be over emphasized. Socio-economic studies must begin with an understanding of the "structure" of a fishery. That is, how the people and organizations in the fishery influence each other and the natural resources on which they are dependent. From a systems perspective, this starting point is the same for understanding the biological system of an individual organism, an ecological community, or an economy. The difference is that for the first two, information can be more readily obtained from direct observation without direct "cooperation" from the components of the system being studied. In the case of an economy, understanding how the system works is more dependent on explanations of their roles by people actually in the system. The ultimate result of fisheries studies (biological and economic), as far as industry people are concerned, is an alteration in their livelihood. If they believe it will be positive change, they may cooperate. If they believe it will be a negative change, they may not only refuse to cooperate, but can provide erroneous information as to how their system works.

In short, cooperation from the people in a fishery is absolutely necessary for understanding a fishery. Unfortunately, establishing and maintaining working relationships with people in a fishery is frequently viewed as relatively unimportant public relations-type work by the scientific community.

The considerable time devoted to the background papers was a worthwhile investment because without the foundation for discussion they provided the workshops would otherwise have been virtually useless in their objectives of obtaining socio-economic information that is not in the literature from people actually involved in the fisheries. It was anticipated that industry people would be quicker to correct faulty impressions than to voluntarily offer ones that had not been presented. This turned out to be a correct supposition.

Workshop Format

The workshop had a highly-structured and closely-followed format (see background papers). Most of the sessions were tedious and were recognized by participants for what they were; namely, an attempt to "pump" information from a moderately cooperative, but skeptical, group. Whenever there were differing opinions, a "concensus" (when reached) was obtained in an American Assembly Style format. No "vote taking" was used to resolve disputes. Everyone was allowed an opportunity to express his (or her) views and all views were considered.

Perhaps the most enduring result was that participants became more cooperative and less skeptical even though some of the topics involved "none-of-your-business" type questions. All industry participants in both workshops said that, if asked, they would cooperate further. Most industry people had never been asked to provide information or offer opinions on their fisheries by scientists or administrators. They sincerely appreciated the opportunity afforded by the workshop. Industry people think most fishery research is not relevant to them or is inefficient and sometimes erroneously conceived or incorrect because researchers do not have information that would be provided by industry people if they were asked.

Most workshop participants concluded the major shortcoming was that the background papers were not distributed to participants several weeks in advance of the workshop. This should definitely be done if such workshops are conducted in the future.

Bottom Line

Participants were quick to refute faculty information in the background papers but not as quick or able to provide new information. This situation could have been improved if the background papers would have been distributed earlier so that participants would have had a better idea about what type of information (e.g., business records) they might have brought with them to the workshop.

In general, the workshop staff was somewhat disappointed in the amount of new information generated as a result of the workshop (compare background papers and final reports). This was not due to a lack of cooperation by participants. In this regard, industry people were more cooperative than anticipated. It is believed this was a result of a thorough job on the pre-workshop background papers and a lack of experience in obtaining the desired type of socio-economic information in such a workshop setting.

The cost of conducting the workshops was relatively small compared to the costs of assimilating and organizing the pre-workshop background material. This suggests that if socio-economic profiles are being prepared, it could be cost effective to conduct such an "industry people workshop" during the preparation of a profile. Such a "workshop" should not be confused with public hearings or other forums where interest groups can present their views or management plans or other policies that are presumably based on biological, economic, and social information. These workshops should be viewed as methods of obtaining specific information that is not otherwise available and review of the factual content of information to be utilized in formulating socio-economic profiles that become the basis for management plans.