Proceedings of a Workshop for Potential Fishery Resources of the Northern Gulf of Mexico

March 4-5, 1980
New Orleans, Louisiana

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PROCEEDINGS OF A WORKSHOP FOR POTENTIAL FISHERY RESOURCES OF THE NORTHERN GULF OF MEXICO

March 4-5, 1980
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PREFACE

In an effort to explore the potential for development of new fishery resources or expand the use of currently underutilized fishery resources of the northern Gulf region, a workshop was held in New Orleans, Louisiana in the spring of 1980. The purpose of this workshop was to gather a cross section of academia and industry together to discuss the potential for development of fishery resources in the northern Gulf region in an effort to increase the utilization of these fishery resources.

The workshop began with a presentation by Mr. Tom Billy of the Office of Utilization and Development, U.S. Department of Commerce, National Oceanic and Atmospheric Administration (NOAA) who brought the group up to date on the federal government's commitment to the development of U.S. fishery resources. Mr. John Reintjes from the National Marine Fishery Service (NMFS) Laboratory, Beauford, North Carolina presented a summary of the biological information on the clupeidae and coastal pelagic fisheries (Spanish Sardine, Round Herring and Thread Herring) resources. The life histories of the northern Gulf Carangidae resources were presented by Mr. Eugene Nakamura from NMFS Laboratory at Panama City, Florida. Mr. Luis Rivas, NMFS Laboratory, Miami, Florida discussed the life history of the Mugillidae resource of the northern Gulf and their potential for development. Mr. Ray Hixon from University of Texas discussed the various squid resources of the Gulf and their potential for development. The first day's session was concluded with a discussion led by Mr. Michael Wascom, Louisiana State University Sea Grant Law Program of the legal aspects of development of these resources. He indicated that there was a great need for interstate cooperation, particularly in the development of an utilization of nearshore resources.

The second day of the workshop centered around marketing, financing development and export of these resources and a discussion of real life problems associated with the development and utilization of these resources from the industries' point of view. The session was begun with a presentation by Mr. Ed Smith, NMFS Laboratory, Pascagoula, Mississippi of federal efforts to market northern Gulf fishery products in the Far and Near East. This discussion was followed with a review of the financial instruments needed to engage in foreign trade as well as a review of the agencies that are available to assist the individual and/or company to engage in foreign trade. This presentation was by Mr. Peter Kenyon, Vice President, Merchants National Bank of Mobile, Alabama. Mr. C. Martin Taylor of C. Martin Taylor and Company of Jacksonville, Florida, a freight forwarder, described the functions of a freight forwarder in assisting in the marketing of fishery products in the export market.

The workshop was concluded with a presentation by Mr. Gene Raffield of Raffield Fisheries of Port St. Joe, Florida. Mr. Raffield related how Raffield Fisheries has been active in developing several new fisheries in the northern Gulf area. He also elaborated on some of the trials and tribulations of engaging in this type of business.

This workshop was sponsored cooperatively by the Mississippi-Alabama Sea Grant Consortium, the Louisiana State University Sea Grant College Program and the Gulf and South Atlantic Fisheries Development Foundation, Inc. Without the support of these agencies, the workshop would not have been possible.

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THE ROLE OF THE DEPARTMENT OF COMMERCE IN DEVELOPMENT OF POTENTIAL FISHERIES RESOURCES OF THE NORTHERN GULF OF MEXICO

by
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During the past year a new Federal policy has been established for fishery development. Fisheries development encompasses cooperative efforts by the Federal government, states, academia and others to assist the fishing industry in development and utilization of non-traditional species which may have been previously fished by foreign boats or not harvested at all.

The Administration's commitment to this agressive policy includes resources to provide financial assistance needed to develop and strenghten the industry and to increase the supply of fishery products available to consumers. We look to the industry for leadership in identifying areas of greatest potential for development and areas needing specific research and other services to accelerate development.

The new policy is the result of increasing questions about the appropriate Federal role in the area of industry development assistance at the same time that such programs were diminishing. The Office of Utilization and Development of the National Marine Fisheries Service had proposed to use Saltonstall-Kennedy (SK) funds to help the industry develop domestic fisheries.

These monies are collected from tariffs on imported fishery products. Questions were raised about this approach. As a result, a task force comprised of representatives of concerned Department of Commerce elements and other Federal agencies was organized to determine the appropriate role of the Federal government in fisheries development. An advisory committee of industry representatives, Sea Grant officials and others was appointed to monitor the task force's studies and to make recommendations.

The task force found that opportunities existed for major expansion of U.S. fisheries because of the Fishery Conservation Management Act and other factors occurring worldwide. Expansion would benefit the nation, particularly in the economic area. Impediments were identified that blocked or slowed developmental processes. Even though industry was investing, building new boats and moving ahead, the task force indicated that the whole process could be accelerated through reshaping Federal programs and working more cooperatively among different Federal and state agencies, Sea Grant and the industry. The benefits to be derived from accelerating the nation's fisheries development far outweighed the cost involved.

There are several areas of active cooperation with the industry specified by the new policy. First is increased financial support for comprehensive regional plans to develop fisheries. Second is expansion of foreign and domestic markets. Particular emphasis is placed on foreign markets with our trade deficit running $2 to $3 million annually in the seafood category. We are also becoming more concerned with and involved in trade negotiations. We need to take better advantage of the International Trade Administration

in the Department of Commerce as well. There are efforts to expand foreign trade in the Gulf area already, including activity by the Gulf and South Atlantic Fisheries Development Foundation, Inc.

Other areas of emphasis are the safety, quality and nutritional value of fish and fishery products. Also, a multitude of federal regulations are in effect and more are coming. Our agency should help eliminate regulatory impediments to the fisheries development process.

Improved planning for public infra-structure is another area for improvement. Infra-structure includes the people, villages, roads, docks, schools and utilities necessary to take advantage of a resource. Alaska, for example, has tremendous resources but does not have the infra-structure in many instances to take advantage of the potential. The Economic Development Administration within the Department of Commerce has been active in infra-structure planning. We are cooperating with them more, providing funding for regional planning and promoting cooperation among states, local jurisdictions, federal programs and industry in better planning infra-structure requirements.

Another area of emphasis is consumer education and involvement. For example, consumers should be a formal part of the process in debates or discussions on such issues as recreational versus commercial fishing, domestic harvesting versus foreign harvesting of resources, relative costs, products preferences, etc.

As part of this policy, fishery development legislation was proposed by the Administration that clearly defines the need for and approach to development of fisheries, recommends funding, identifies basic policy, and recognizes the importance of the U.S. industry's need for expansion.

To implement the policy and begin the process, our agency announced that $10 million in SK funds were available in FY 1980 for grants for fisheries development projects, particularly encouraging comprehensive proposals and participation by fishery development foundations. We received approximately 300 proposals requesting $50 million for the first year's funding. Most of the proposals were good and appeared to be well supported with matching funds. That strong response clearly supports the idea that a need for Federal support exists. Hopefully the proposed legislation will lead to even greater support of the development process.

The Gulf and South Atlantic Fisheries Development Foundation has accumulated initial information on fishery development potential, stock quantities and the potential for processing and marketing different species. On the basis of this earlier work, the Foundation has identified tasks and submitted a comprehensive proposal for SK funding which will assemble additional data and information needed to accelerate development of Gulf area resources. Additional research on selected fish stocks, particularly those of interest to industry, would receive support from the Washington perspective. Such information is vital to decisions on the feasibility of developing additional fisheries and on how to harvest these resources commercially. This workshop is exactly the kind of process we wanted to have, with the interplay of people with different interests, different areas of knowledge, particularly the industry and their practical understanding of developing and expanding fisheries of the Northern Gulf of Mexico.

Questions from the audience:

Q. What is the Department of Commerce doing in regard to the high duty on U.S. fish in foreign countries?

A. The entire Federal sector is involved in negotiations to encourage overall reduction of tariffs, consistent with current Federal policy. Trade missions to target countries for expansion of our exports are also planned. Key countries are Japan, Spain, Germany, Italy, France, Portugal and several in South America and Africa. Two trade missions are

currently being set up for Europe and Japan. Formal negotiations to reduce or eliminate both tariff and non-tariff trade barriers will be conducted.

Q. The shrimp market is a basic fishery here, and it has come down dramatically in recent weeks. Is there a move under way to limit or restrict shrimp imports?

A. Our agency is not currently advocating restricting imports of shrimp or other products at this time. We feel that if we can help alleviate the problem by accelerating development and providing alternatives for fishermen and processors, the problem of competition from imports will work itself out.

Q. The U.S. International Trade Commission voted 3 to 0 in favor of lifting the tariff on Canadian fishery products. Will this hurt our industry?

A. The general policy of the administration is to eliminate or reduce tariffs on an across-the-board basis. That policy is in followup to a law passed to move in that direction.

Q. Our imbalance of trade in fishery products is great. What commodities do we have that we can export on our present production basis?

A. There is real interest in domestic production of fish blocks for both domestic and foreign use. The 200 mile zones established around the world have reduced access to several nations, and they are looking to us as a potential producer of fish blocks for export. They would then process the blocks into various products for their established markets. There is interest in exporting squid. Alaskan pollock has potential as surimi, an intermediate product used to make a variety of fish products in Japan. Pollock roe in certain seasons has a good potential market in Japan.

Gulf interests are exploring markets in Nigeria and other countries for either whole or processed products shipped in bulk rather than sophisticated manufactured products. We need to tie current U.S. capability with interest overseas and identify priorities for development now.

Q. Are these trade missions to Europe going to discuss specific fish species? Hake, for example, is a staple fish in Spain. Has Spain identified hake in the Gulf or on the East Coast?

A. Some countries have identified the species or type of products they are interested in. Hake has not be identified to my knowledge.

Q. What is the duration of those SK funds?

A. The current Administration commitment is to make approximately $20 million per year available through fiscal year 1984 — a five-year period. If proposed legislation passes, even more than the current projected $20 million per year could become available. Some of that $20 million is used for in-house fishery development programs, with the remainder available for funding proposals.

Q. You indicated your agency seeks to eliminate or modify federal regulations that impede fishery development. Yet you have, in effect, laid new administrative requirements. The requirements in your Federal Register notice for the minority business plan specifically forbid us, as a public university contrained to operate under state laws, to do the very thing the minority business plans were designed to accomplish.

A. If this approach prohibits you from following through on some work, write us and indicate your problems and what approach you feel would be appropriate. We would certainly consider your problems and address them. It is not too late. Our initial regulatory review efforts have focussed on effluent guidelines and the pending additional requirements seafood processors are going to be facing.

MARINE HERRING AND SARDINE RESOURCES OF THE NORTHERN GULF OF MEXICO

by
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INTRODUCTION

Other than the menhadens (*Brevoortia patronus, B. smithi,* and *B. gunteri*), clupeoid fishes, which also include the herrings, sardines, and anchovies, support no large fisheries in the Northern Gulf of Mexico. Yet in other parts of the world they support large fisheries. Notable examples are the Peruvian anchoveta, California sardine, South African pilchard, and the Indian oil sardine.

Because most clupeoids are small, bony, and oily, they are not considered desirable foodfishes. Few are consumed fresh and few are frozen. Instead most are preserved by salting, as are North Sea herrings, or are processed and canned as specialty foods, such as kippers, anchovies, and sardines. Some, such as the Peruvian anchoveta and the Atlantic and Gulf menhaden, are the raw material for a large fish meal and oil industry. Notable exceptions are the American, European, and Indian shads, which are large and exceptionally fine food fishes.

Because many of these or similar species support sizable fisheries in other parts of the world, the question has often been asked whether any of these species are abundant enough in the northern Gulf to support and sustain a fishery. There is no clear answer at this time, primarily because there is little or no information for any of these species on life history, distribution, or relative abundance. As a starting point, I have collected and assembled what information is available on these species in the Gulf or in other parts of the world where they occur.

Of the species known to occur, only four, in addition to anchovies, appear to be abundant enough to be potentially valuable. These are Atlantic thread herring, round herring, Spanish sardine, and scaled sardine.

All of these, including the anchovies, have some general characteristics in common. All are relatively small, fast-growing species that have a life span rarely more than 3 years, reach sexual maturity early, and are highly prolific. They are low on the trophic level, feeding primarily on plankton, and therefore are prey to all the larger fishes, sharks, marine mammals, and sea birds. They are fast swimmers and occur in small dense schools, often making vertical day/night movements, as well as geographic daily and seasonal movements.

SPANISH SARDINE

Sardinella anchovia

Distribution and Abundance

In the western Atlantic the Spanish sardine ranges from Cape Cod, Massachusetts, south along the coast to Florida, and along the entire coastline of the northern and

southern Gulf of Mexico and the Caribbean south to Brazil (Hildebrand 1964). Areas of noted abundance are the south Atlantic and Gulf coasts of the Undited States, the Campeche Banks off Mexico, and the northeastern coast of Venezuela.

Local abundance appears to be related to seasonal and diurnal movements. Along the Atlantic coast they apparently move south in autumn and north in spring (Hildebrand 1964). In Biscayne Bay, Florida, adults appear in fall and winter but are absent in spring and summer (Low 1973). Along the northern Gulf coast, schools are found off western Florida from April to October, usually within the 20-fathom curve, and are particularly abundant in the bight between Cape San Blas and Pensacola Bay. Concentrations of separate schools moving near the surface have been observed 15 to 40 miles southwest of Tampa Bay in November, and in February and March demersal schools have been found 90 miles from the Bay (Prosvirov and Varea 1965). Off Venezuela, Spanish sardine are abundant near shore from December to May but scarce or absent in summer (Simpson and Gonzalez 1967).

Spanish sardine also appear to make vertical diurnal movements. They remain near the bottom during the day and rise to midwater at dusk, taking 15 to 20 minutes to make the upward movement of 200 to 250 feet (Prosvirov 1967). These vertical movements seem to be governed by illumination, since schools concentrate in midwater on foggy or dark days.

Distribution appears to be widespread. Divers have reported concentrations near oil rigs, wrecks, and reefs. Occasionally they have been caught in trawls from deep water by research vessels off the edge of the Continental Shelf (Cruise reports Pascagoula Laboratory NMFS).

Distribution may be controlled by temperature and salinity or indirectly by these factors through their influences on zooplankton. Prosvirov and Varea (1965) reported that dense schools have been found in areas of upwelling where zooplankton biomass is high, salinity exceeds 35 ppt, and temperature is 15° to 16°C. In February and March, Prosvirov (1967) found dense schools on the outer Continental Shelf where the temperature exceeded 17°C and salinity exceeded 36 ppt. Low (1973) suggested that appearances and disappearances of schools in Biscayne Bay, Florida, were related to the abundance of plankton.

Early Life History

Spawning occurs in the open waters of the Gulf, although the exact areas of spawning are difficult to determine. According to Houde et al. (1976, 1979), most spawning in the eastern Gulf occurs over wide areas where depths are between 10 and 50 m, although some eggs and larvae have been recovered where depths were 200 m. In the western Gulf, larvae have been reported from as far out as the Continental Shelf off Texas (Finucane, Collins, and Barger 1978). Eggs and larvae have been collected in the eastern Gulf in all seasons, but are most abundant from May to September (Houde et al. 1976,1979), and in the western Gulf from April to October (Finucane, Collins, and Barger 1978). Since spawning occurs over a long period, a given year class will have a wide range in lengths (Prosvirov and Varea 1965). Elsewhere, off the northeast coast of Venezuela, Lopez (1972) reported that eggs were most abundant from August to November and in February and May, while Simpson and Griffiths (1967) stated that spawning occurred year round but was most intense during the upwelling season from December to April.

Only a few larvae have been described. Houde and Fore (1973) show figures of a larvae 7.8 mm and 19.3 mm, while Simpson and Gonzalez (1967) show detailed illustrations of developing embryos but no larvae. Larvae from off Brazil that may have been Spanish sardine were described by Aboussouan (1969); larvae of *S. aurita* were described by D'Ancona (1956).

Fecundity estimates for Spanish sardine in the Gulf are sparse. For eight females, 14.4 to 15.5 cm SL, collected near Palm Beach, Florida in 1971, estimates ranged from 30,718 to 86,269 (Martinez 1972). In the Mediterranean fecundity ranged from 3,710 to 48,600

depending on size of females (Ben-Tuvia 1960); off West Africa it ranged from 10,000 to 270,000.

Age Structure

The life span is relatively short since few fish older than age 3 have been found. Fish caught by trawl off Florida were 49% age-2 and 51% age-3 (Prosvirov and Varea 1965). Fish caught by haul seine in the Gulf of Cariaco in November were 23% age-1, 46% age-2, 20% age-3 and 11% age-0, 4, or 5 (Heald and Griffiths 1967).

Sex Ratio

Although data are scarce, females appear to outnumber males. Prosvirov and Varea (1965) reported a male female ratio of 1:2 for fish from the Gulf of Mexico, and Heald and Griffiths (1967) reported a ratio of 1.1:2 for about 1,300 fish from Venezuela. Houde (unpublished data), however, reported a ratio of 1.1:1 for 163 fish sampled from a commercial fishery near Panama City from 1971 to 1974.

Length and Weight

There is little published information on length and weight in the Gulf. Apparently few fish larger than 200 mm occur. Off Florida, fish that had completed two seasons of growth ranged from 135 to 172 mm; fish 3 years old ranged from 162 to 200 mm (Prosvirov and Varea 1965).

For fish taken off Venezuela, length averaged 161.3 mm at age-1 (N=430), 176.4 mm at age 2 (N=970), 186.8 mm at age-3 (N=363), and 200.0 mm at age-4 (N=3); lengths back calculated from scale measurements averaged 137.2 at age-1, 168.0 at age-2, 179.5 mm at age-3, and 202.1 mm at age-4 (Heald and Griffiths 1967).

Age and Size at Sexual Maturity

For the Gulf of Mexico, most fish appear to mature at the end of their second year at a minimum size of about 135 mm (Prosvirov 1967; Schmidt 1972). By age-3 and 195 mm, all have attained maturity (Schmidt 1972).

Exploitation

The largest fishery in the Western Atlantic is off Venezuela, where annual landings of more than 40,000 tons have been reported. Mexico has reported landings of 1,000 tons in some years, and Sal'nikov (1965) and Sokolova (1965) have reported Spanish sardine in catches from Campeche Banks. An estimated 1,000 tons are landed annually in a small seine fishery from May to October in the Florida panhandle from Port St. Joe to Pensacola. Most of this catch is used for bait.

In 1957 a 35-foot mackerel boat was equipped with a west coast lampara sardine seine and began fishing off St. Petersburg, Florida, for Spanish sardine for bait. Some thread herring also were caught. In 1958 the Spanish sardine did not reappear and since the demand for thread herring was poor, the fishery was terminated (Butler 1961).

ATLANTIC THREAD HERRING

Opisthonema oglinum

Distribution and Abundance

The thread herring ranges from Cape Cod, Massachusetts, to Brazil and is common throughout the Gulf of Mexico and the Caribbean. There is probably no exchange between fish of the Atlantic and Gulf coasts, since no fish tagged in the Atlantic have been recovered in the Gulf.

Seasonal movements appear to be pronounced along the Florida west coast, the fish moving south in autumn and north in spring (Fuss, Kelly, and Prest 1969). Commercial landings and catch per unit of effort were high in fall and winter off Fort Myers and low in summer. Gill net catches peaked off St. Petersburg in late spring and early summer.

Estimates of stock size have varied. Bullis and Thompson (1967) estimated stock size at

1 million tons, and Sykes (1968) suggested that annual catch might be 500,000 tons. Kinnear and Fuss (1971) estimated that the resource in Florida waters contained as much as 750,000 tons. On the basis of egg and larvae abundance, Houde (1977a) estimated that adult biomass ranged from 108 to 372 thousand metric tons, and that the annual potential yield ranged from 27,500 to 186,200 metric tons.

School size, determined from purse seine sets, ranged from 8 to 39 tons and averaged 18 tons.

Early Life History

Spawning occurs in open waters apparently throughout the entire Gulf, but information on spawning in the central and western areas is sparse. In the eastern Gulf off southwestern Florida, larvae have been collected from March to September and eggs from May to August, all within 30 miles of the coast (Houde 1977 a). Peak spawning probably occurs from May through July (Fuss, Kelly, and Prest 1969). Off south Texas a small number of larvae were collected during August and September 1977 (Finucane, Collins and Barger, 1978). The only description of larvae is provided by Richards, Miller, and Houde (1974), who also describe meristic characters and five proportional measurements. Prest (MS.) [1/] estimated fecundities from 13,638 to 50,339. Young of the year thread herring have not been observed in large numbers in nearshore shallow areas.

Age Structure

The only information on age structure is given by Fuss et al. (1969), who indicate that only ages-1 to-3 are found.

Sex Ratio

In summer populations off St. Petersburg Beach the sex ratio of males to females was about 1:5; in winter off Fort Myers it was 1:1 (Fuss 1968). Prest (MS.) [1/] reported that the sex ratio from March to December reflected a cyclic fluctuation in the number of males. In March the ratio of males to females was 1:1, in April about 1:2; in May to July about 1:5; in August 1:2; and from September to December about 1:1.3.

Length and Weight

Mean lengths for three age groups in commercial catches off Florida were 146 mm for age-1, 149 mm for age-2, and 148 mm for age-3. The lack of any large difference in the mean length indicated that the fish were schooling by size. Hildebrand (1964) reported that fish reached about 35 to 65 mm at the end of year 1 and about 90 to 120 mm at the end of year 2.

Fork lengths of fish taken at different seasons from purse seine catches off Fort Myers in 1967-68 ranged from 100 to 180 mm, with a mean of 148. Fall catches averaged 146 mm, winter catches 150 mm, spring catches 148 mm, and summer catches 144 mm. Maximum size reported is 300 mm TL (Hildebrand 1964). No information is available on weights.

Age and Size at Sexual Maturity

Fork length at maturity ranged from 135 to 169 mm. No information is available on age.

Exploitation

Menhaden purse seiners have always caught thread herring incidentally to menhaden, but since catches are not identified by species the size of annual landings is unknown. Probably it is well below 0.5% of the menhaden catch. Small catches mainly for bait have been made by a variety of gear, mainly haul seines, for many years. In 1957 a 35-foot mackerel boat was equipped with a lampara seine to fish for Spanish sardine off St. Peters-

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1/ K.W. Prest, Jr. 1968. Reproduction of Atlantic thread herring, *Opisthonema oglinum*, in the northern Gulf of Mexico, Manuscript, Beaufort Laboratory, NMFS, Beaufort, NC 28516

burg. Thread herring was caught incidentally but were not as desirable for bait as the sardines. When the sardines failed to reappear in 1958, fishing was terminated (Butler 1961). In the winter of 1958-59 a shrimp vessel equipped with a lampara seine fished for thread herring in the same area and made catches of up to 27 tons per set. Later, three vessels, the largest a 53-foot shrimp boat, were outfitted as single-boat purse seiners. Catches ranged from 5 to 40 tons per set, but bad weather and difficulty in transporting the catches to reduction plants at Apalachicola, Florida, or Pascagoula, Mississippi, caused the operation to end in 1960 (Butler 1961). In 1967 a reduction plant was opened near Fort Myers. Initially, one vessel operated a single-boat seine. It was later joined by a menhaden vessel fishing a conventional two-boat seine. Landings totaled 3,500 tons by the end of December. In November, a Louisiana menhaden vessel also fished in the area and landed 1,150 metric tons at its home port (Fuss 1968). The new fishery closed in 1968, after Florida passed a law in 1967 allowing counties to prohibit purse seining within 3 nautical miles of the coast. About 12,000 metric tons were landed in 1968 (Fuss, Kelly, and Prest 1969).

SCALED SARDINE

Harengula jaguana

Distribution and Abundance

The scaled sardine inhabits the warm temperature and tropical waters of the western Atlantic from Cape Hatteras, North Carolina, to southern Brazil, but is not abundant north of Cape Canaveral, Florida. It reaches greatest abundance along the Gulf coast of the United States and Mexico and in the Caribbean, where it occurs in or near the saline bays and estuaries. It rarely occurs offshore beyond the 20-fathom curve. On the basis of the distribution of eggs and newly hatched larvae, Houde (1977c) believes that most of the adult population in Florida occurs within 3 nautical leagues of the coast.

Salinity and temperature are probably factors that influence distribution. Scaled sardines are abundant in Mississippi Sound from August to November, but are present all winter long in Biscayne Bay, Florida, where temperature may reach near 15°C at times. After sudden cold fronts, cold kills are often reported. Perry and Boyes (1978) obtained their largest catches at salinities between 15 to 20 ppt, and they believe that larger fish are more abundant in salinities below 20 ppt and smaller fish at higher salinities of 25 to 30 ppt.

On the basis of the Gulland virgin biomass procedure, Houde (1977c) estimated that in the eastern Gulf, potential yield is between 46,132 and 92,264 metric tons. These estimates expanded to the entire U.S. Gulf coast ranged from 151,000 to 320,000 metric tons.

Early Life History

Most spawning is in the open Gulf although some may occur in bays and estuaries. Off southeast Florida it occurs from about February to August and peaks in April (Springer and Woodburn 1960; Martinez and Houde 1975). In the eastern Gulf, eggs or larvae have been collected from January to September, but are most abundant from May to August. Off Florida, most larvae have been collected inside the 20-m curve, and four have been taken between the 20-and 30-m curve. Off the Texas coast, Gunter (1945) suggests one spawning period in April and another in September.

Eggs and larvae have been described from specimens reared in the laboratory (Houde and Palko 1970; Houde, Richards, and Saksena 1974). Transformation to juveniles is complete at 22 to 24 mm SL. Embryos from Brazil have been described by Matsuura (1972), and eggs and larvae from Cuban waters have been illustrated by Gorbunova and Zvyagina (1975).

Fecundity increases as fish get larger and ranges from 5,563 to 52,753 (Martinez and Houde 1975).

Age Structure

There is little information on age structure. Life expectancy is about 3 years (Breder

1948). A mature female examined by Martinez and Houde (1975) was age-3. Of 21 mature females examined by Martinez (1972), 10 were age-1, 5 age-2, and 6 age-3.

Sex Ratio

Of 394 fish examined by Martinez and Houde (1975), 191 were males, 203 females.

Length and Weight

Maximum length is probably around 200 mm TL (Breder 1948). The largest fish examined by Rivas (1964) was 140 mm SL and by Martinez and Houde (1975) 163 mm SL. Estimates of average growth per month were 11 to 13 mm TL per month in Mississippi waters (Christmas and Waller 1973) and 12.5 mm TL in Texas waters (Gunter 1945). In Florida waters, young of the year fish grew from 9 to 10 mm TL per month (Low 1973). Of 21 females examined by Martinez (1972), 10 were age-1 and averaged 106.6 mm SL and 29.85 g, 5 were age-2 and averaged 136.6 mm SL and 69.66 g, and 6 were age-3 and averaged 143.0 SL and 73.29 g.

Age and Size at Sexual Maturity

Although a few fish sexually mature at the end of 1 year, most mature at the end of 2 years when they range in length from 80 to 130 mm SL (Martinez and Houde 1975).

Exploitation

There are no commercial landings. Houde (1977b) estimated that about 500 tons or less are landed annually in Florida for bait by commercial and recreational fishermen. Scaled sardines occur frequently in shrimp fishery discards. In 149 samples taken across the northern Gulf, 1975-77, approximately one-third of the discarded fish were scaled sardines. In the industrial trawl fishery off Louisisana and Mississippi nearly 2% of the landings are scaled sardines.

ROUND HERRING

Etrumeus teres

Distribution and Abundance

The round herring is a cosmopolitan species found throughout temperate and subtropical marine waters. Separate stocks or subspecies are recognized in six main areas: Western North Atlantic, Eastern Pacific (including Hawaii and the Galapagos Islands), South Africa, Red Sea (including Gulf of Aden), South Australia, and Japan.

They are found off the coast of the United States and throughout the Gulf of Mexico in deeper waters along the slope and edge of the Continental Shelf, where they occur in dense schools. Although occasionally found in bays and estuaries, they are rare in these areas. Except for some unexplained periods of phenomenal abundance along the Atlantic coast (Scattergood 1953; Hildebrand 1964), schools rarely occur nearshore. Bait fishermen along the Florida coast were unfamiliar with the species.

Often they school with other species. Bullis, Carpenter, and Roithmayr (1971) reported a mixed school of round herring and Spanish sardine 50 miles west of Tampa that was 50 miles long, 10 miles wide, and about 12 feet thick. In January 1969, a massive school of round herring and rough scad was reported off Cameron, Louisisana, that was 35 miles long (Cruise reports - Pascagoula Laboratory, NMFS). Off South Africa round herrring are often mixed in schools with anchovy and mackerel (Geldenhuys 1978).

Apparently none of the major stocks make any seasonal movements. Whitehead (1963) suggests that round herring in the Red Sea may migrate there from the Mediterranean, but there is no evidence to support this assertion.

According to Bullis et al. (1971), schools make diurnal vertical movements. During the day they may be 5 to 20 fathoms off the bottom, but at night they are found near the surface.

The biomass and potential yield of round herring may be large but very variable. On the

basis of the number of eggs and larvae in plankton samples, Houde (1977b) estimated biomass in the eastern Gulf to be about 718,000 metric tons in 1971-72 but only 131,000 in 1972-73. At the 0.95 probability level, the estimates ranged from 517,000 to 918,000 in 1971-72 and 45,000 to 217,000 in 1972-73. By extrapolation, assuming that herring concentrations were uniform over the entire area, estimates for the entire Gulf ranged from 440,000 to 2,300,000 metric tons. Potential yield, based on the method of Gulland (1971), was between 33,000 and 421,000 metric tons for the eastern Gulf and between 110,000 and 1,370,000 for the entire Gulf.

Early Life History

Spawning apparently occurs from about November to May. Eggs and larvae have been colllected in the eastern Gulf only during those months and are most abundant in January and February (Houde 1977b). Off the south Texas coast larvae have been collected from December to April (Finucane et al. 1978). Fore (1971) reported that spawning is from December to March. From the distribution of pelagic eggs, Houde (1977b) concluded that there is a major spawning area about 90 miles west-southwest of Tampa Bay and a minor area just north of the Dry Tortugas. Off the Texas and Louisiana coasts, spawning occurs from 54 to 197 km offshore and may extend beyond the Continental Shelf (Fore 1971).

Eggs and larvae have been described by Houde and Fore (1973). Larvae are distinct among clupeoids in the Gulf, being distinguished by characteristic pigmentation and prominent teeth.

Fecundity of eight females, 130 to 165 mm SL, ranged from 7,446 to 19,699 (Houde 1977b).

Age Structure

There is no information on age structure of round herring in the Gulf. From South African commercial catches, Geldenhuys (1978) obtained samples from 1965-73 that averaged 51% age-0, 19% age-1, 9% age-2, 15% age-3, 5% age-4, and 0.5% age-5. There was considerable variation from year to year, however, the dominant age group varying from age-0 to age-3. Round herring in catches off Japan apparently range from age-1 to age-3 (Ito 1968).

Sex Ratio

Houde (1977b) reported 39 males and 32 females in a sample of 71 fish. In the South African fishery, Geldenhuys (1978) reported the sex ratio of males to females was 1:1.2 for the period 1965-71.

Length and Weight

Maximum length in the western Atlantic is about 250 mm (Hildebrand 1964). Houde (1977b) examined eight gravid females, ranging from 130 to 165 mm in length and 30 to 56 g in weight. In South African catches, lengths ranged from 80 to 230 mm SL and weights from 8 to 56 g for fish age-0 to age-5 (Geldenhuys 1978). Age specific mean lengths for the South African fishery were 16.73 cm SL for age-1, 19.03 for age-2, and 20.20 for age-3; for the Japanese fishery, length ranges for age-1 fish were 13.3 to 17.7 cm SL, for age-2 17.8 to 21.4 cm and for age-3 21.5 to 24.0 cm.

Age and Size at Sexual Maturity

Little information on age and size at maturity is available for round herring in the Gulf. Houde (1977b) found that fish 130 mm SL and larger were sexually mature. In the South African fishery, 50% of age-3 fish and 100% of age-5 fish were mature (Geldenhuys 1978). In the Japanese fishery, females appeared mature at 170 mm SL (Ito 1968).

ANCHOVIES

Abundance and Distribution

Anchovies are small herring-like fishes that are found throughout most of the temperate and subtropical marine waters of the world. They differ from other clupeoids in having a large gaping mouth on the lower side of the head. There are eight species present throughout the Gulf that have been reported (Daly 1970; Whitehead 1973). These are:

Bay Anchovy	*Anchova mitchilli*
Striped Anchovy	*A. hepsetus*
Silver Anchovy	*Engraulis eurystole*
Dusky Anchovy	*Anchoa lyolepis*
Cuban Anchovy	*A. cubana*
Longnose Anchovy	*A. nasuta*
Bigeye Anchovy	*A. lamprotaenia*
Flat Anchovy	*Anchoviella perfasciata*

Of the eight, only four species — the bay anchovy, striped anchovy, silver anchovy, and dusky anchovy — are distributed widely enough and are abundant enough to be considered important. They also reach a larger size — up to 15 mm for the striped anchovy and silver anchovy — than the other species, which may get no larger than 8 mm. In the Gulf, nearly all anchovies, regardless of species, are less than 10 mm. All are similar to each other in appearance and are difficult to identify by visual observation alone.

Bay Anchovy

Of all species, the bay anchovy appears to be the most abundant. In the Gulf of Mexico inventory (Franks et al. 1972), it was the most abundant fish in the collections. Gunter (1938 a, b) ranked it as the fish with the greatest species mass on the Louisiana coast, and Christmas and Waller (1973) and Swingle (1971) listed it first in abundance in Mississippi and Alabama waters. Norden (1966), Fox and Mock (1968), Perret et al. (1971), and Juneau (1975) all found that the bay anchovy dominated their collections.

Bay anchovies spend most of their life in estuaries and nearshore areas and apparently are euryhaline. Swingle (1971) found them equally distributed in salinities ranging from 5 to 19 ppt, and Christmas and Waller (1973) found no discernible relation between their distribution and salinity above 2.0 ppt.

Despite their euryhaline nature, they apparently prefer the upper estuaries and the lower saline regions of bays and sounds, except during spawning. Although schools may be dense, they are relatively small. Often schools comprise both the bay anchovy and striped anchovy.

Striped Anchovy

This species also inhabits coastal and estuarine waters except during the coldest months. Its distribution apparently is influenced by salinity, for it is found in greatest abundance only in areas where the salinity is higher than 15 ppt (Gunter 1945; Swingle 1971; Christmas and Waller 1973) or 20 ppt (Perry and Boyes 1978). In coastal areas striped anchovies form mixed schools with bay anchovies, but in the open Gulf they are more likely to be found with silver anchovies (Pequegnat, Wormuth, and McEachran 1977; Wormuth, Pequegnat, and McEachran 1979).

Silver Anchovy

Although it has been collected in nearshore waters, it generally is considered an offshore oceanic species (Hildebrand 1964; Jones, Martin, and Hardy 1978).

Dusky Anchovy

This species is only an occasional visitor to northern Gulf estuaries. It is most abundant during warmer months and is absent from most places in winter. There is no information on relative abundance or factors that may affect distribution.

Early Life History

Bay Anchovy: Most spawning occurs in nearshore areas, where eggs hatch and larvae metamorphose before moving into estuaries (Gunter 1945). Since some spawning occurs in estuaries on the Atlantic coast (Jones, Martin, and Hardy 1978), it is possible that it also occurs in larger estuaries along the Gulf coast.

Spawning appears to occur throughout the year (Perry and Boyes 1978). In Texas, ripe fish have been taken from March to August (Gunter 1945) and larvae from May to November and in February (Hoese 1965). In Louisiana, specimens less than 30 mm TL have been collected in all months of the year (Perret et al. 1971). In Mississippi, Edwards (1967) found evidence of spawning from February to August, and Christmas and Waller (1973) noted that it may extend into October.

Fecundity may range from 250 to 2,000 (Perschbacher and Schwartz 1979).

Striped Anchovy: Spawning appears to occur in offshore waters (Christmas, Perry, and Waller 1974; Finucane and Collins 1977; Finucane et al. 1978) from about February to September (Christmas and Waller 1973; Gunter 1945; Hoese 1965; Swingle 1971). Larvae have been described by Jones, Martin, and Hardy (1978), who incorporated earlier descriptions by Hildebrand and Cable (1930).

Silver Anchovy: Spawning occurs offshore in nearly every month of the year, with peaks in spring and autumn.

Dusky Anchovy:

No information.

Age Structure

No information is available, other than that the life span does not extend much beyond 1 year for any species.

Sex Ratio

No information is available, except for the dusky anchovy. In a sample of 96, 42 were male, 52 female (Christmas, Perry and Waller 1974).

Length and Weight

Because anchovies have a short life span and spawn in most, if not all months, length and age information is difficult to interpret. Length frequencies are confounded by continual recruitment. For the bay anchovy, Edwards (1967) estimated growth to be 18.0 mm TL in the first month and 10.0 mm per month for the following 2 months. In Texas, mature males averaged 56.3 mm TL, mature females 60.0 mm (Gunter 1945). Herke (1971) suggested that bay anchovies may produce two generations a year. For the striped anchovy, Dawson (1965) found that 219 fish ranged from 65 to 140 mm TL. Roessler (1970) reported that samples of striped anchovy from south Florida had mean modal lengths that ranged from 95 to 195 mm TL. Roessler (1970) reported that samples of striped anchovy from south Florida had mean modal lengths that ranged from 95 to 195 mm TL during winter. Christmas and Waller (1973) estimated growth to be from 13.0 to 15.0 mm TL each month in Mississippi Sound, and Christmas, Perry, and Waller (1974) reported growth to be 13.3 mm SL each month in offshore waters. No information is available for the dusky or silver anchovy.

Age and Size at Sexual Maturity

All species probably mature by the time they are a year old. For bay anchovies, some may mature when they are only a few months old (Edwards 1967).Gunter (1945) reported both males and females with developing gonads at 36 to 37 mm TL, and Hildebrand and Cable (1930) reported gravid females 45 to 50 mm TL.

DISCUSSION

Except for the Gulf menhaden fishery, which is fully developed and has landings at or

near the calculated maximum, fisheries for the coastal herrings, sardines, and anchovies are very small or non-existent. Yet estimates of potential yield for thread herring, round herring, and scaled sardine are large enough to suggest that these species, singly or in aggregate, could support a fishery. One question, of course, is "Are these estimates reliable for the years they were made or valid for subsequent years?"

For most species the estimates of stock size are based on estimated numbers of eggs and have a wide range. Estimates range from 95,000 to 190,000 metric tons for round herring, 46,000 to 92,000 tons for scaled sardines, and 60,000 to 120,000 metric tons for thread herring. These estimates are based on only one or two years of data. Since there are many problems associated with quantitative plankton sampling, the estimates must be substantiated with other independent estimates of stock size and yield before they can be accepted with confidence.

Thread herring have been caught by menhaden vessels whenever the opportunity has arisen, yet they have constituted only a small fraction of the annual catch. If they are as abundant as some estimates suggest, one would expect them to constitute a much higher percentage of the landings than they have historically. Even in the small fisheries that have been specifically directed at them in eastern Florida, the catches have been small.

Even if stock sizes were shown to be large enough to support a fishery, other problems would remain before a fishery could be developed. One problem is continuous supply. For a fishery to remain economically viable, landings of a certain minimum size must be sustained each year. Factors that can threaten this supply are sharp and sudden drops in resource abundance as a result of year class failures, failure of the resource to appear in a given area at a specific time because of changes in seasonal movements, or disappearance of a resource from a given area as a result of environmental change or degradation.

Another problem that is just beginning to receive serious attention by fishery biologists is the role of low level trophic feeders, such as the clupeoids, in the food chain and the effect of large fluctuations in abundance of these prey species on levels of abundance of the larger predatory fishes that sustain man's commercial and recreational fisheries. For example, if man should begin to harvest great numbers of these clupeoids in the Gulf, would the population of pelagic predatory fishes that feed on them be reduced?

For most of the species discussed in this paper, there is little or no information on year class variations or factors that may influence these variations, seasonal changes in distribution and abundance, or the importance of these species in maintaining populations of larger predators. Until these and other aspects of life history are better understood, and until other methods of estimating stock size and yield are developed, there seems little likelihood that fisheries can be, or will be, developed.

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CARANGIDS OF THE NORTHERN GULF OF MEXICO

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INTRODUCTION

The family Carangidae consists of about 200 species of fishes in tropical and temperate waters throughout the world. Thirty-seven of these occur in waters of the U.S.A., twenty-four in the northern Gulf of Mexico. All are predacious, feeding on fishes, molluscs, or zooplankton. Carangids have narrow caudal peduncles and forked caudal fins. They are strong swimmers. Their body shapes vary from fusiform to high-bodied and laterally compressed. Each has a pair of stout spines that precede the anal fin. Most species occur in schools, while some are solitary. All members of this family are believed to be pelagic spawners, and their eggs are believed to be planktonic. Most of the juveniles are banded; some species may retain the bands in adulthood. Many of the young are found in association with floating and swimming objects, such as jellyfish, *Sargassum*, and flotsam. Several species have been suspected of causing ciguatera (poisoning from eating fish). The family contains species that are notable in various parts of the world as food fishes and as sport fishes.

The purpose of this review is to summarize what is known about the carangid fishes of the northern Gulf of Mexico. For life history information, the availability of the information rather than the information itself was summarized. Much of the data on the scads (species of *Trachurus* and *Decapterus*), the Atlantic bumper (*Chloroscombrus chrysurus*), and the blue runner (*Caranx crysos*) were obtained from a synopsis of coastal herrings and associated species prepared by Reintjes (1979). Most of the available data on the early life history of carangids were obtained from Aprieto (1974), Jackson (1976, 1977a, 1977b, 1979a, 1979b), and Johnson (1978). Bohlke and Chaplin (1968), Hoese and Moore (1977), Randall (1968), and Walls (1975) were very useful references for the species accounts. Other information was obtained from various sources in the literature. References cited in the bibliography were selected as appropriate for, or relating particularly to, the northern Gulf of Mexico.

CARANGIDS OF THE NORTHERN GULF OF MEXICO

Two dozen species of carangids (Table 1) are known to occur in the northern Gulf of Mexico. Some are regarded as prized food fish (e.g., Florida pompano, *Trachinotus carolinus*), some as excellent game fish (e.g., greater amberjack, *Seriola dumerili*), some as curiosities (e.g., lookdown, *Selene vomer*), some as excellent bait for game fishes (e.g.,

round scad, *Decapturus bipinnulatus*), and some as nuisance or trash fish (e.g., Atlantic bumper, *Chloroscombrus chrysurus*). A brief account of each of the twenty-four species follows.

Leatherjacket, *Oligoplites saurus*

The leatherjacket is a laterally compressed fish, dark greenish on its back, silvery on its sides, and with yellow fins (especially the caudal). It is a schooling species. This species has very stout, sharp spines anterior to both the dorsal and anal fins. These spines, according to Hoese and Moore (1977), "contain a small amount of poison, so it should be handled with care." This species occurs in the eastern Pacific and the western Atlantic; in the Atlantic, it ranges from New England to Uruguay. It is common in the northern Gulf of Mexico.

Rainbow Runner, *Elagatis bipinnulata*

This fish has a fusiform body with horizontal bands — a narrow blue, a broad yellow, a narrow blue, and a narrow yellow (from top to bottom) — along its flanks. It is strictly pelagic, occurring sometimes in schools and sometimes solitarily. The rainbow runner is regarded highly as both a sport fish and a food fish. It is circumtropical; in the western Atlantic, it is found from New England to Venezuela. The rainbow runner is not seen often in the northern gulf.

Florida Pompano, *Trachinotus carolinus*

The Florida pompano is a deep bodied, silvery fish with a short, blunt snout. This species is eagerly sought by both sport and commercial fishermen. It is the highest valued of all of the carangids in the market place. The young are frequently found along the shores of the northern gulf. It occurs from New England to Brazil. This species is common in the northern gulf.

Permit, *Trachinotus falcatus*

The permit is shaped similarly to the Florida pompano, but it gets much larger (up to 50 pounds). It too is a popular sport and food fish. The young of this species can be distinguished from the Florida pompano by the color of its fins — reddish in permit, yellowish in Florida pompano. The young of this species is also found frequently along the shores of the northern gulf. The species occurs in both the eastern and western Atlantic, in the latter from New England to Brazil. The permit is not as common as the Florida pompano in the northern gulf.

Palometa, *Trachinotus goodei*

This fish is also shaped similarly to the Florida pompano, except that its dorsal and anal fins are elongated. Four of five dark, thin, vertical bars are present on its sides. The palometa occurs from New England to Brazil. It is not common in the northern gulf.

Almaco Jack, *Seriola rivoliana*

Of the amberjacks (genus *Seriola*), this species has the most elongated dorsal and anal fins. It may attain a size of 50 pounds. The young, which have prominent dark bars on their sides, as do all the juveniles of this genus, are often found near floating *Sargassum*. It is a cosmopolitan species; in the western Atlantic, it ranges from New Jersey to Argentina. The almaco jack is rarely seen in the northern gulf.

Lesser Amberjack, *Seriola fasciata*

As its name implies, this is one of the smaller amberjacks. It is poorly known and is rare in the northern gulf. The young of this species also may be associated with floating *Sargassum*. This species occurs on both sides of the Atlantic. In the western Atlantic, it is known from New England to Cuba.

Greater Amberjack, *Seriola dumerili*

The greater amberjack is a very common species in the northern gulf. It is eagerly

sought by sport fishermen, and although it is a fine food fish, it is often not eaten by them. This is the largest of the amberjacks, attaining weights well over 100 pounds. It, like the other species of *Seriola*, has a prominent dark stripe extending from the tip of the snout, passing through the eye, and extending to the origin of the dorsal fin. These stripes are evanescent features of the genus *Seriola*, as they become very prominent when the fish is excited and then fade away when the fish become quiescent. The greater amberjack is one of the major suspects of ciguatera in the Caribbean. Small juveniles are often associated with floating *Sargassum*. The greater amberjack is a circumtropical species. In the western Atlantic, it occurs from New England to Brazil.

Banded Rudderfish, *Seriola zonata*

The juveniles of this species are often found around pilings and piers in inshore waters. In offshore waters, the small juveniles are associated with jellyfishes and other floating objects. Larger juveniles are often seen in association with sharks, along with the pilot fish (*Naucrates ductor*). This species ranges from Nova Scotia to Brazil in the western Atlantic. The banded rudderfish is the second most common species of *Seriola* in the northern gulf.

African Pompano, *Alectis crinitus*

Juveniles of the African pompano are characterized by long fin rays on both the dorsal and anal fins. These fin rays may get as long as four times the body length. As the fish attains adulthood, these rays become shorter, probably through abrasion. This species is circumtropical. In the western Atlantic, it occurs from New England to Brazil. The African pompano is seen frequently in the northern gulf.

Atlantic Moonfish, *Voemer setapinnis*

The atlantic moonfish is characterized by a steep and slanting forehead, laterally compressed body, and silvery appearance. The juveniles have a prominent black spot on each side. This species is common in the northern gulf and is found frequently in the stomachs of billfishes. It is found in the eastern Pacific and in both the eastern and western Atlantic. In the latter, it occurs from Nova Scotia to Uruguay.

Lookdown, *Selene vomer*

The lookdown is shaped similarly to the Atlantic moonfish, except that the slant of the forehead is much steeper, and the dorsal and anal fins are elongated. The length of the extended dorsal fin rays in juveniles is very pronounced and may be greater than twice the length of the body. The juveniles do not have black spots on their sides. This species is not abundant in the northern gulf. Its distribution in the Atlantic and Pacific is similar to that of the Atlantic moonfish.

Rough Scad, *Trachurus lathami*

This species is characterized by having scutes along its entire lateral line. It is a pelagic schooling species. The rough scad appears to be abundant along the Texas coast, more so than in the northeastern gulf. It occurs in the western Atlantic from new England to Argentina.

Round Scad, *Decapturus punctatus*

The round scad has a fusiform body, and because of this, it is called cigar fish or cigar minnow, especially in the northeastern gulf where it is more abundant than in other areas of the northern gulf. It is a pelagic schooling species, occurring sometimes in schools mixed with other species, such as the rough scad, Spanish sardine (*Sardinella anchovia*), and chub mackerel (*Scomber japonicus*). It is quite abundant in inshore waters of northwest Florida during the warm months and is used as bait by sport fishermen. This species is known from both sides of the Atlantic. It ranges from New England to Brazil in the western Atlantic.

Bigeye Scad, *Selar crumenophthalmus*

The shape of the body of the bigeye scad is similar to that of the rough scad, but the

lateral-line scales are not all developed into prominent scutes as they are in the rough scad. This species is circumtropical, and although it may occur in large schools elsewhere, it is relatively uncommon in the northern gulf. In the western Atlantic, it ranges from Nova Scotia to Brazil.

Atlantic Bumper, *Chloroscombrus chrysurus*

This laterally compressed fish has a very slim caudal peduncle with a black spot at the upper base of the caudal fin, which is yellow. It, like the Atlantic moonfish, is frequently found in the stomachs of billfishes in the northern gulf. Small juveniles are frequently found under jellyfish. This species occasionally occurs in large schools in the northern gulf, where it is common. In the western Atlantic, it occurs from New England to Uruguay.

Bluntnose Jack, *Hemicaranx amblyrhynchus*

The young of this species is usually found under jellyfishes. This is one of the smaller species of jacks. Information on this species is sparse. It is not common in the northern gulf. In the western Atlantic, it ranges from North Carolina to Brazil.

Cottonmouth Jack, *Uraspis secunda*

This jack obtained its name from its milky-white tongue. It is a circumtropical species. In the western Atlantic, it occurs from New England to Brazil. It is uncommon in the northern gulf.

Bar Jack, *Caranx ruber*

The name of this jack is derived from a dark band, or bar, that extends along the base of the dorsal fin and down to the tip of the lower lobe of the caudal fin. This species, like the greater amberjack, has been implicated in ciguatera in the West Indies. It ranges from New Jersey to Brazil in the western Atlantic. It is very uncommon in the northern gulf.

Yellow Jack, *Caranx bartholomaei*

The shape of this species is similar to that of the bar jack. The yellow jack lacks the dark bar, has yellow fins and is tinged with yellow on its flanks. It too has been implicated in ciguatera in the West Indies. This fish is very uncommon in the northern gulf. It occurs in the western Atlantic from New England to Brazil.

Blue Runner, *Caranx crysos*

The blue runner is also known as the hardtail or hardtail jack. It is abundant in the northern gulf, frequently occurring in schools. It is shaped similarly to the bar jack and yellow jack. It can be distinguished by the black tips of its caudal fin. This species also has been found in stomachs of billfishes in the northern gulf. It occurs in both the eastern and western Atlantic; in the western, its range extends from Nova Scotia to Brazil.

Black Jack, *Caranx lugubris*

The black jack, as its name implies, is very darkly pigmented. Its forehead is much more steeply inclined than the other species of *Caranx*. Although it is circumtropical, it is rarely seen in the northern gulf. In the western Atlantic, this species ranges from Bermuda to Brazil.

Crevalle, *Caranx hippos*

This fish is also called jack crevalle and crevalle jack. It also has been implicated in ciguatera. The crevalle has a prominent black spot on the upper posterior margin of its opercles and also on the lower rays of its pectoral fins. It is a highly favored fish for both sport and food. The species is circumtropical. In the western Atlantic it ranges from Nova Scotia to Uruguay. It is very common in the northern gulf, sometimes occurring in large schools.

Horse-Eye Jack, *Caranx latus*

This fish is similar to the crevalle, but it lacks the black spot on the opercles and pectoral

fins. It may be misidentified as a crevalle by most fishermen, and therefore it may be more common in the northern gulf than is supposed. It also has been implicated in ciguatera. In the western Atlantic, this species ranges from New Jersey to Brazil.

LARVAL AND JUVENILE BIOLOGY

The availability of information on various aspects of the early life history of those species occurring in the northern Gulf of Mexico was summarized (Table 2). Larval descriptions of 11 or 12 species and juvenile descriptions of 18 species have been published. Because ichthyoplankton surveys and faunal surveys have been conducted in both inshore and offshore waters, much data on the distribution and occurrence of larvae and juveniles are available. The availability of data on growth and maturation size, however, is limited. The behavior data pertains to the association of juveniles with jellyfishes, *Sargassum*, and flotsam.

ADULT BIOLOGY

The availability of information on aspects of the adult life history was also summarized (Table 3). Although information for the indicated species may be available from other parts of the world, data from the northern gulf are very sparse. The spawning information is derived from inferences made from the occurrences of larvae and early juveniles. The distribution data were derived from faunal surveys conducted by state conservation departments and the U.S. Bureau of Commercial Fisheries. Note that data on food and on age and growth of these species are non-existent for the northern gulf. The predators of the five species have been identified in food studies of billfishes in the northern gulf. Comparison of the availability of information on pre-adults and adults (Tables 2 and 3) clearly shows the greater paucity of data on adults.

COMMERCIAL LANDINGS

Commercial landings statistics are available for six species (Table 4). The statistics are for the entire Gulf of Mexico. Amberjack landings since 1970 have shown a slow but steady increase. The blue runner landings have fluctuated through the years; it declined the last two years. Landings of cigarfish, permit, and pompano have fluctuated, but all showed a decline in 1978 from the previous year. Crevalle landings appear to indicate a leveling off at about 1,600,000 pounds in the last three years.

The values of the landings (Table 4) clearly show that the pompano is the most valuable species of the six. The five other species show values of less than a dollar a pound, and the pompano show a value exceeding a dollar a pound. In 1978, its value rose to over two dollars a pound.

Mexican landings of crevalle and blue runner (data for other species not available) in the Mexican sectors of the Gulf of Mexico (Table 5) show similarities in trend to the U.S. landings. From 1976 to 1978, the landings of crevalle seemed to stabilize at approximately 2,000,000 pounds, whereas the blue runner landings during the same period show a continuing decline. No explanation for the similar trends in the two countries for these two species is available.

METHODS OF CAPTURE AND MARKETS

Capture methods and the uses to which the catches are put were summarized for seven species of carangids in the Gulf of Mexico (Table 6). Haul seines (also called beach seines), purse seines, gill nets, trammel nets, and various techniques using hooks and lines are used to catch carangids. Pompano and Atlantic bumper are caught in trawls as incidental catches. Shrimp trawlers catch both pompano and Atlantic bumpers. The pompano are valued sufficiently to be kept, whereas the Atlantic bumper is discarded. Atlantic bumpers are also caught by industrial fish trawlers, which keep their entire catches for the

pet-food producers. Blue runners, cigarfish, and Atlantic bumpers are used for bait by trollers and by crabbers. Blue runners are also sold to zoos for animal food. Blue runner, crevalle, and amberjack are sold for human consumption in both domestic and foreign markets. The pompano and permit are sold for human consumption only in domestic markets.

SUMMARY

Knowledge of the twenty-four species of carangids that have been reported from the northern Gulf of Mexico is inadequate to determine the feasibility of exploitation or of greater exploitation. More information on the early life history of these species is available than on their late juvenile and adult life history. Information on the distribution and abundance of economically harvestable quantities, yield estimates, and biomass estimates are non-existent. Until such data become available, fishermen will have to depend upon their own exploratory efforts, or on luck, to increase catches of carangids in the northern Gulf of Mexico.

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Table 1. Carangids of the northern Gulf of Mexico (from Hoese and Moore, 1977).

Name	Maximum size (inches)
Leatherjacket (*Oligoplites saurus*)	10
Rainbow runner (*Elagatis bipinnulata*)	12
Florida pompano (*Trachinotus carolinus*)	17
Permit, (*Trachinotus falcatus*)	31
Palometa, longfinned pompano (*Trachinotus goodei*)	12
Almaco jack (*Seriola rivoliana*)	36
Lesser amberjack (*Seriola fasciata*)	12
Greater amberjack (*Seriola dumerili*)	36
Banded rudderfish (*Seriola zonata*)	24
African pompano (*Alectis crinitus*)	24
Atlantic moonfish (*Vomer setapinnis*)	15
Lookdown (*Selene vomer*)	12
Rough scad (*Trachurus lathami*)	8
Round scad, cigarfish (*Decapturus punctatus*)	7
Bigeye scad (*Selar crumenophthlamus*)	12
Atlantic bumper (*Chloroscombrus chrysurus*)	12
Bluntnose jack (*Hemicaranx amblyrhyncus*)	11
Cottonmouth jack (*Uraspis secunda*)	8
Bar jack (*Caranx ruber*)	22
Yellow jack (*Caranx bartholomaei*)	36
Blue runner, hardtail (*Caranx crysos*)	26
Black jack (*Caranx lugubris*)	36
Crevalle, common jack (*Caranx hippos*)	40
Horse-eye jack (*Caranx latus*)	22

Table 2. Availability of information on early life history of carangids of the northern Gulf of Mexico (X = information is available).

	Description of			Growth	Distribution [1]	Behavior	Maturation Size
	Eggs	Larvae	Juveniles				
Leatherjacket	X	X	X	X	X		
Rainbow runner		X	X			X	
Florida pompano	X		X	X	X		X
Permit		X	X	X	X		
Palometa			X				
Almaco jack			X			X	
Lesser amberjack			X			X	X
Greater amberjack	X [2]	X [2]	X [2]		X	X	X
Banded rudderfish		X	X			X	
African pompano			X		X		
Atlantic moonfish			X		X		X
Lookdown		X	X		X		
Rough scad						X	
Round scad		X	X	X	X		
Bigeye scad	X	X			X		
Atlantic bumper					X	X	X
Bluntnose jack						X	
Cottonmouth jack			X				
Bar jack							
Yellow jack		X	X			X	
Blue runner		X	X		X	X	X
Black jack							
Crevalle jack		? [3]	X		X	X	
Horse-eye jack		? [3]				X	

[1] Distribution in northern gulf
[2] Need confirmation
[3] Description of one may actually be that of the other

Table 3. Availability of information on adult carangids of the northern Gulf of Mexico (X = information is available).

Predators [1]	Food, Age, & Growth [1]	Length-Weight [1]	Sex Ratio Relat. [1]	Fecundity	Spawning [1]	Distrib. & Abund. [1]	Migration
Leatherjacket					X	X	
Rainbow runner					X	X	
Florida pompano				X	X	X	
Permit					X	X	
Palometa					X		
Almaco jack					X		
Lesser amberjack							
Greater amberjack					X		X [2]
Banded rudderfish					X		
African pompano							
Atlantic moonfish	X				X	X	
Lookdown					X		
Rough scad					X	X	
Round scad		X	X		X	X	
Bigeye scad	X				X	X	
Atlantic bumper	X	X			X	X	
Bluntnose jack							
Cottonmouth jack							
Bar jack							
Yellow jack					X		
Blue runner	X				X		
Black jack							
Crevalle jack					X		
Horse-eye jack					X		

[1] In northern Gulf of Mexico

[2] Longest migration: 1,560 miles from Jacksonville, FL to Columbia, South America; longest time at large: 7.3 years.

Table 4. Landings and values of carangids in the U.S. Gulf of Mexico.

	1970	1971	1972	1973	1974	1975	1976	1977	1978
					Thousand Pounds				
Amberjack	20	45	44	39	58	91	96	131	156
Blue runner	1,378	2,227	2,063	1,374	658	1,680	1,921	1,348	661
Cigarfish	259	527	509	519	725	696	771	903	687
Crevalle	576	676	903	2,428	2,089	2,847	1,630	1,407	1,755
Permit	12	21	82	66	58	207	161	62	6
Pompano	906	859	1,126	948	1,245	1,193	948	915	639
					Thousand Dollars				
Amberjack	2	4	2	3	4	11	10	15	24
Blue runner	62	90	103	87	59	170	126	164	91
Cigarfish	39	70	68	79	110	104	115	129	111
Crevalle	22	21	33	137	137	202	133	115	166
Permit	1	3	14	13	11	41	43	22	2
Pompano	1,009	1,075	1,435	1,129	1,565	1,327	1,267	1,375	1,289

Table 5. Landings of crevalle and blue runner in the Mexican Gulf of Mexico.

Year	Crevalle [1] (*Caranx hippos*)		Blue runner [2] (*Caranx crysos*)	
	Kilograms	**Pounds**	**Kilograms**	**Pounds**
1968	381,758	841,624	906,072	1,997,526
1969	444,355	979,625	818,390	1,804,222
1970	504,910	1,113,124	678,697	1,496,255
1971	407,600	898,595	679,645	1,498,345
1972	618,100	1,362,663	685,360	1,510,945
1973	767,101	1,691,151	858,999	1,893,749
1974	923,928	2,036,892	752,758	1,659,530
1975	1,146,809	2,528,255	536,847	1,183,533
1976	873,739	1,926,245	238,931	526,747
1977	899,456	1,982,941	249,982	551,110
1978	965,722	2,129,031	204,706	451,295
Total	7,933,478	17,490,146	6,610,387	14,573,256

[1] Mexican common name: Jurel
[2] Mexican common mame: Cojinuda

Table 6. Methods of capture and uses of caringids in the Gulf of Mexico.

	Capture Method						Uses			
	Trawl	Haul Seine	Purse Seine	Gill Net	Tram-mel Net	Hook & Line	Zoos	Bait	Pet Food	Hu-man Food
Blue runner		X	X	X	X	X	X	X		X [1]
Cigarfish		X	X					X		
Crevalle		X	X	X	X	X				X [1]
Permit		X		X	X	X				X
Pompano	X	X		X	X	X				X
Amberjack				X		X				X [1]
Atlantic bumper	X							X	X	

[1] Both domestic and foreign

QUESTIONS AND ANSWERS SESSION

Eugene Nakamura

Q. Are there reports of ciguatera in fish from the northern Gulf at all?

A. I am unaware of any ciguatera in the northern Gulf of Mexico.

Q. One thing you didn't mention is the growth of pressure on some stocks. Some of the information that is available through the Management Plan indicates that some of these stocks are partially harvested because of lack of a market or whatever and yet in some of your information you show a decline. What ones would you say receive the most pressure and which ones do you think could stand additional harvesting pressure?

A. A species that has been receiving increasing fishing pressure in the last few years is the amberjack. The reason is that, at least in the northeastern Gulf of Mexico, we've had for the five year period, relatively poor king mackerel years, so that the interest of the recreational fishermen has switched from that species to others and they have been catching a lot of amberjack. I suspect that it can still withstand some more pressure. I can't give you figures, I'm just giving you my impression. I suspect that the scads can also stand increasing pressure. There is some concern or there certainly will be I am sure if a heavy commercial fishery developes for these cigar minnows that the recreational interests will let their feelings be known about harvesting of these species. They believe that without these cigar minnows in our area in the Northeast Gulf of Mexico that the predators will disappear and their sportfishing activities will decline.

Q. One last question, the majority of this information is based on results caught in unusual fishing?

A. Correct.

Q. Am I safe in assuming that in this point in time there really hasn't been that much work on the distribution of species in offshore waters?

A. That is correct. The Oregon II has gone out. They trawled and they recorded what they caught. That is where much of that distribution information on the adult life history comes from. Much of that is from Oregon II. That information is known, they know exactly where they were, the depth of the water, the temperature of the water, the salinity of the water, the characteristics of the bottom, etc.

Q. Are our fishing techniques similar to what is being used in other parts of the world to catch carangid?

A. I don't know too much about fishing for carangides in other parts of the world. Because some of these small scads occur in sizeable schools, I am sure that they are caught with nets, I am sure that they are not caught individually. And the larger fish I am sure are caught with various nets — gill netting, trammel netting, seines — there aren't too many methods of fishing, so I am sure that there are certain similarities in the methods of capture. The Mexicans though, do use traps, which we don't use.

SYNOPSIS OF KNOWLEDGE ON THE TAXONOMY, BIOLOGY, DISTRIBUTION, AND FISHERY OF THE GULF OF MEXICO MULLETS (PISCES: MUGILIDAE)

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INTRODUCTION

Although mullet have been commercially exploited along the American Gulf coast for well over a century, meaningful data on the fishery were not available until about 1895. Since then, virtually all writers on the subject have agreed that this is the most important fishery along the Gulf coast of Florida. It is probably also true that the mullet fishery is one of the most important among those conducted for coastal pelagic fishes along the entire Gulf coast.

The Gulf of Mexico mullet fishery is based primarily on the black mullet (*Mugil cephalus*) and the silver mullet (*Mugil curema*). Four other species, however, occur in extreme southwestern Florida, and this will be discussed in the section on taxonomy. Until about 35 years ago, the classification of Gulf and Caribbean mullet was poorly understood, and at present, the problem is not yet entirely solved. Since the monitoring of the fishery began, about 85 years ago, it has been well established that the black mullet is, by far, the most important Gulf species. The silver mullet is much less abundant, particularly along the northern Gulf coast, and there is virtually no silver mullet fishery west of the panhandle of Florida. Until 1958, the black and silver mullet were not separated and the catches were reported simply as "mullet." In this study, therefore, catch statistics before 1958 will not be considered except sporadically and mainly for historical purposes. There is an artisanal fishery for mullet scattered along the Gulf coast. Mullet are also taken for food by cane-pole fishing in freshwater waterways.

During the early days of the fishery, mullet was marketed fresh (78%), salted (21%) and the remaining one percent constituted the roe which was mostly salted. At present, mullet are also very important as a bait fish in the recreational fishery.

This paper is based on the bibliography appended at the end and my own unpublished observations. Because the various subjects treated in this study can be easily found in the various papers listed in the bibliography, I have omitted direct references or citations in the text in order to conserve space and avoid unnecessary repetitions.

The most recent attempt to focus attention on the Florida mullet industry, its problems, and solutions consists of a collection of six papers edited by James C. Cato and William E. McCullough. These papers were published together in 1976 under sponsorship of the Florida Sea Grant Program (see bibliography).

TAXONOMY AND DISTRIBUTION

Mullet belong to the family Mugilidae which is of worldwide distribution in tropical and

temperature waters. This family forms a compact group quite distinct from other families and comprises several genera and species. Because they look so much alike, the species of mullet are difficult to identify.

As already noted in the introduction, six species of mullet may be involved in the Gulf of Mexico fishery. Except for the black mullet (*Mugil cephalus*) and the silver mullet (*M. curema*), the other four species (*M. liza, M. gaimardianus, M. trichodon,* and *M. gyrans*) are confined to extreme south Florida and constitute a negligible factor in the Gulf fishery. These four species, however, are common in the West Indies and southward.

Mugil liza does not have a common name in English, but it is called "lebrancho" in Cuba and in other Spanish-speaking countries of Latin America. It is closely related to our black mullet from which it is not easy to distinguish. The lebrancho, however, reaches a much larger size, and specimens two feet long are common. *M. gaimardianus* is called "redeye mullet" in south Florida and "lisa ojo de perdiz" (quaileye mullet) in Cuba. It is very closely related to our silver mullet from which it can only be distinguished, when fresh, by the eye color. They are both "silver" and reach about the same size. *M. trichodon*, the "fantail mullet", is also silvery and may be distinguished from the silver and redeye mullets by the larger scales and the larger tail which, in addition, has a more pronounced black margin. This species is somewhat smaller than the other two. Finally, *M. gyrans*, the "whirligig mullet" has been a source of confusion. It was originally described from juvenile specimens which had only two anal spines (all juveniles of the species of *Mugil* have only two anal spines; three in the young and adult). Because of this, the whirligig mullet was considered, not only to represent a new species (*gyrans*) but a different genus as well (*Querimana*). Subsequently, when it was found that the possession of only two anal spines was a juvenile trait, the species was restored to the genus *Mugil* and considered to be the juvenile of *M. liza* the "lebrancho." Also, the adults of the whirligig mullet have been confused with those of the fantail mullet because of the large scales. It is now known, at least to me, that the whirligig mullet represents a separate, valid species ranging from south Florida southward and reaching about the same size as the fantail mullet (less than a foot).

The six species of mullet herein discussed may be classified into two groups according to coloration and the presence or absence of scales on the second dorsal and the anal fins. Those are easily observable qualitative characters. The black mullet and the lebrancho are distinguished from the other four species by their darker color produced by the black longitudinal striped along the body sides. Also, the second dorsal and anal fins of these two species are devoid of scales (naked). In the silver, redeye, fantail, and whirligig mullets the general sheen of the body is silvery, without pronounced, longitudinal dark stripes. In these four species, the second dorsal and anal fins are densely scaled.

Precise identification of the species involved is basic to stock definition and assessment which in turn are basic to the proper management of the fishery. About 30 years ago, an assessment of the silver mullet (*M. curema*) fishery was made in which at least three species of "silver mullet" were mistakenly lumped together. Needless to say, that study, which cost much time and money, was useless. In the case of mullets, positive identification should be done by a taxonomist familiar with the group. In order to facilitate preliminary identification, however, a simplified key is given below.

1a. - Second dorsal and anal fins almost entirely scaleless, the anterior rays with a few small scales. Head somewhat wider than deep. Sides of body with conspicuous, longitudinal dark stripes. Second dorsal fin with one spine and 8 soft rays. Anal fin with three spines and 8 soft rays (two spines and 9 soft rays in juveniles).

2a. - Lateral scales 31 to 36. Pectoral fin longer than distance between last spine of first dorsal fin and origin of second dorsal fin. Origin of second dorsal fin above origin of anal fin. Head depth, at center of eye, more than 2.3 in its

length. Posterior edge of caudal fin angular.
LEBRANCHO. 1. *M. liza*

2b. - Lateral scales 38 to 42. Pectoral fin shorter than distance between last spine of first dorsal fin and origin of second dorsal fin. Origin of second dorsal fin behind origin of anal fin. Head depth, at center of eye, less than 2.3 in its length. Posterior edge of caudal fin evenly concave.
BLACK MULLET 2. *M. cephalus*

1b. - Second dorsal and anal fins densely scaled. Head about as wide as deep, or somewhat deeper than wide. Sides of body without conspicuous, longitudinal dark stripes. Second dorsal fin with one spine and 7 or 8 soft rays. Anal fin with three spines and 8 or 9 soft rays (two spines and 9 or 10 soft rays in juveniles).

3a. - Lateral scales 29 to 31. Second dorsal fin with one spine and 7 soft rays. Anal fin with three spines and 8 soft rays (two spines and 9 soft rays in juveniles).
WHIRLIGIG MULLET 3. *M. gyrans*

3b. - Lateral scales 32 to 40. Second dorsal fin with one spine and 8 soft rays. Anal fin with three spines and 8 or 9 soft rays (two spines and 9 or 10 soft rays in juveniles).

4a. - Anal fin with three spines and 8 soft rays (two spines and 9 soft rays in juveniles). Lateral scales 32 to 36, usually 33 to 35. Teeth conspicuous, clearly visible without a lens. Origin of first dorsal fin nearer to middle of caudal base than to tip of snout.
FANTAIL MULLET. 4. *M. trichodon*

4b. - Anal fin with three spines and 9 soft rays (two spines and 10 soft rays in juveniles). Lateral scales 35 to 40, usually 36 to 39. Teeth inconspicuous, almost invisible without a lens. Origin of first dorsal fin about midway between middle of caudal base and tip of snout.

5a. - Lateral scales 35 to 38, usually 36 or 37. Teeth more than 30 on each side of upper jaw and on each side of lower jaw. Eye red in life.
REDEYE MULLET 5. *M. gaimardianus*

5b. - Lateral scales 37 to 40, usually 38 or 39. Teeth fewer than 30 on each side of upper jaw and on each side of lower jaw. Eye not red in life.
SILVER MULLET 6. *M. curema*

SPAWNING

On the basis of gonad condition and occurrence of larvae and juveniles, the spawning season of the black mullet extends from late October to February with a peak in late November and early December. During the peak spawning period, mullet are either very ripe or recently spent. Juveniles 24 or 25 mm TL appear in November and are very numerous in January. Spawning usually takes place 5 to 20 miles offshore but it has been observed to occur as far offshore as 50 miles. Size at maturity ranges from 200 to 355 mm TL. At 200 mm TL, black mullet are at least two years old but most fish mature when they are three years old. Average fecundity ranges from 0.5 to 1.0 million eggs depending on size. Black mullet apparently spawn throughout the entire northern Gulf of Mexico. Eggs and/or larvae have been found from 50 miles off the Mississippi coast to 70 miles off the coast of southwestern Texas.

Also on the basis of gonad condition, silver mullet appear to spawn from April to June. Peak spawning probably occurs in May when the highest percent of fully ripe and spent fish are evident. There is evidence indicating that spawning occurs well offshore over the

outer Continental Shelf. Size at maturity is about 225 mm TL.

It appears then that the black mullet is a winter spawner and the silver mullet a spring spawner. Late February through early April marks the period separating the spawning seasons of these two species. Their spawning peaks are separated by a period of about four months.

AGE AND GROWTH

After hatching, juvenile black mullet measure 24 or 25 mm in November. They grow rapidly, and by June many of them reach a TL of about 100 mm. By the following November, they are about one year old and measure from about 100 to about 150 mm TL. Young black mullet reach an average TL of 110 mm at Pensacola, 115 at Apalachicola, and 148 at Cedar Key during September of their first year of life. The period of maximum growth was during May through August. Scale analysis has indicated that the mullet from Pensacola and Apalachicola grow considerably slower than those from Cedar Key. After the first year, growth gradually slows down until an asymptote ($L\infty$) is reached toward the end of the life span. This probably occurs at an average TL of about 600 mm, but nothing definite is known about the age at this size. These large fish are probably five or six years old. Mullet enter the commercial fishery at an average size of about 185 mm TL. It is probable that this size is attained toward the end of the second year of life and, as indicated in the preceding section, most are still sexually immature. Age and growth studies have shown that the black mullet may live at least four years. On the average, they measure 150 mm FL at the end of the first year, 250 at the end of the second, 290 at the end of the third, and 315 at the end of the fourth year of life. Other studies by Mexican scientists on black mullet from Veracruz have shown that the fish may live at least six years and reach an $L\infty$ of 510 mm.

In the black mullet, growth during the spring and summer is more than double the growth during the fall and winter. This differential seasonal growth is probably associated, either directly or indirectly, with temperature. A reliable method for aging gulf black mullet beyond the fourth year of life is not yet available.

There is little information available on the age and grówth of silver mullet in the Gulf of Mexico. Off the coast of Georgia, larvae measuring 17 to 24 mm SL are estimated to have been hatched in late March or early April. Juveniles about 120 mm SL in October are estimated to be about seven months old. At a growth rate of about 17 mm per month, juveniles would reach about 200 mm SL at the end of their first year and may be sexually mature at that age. The average length of silver mullet taken by the fishery off Florida is 250 mm (10 inches) with a maximum of 350 mm (14 inches). Sexually mature individuals taken from a spawning school averaged 198 mm in length. Because growth gradually slows down as the fish get larger, the average growth rate of about 17 mm per month cannot be applied to older fish. It is estimated, however, that the average 250 mm fish taken by the fishery are about two years old. The maximum size of 350 mm given above is estimated to correspond to an age of at least three years and perhaps four or more. A reliable method for aging Gulf silver mullet beyond the second year of life is not, as yet, available.

MIGRATIONS

It appears that the migrations of both the black and the silver mullet mostly involve offshore and onshore movements related to spawning and feeding. A major portion of the life of these species is spent in the coastal bays and inlets. In these habitats, the black mullet, especially the young, may enter coastal lagoons of high salinities in excess of 75 o/oo, such as the Upper Laguna Madre of Texas. During the spring and summer, however, black mullet enter the fresh waters of rivers, canals, and inland waterways. In the fall and winter, during the spawning season, the fish return to salt water and migrate offshore up to 50

miles to spawn. After spawning they return to the coastal waters to resume their annual cycle. The offshore-onshore movements of the silver mullet are similar to those of the black mullet, but they occur at different seasons. Silver mullet migrate offshore to spawn in the spring when the black mullet have just returned to coastal waters. The two species coincide in coastal waters during July, August, and September. During the fall and winter, silver mullet may enter fresh water just as the black mullet does in the spring and summer.

Tagging experiments have shown that although a few black mullet travel long distances, most of them remain in a comparatively small area. This suggests that there may be a number of local populations each separate and distinct. Apparently, black mullet off the Gulf coast of Florida do not make extensive migrations. Ninety percent of the tagged fish were recovered within 20 miles of the place of release. One migration of 150 miles, however, has been recorded from a fish tagged in Cedar Key and recovered in Apalachicola. Migrations in fresh water, upstream in river and inland waterways may sometimes cover relatively long distances. Black mullet found in Lake Texoma at the Texas-Oklahoma boundary, probably got there by way of the Mississippi River and its tributary, the Red River. The distance traveled by these fish, from the mouth of the Mississippi to Lake Texoma is close to 1,000 miles, taking into account the meanders and bends of these rivers.

POPULATIONS (STOCKS)

In the Gulf of Mexico, the black mullet is intensively exploited by U.S. fishermen over a very large area extending from Everglades, Florida to Brownsville, Texas. In the remainder of the Gulf, from Matamoros to Yucatan, the black mullet is also intensively exploited by Mexico. In 1978, the U.S. catch amounted to 26.4 million pounds and, for the same year, Mexico reported 32.1 million pounds. It is, therefore, for management purposes, very important to know whether the species is composed of one or several smaller populations in the area under consideration. In the second instance, extensive exploitation of any of the populations would have little or no effect on the others. On the other hand, overexploitation of a single, large homogeneous population, in this case the entire Gulf of Mexico, might conceivably deplete the fishery, either biologically or economically.

Tagging experiments have shown that the black mullet of the Gulf of Mexico are separated from those of the east coast of Florida and farther north. The break occurred at Florida Bay, the southernmost tip of the mainland. These findings were subsequently corroborated by racial studies based on meristic and proportional characters. There is no information as to whether a break may, or may not occur between the Gulf and the Caribbean Sea around the outer tip of the Yucatan Penninsula.

Tagging experiments also have suggested that there may be several more or less independent stocks of black mullet along the west and panhandle coasts of Florida. These findings were also subsequently corroborated by racial studies. Three populations or stocks have been designated: (1) from Lemon Bay (Englewood) to Steinhatchee; (2) from St. Marks to Apalachicola; and (3) a single Pensacola population. No boundaries have been defined for these populations which are considered to be loosely knit, partly intergrading aggregations. I have found no information on the possible occurrence of other populations west of the panhandle of Florida or along the Mexican sector of the Gulf of Mexico.

The existence of more than one population in the Gulf of Mexico must be considered with caution. It is definitely known that mullet eggs and larvae are widely dispersed by ocean currents, particularly those of individuals that spawn well offshore. According to the current patterns in the Gulf of Mexico and in the Caribbean Sea, adult mullet found in the Gulf could have been spawned in the Caribbean. By the same token, young, or even adults, occurring along the Florida Gulf coast, could have been spawned as far to the northwest as off Louisiana, Mississippi, or Alabama. The genetic homogeneity of alleged dissimilar populations of mullet in the Gulf is, therefore, open to question. until this prob-

lem is fully investigated, it might be better to consider the Gulf black and silver mullets as each constituting a single stock for management purposes.

PRODUCTION

Mullet have been commercially exploited, processed, and marketed along the American Gulf coast for well over a century. Meaningful data on production, however, were not available until 1895. In that year 10.5 million pounds were landed valued at $120,533. The price per pound was $0.01.

Since the monitoring of the fishery began, 85 years ago, it has been well established that the black mullet is, by far, the most important of the two Gulf species. The silver mullet is much less abundant, particularly along the northern Gulf coast west of the Florida panhandle. There is virtually no silver mullet fishery in Alabama, Mississippi, Louisiana, and Texas. Based on production statistics from 1958 to 1978, the average annual catch of silver mullet (0.6 million pounds) represented only 2 percent of the average annual catch of black mullet (29.2 million pounds).

Until 1958 the black and silver mullet were combined and the catches were reported simply as "mullet." In this paper, therefore, catch statistics before 1958 will not be considered. The annual catch, its value, and the price per pound for the black and the silver mullet are given in Table 1 and graphed in Figures 2 and 3 for the years 1958 through 1978. Catch statistics for 1979 are not yet available as of the date of this writing (February 23, 1980). Figure 2 shows that the catch of black mullet has fluctuated considerably during the 21-month period. It reached its highest point of 36.3 million pounds in 1964 and its lowest of 18.5 in 1976. On the average, the black mullet catch has steadily decreased since 1964, except for a rather sharp rise beginning in 1977. There is no way to predict what the future trend might be. The value of the black mullet catch also has fluctuated markedly although to a lesser degree. On the average, the value remained fairly constant from 1958 to 1965, and it has steadily increased since then. The interaction between catch and value may be better expressed by the price per pound as shown in figure 2. From a low of $0.05 in 1963, the price per pound has steadily increased to $0.19 in 1977 with a slight drop to $0.18 in 1978.

As shown in figure 3, the silver mullet catch also has fluctuated considerably during the 21-year period. The highest catch of 1.0 million pounds occured in 1958, 1967, and 1968. The lowest catch of 0.4 occured in 1960 and in 1972. On the average, and despite the market fluctuations, the silver mullet catch has remained fairly constant at 0.6 million pounds during the 21-year period. The value of the catch also has fluctuated considerably; but in terms of price per pound, it remained fairly steady at an average of $0.06 from 1958 to 1968. It has steadily and rather rapidly increased from $0.07 in 1968 to $0.21 in 1978.

It is interesting to note, as shown in figures 2 and 3, that in general, the years of high catch for the black mullet correspond to years of low catch for the silver mullet and vice-versa. For example, 1962, 1964, 1969, and 1972 represent years of relatively high catch for the black mullet and relatively low catch for the silver mullet. On the other hand, 1967, 1968, and 1978 represent years of relatively high catch for the silver mullet and relatively low catch for the black mullet.

Florida is, by far, the largest producer of black mullet among the Gulf states as shown in table 2. During the period of 1958 through 1978, Florida produced 561.2 millions of pounds and the other combined Gulf states only 53, for a total of 614.2 million pounds. Of this total, the 53 million produced by Alabama, Mississippi, Louisiana, and Texas combined represent only 8.6 percent. In other words, the state of Florida produces on the average, 91.4 percent of the U.S. catch of black mullet in the Gulf of Mexico.

As already indicated, mullet is also marketed as a bait fish. It is used whole with the backbone removed and rigged for trolling by the recreational fishery, especially for sailfish and marlin. The smaller silver mullet is used mainly for sailfish and white marlin and the larger

black mullet for blue marlin. As a bait fish, mullet bring a higher price than as a food fish, and both species are equally priced. As of this writing (February 24, 1980), the wholesale price is $0.40 per pound and the retail price fluctuates from $0.65 to $0.70.

There is an artisanal mullet fishery scattered along the Gulf coast. It consists of individuals, not necessarily professional fishermen, who catch their own mullet, for food and bait, mostly with cast nets. Mullet are also taken for food, by cane-pole fishing, in freshwater waterways, usually by low-income persons who supplement their protein diet in that manner. These artisanal catches are not reported, and they are nearly impossible to estimate. They probably represent, however, a negligible amount compared to the total reported catch.

Black mullet and silver mullet catch statistics for the entire Mexican section of the Gulf of Mexico are available for the years 1968 through 1978. No monetary values were given and the catch was recorded in kilograms. These catches, converted into pounds, are given in table 3 and graphed in figure 4. In 1968, 1969, and 1975, the black mullet catch was much greater than the silver mullet catch but in the other eight years (73% of the reporting period) silver mullet catch is much greater than that for the black mullet. This is somewhat the reverse of conditions in the northern U.S. Gulf of Mexico where the black mullet is much more abundant than the silver mullet. These reverse conditions are not surprising because the black mullet is more of a temperate water fish, whereas the silver mullet is more of a tropical fish. Compared with the U.S., the Mexican black mullet catch was much smaller (32.1 vs 284.6 million pounds) for the comparable period of 1968 through 1978. On the other hand, the Mexican silver mullet catch for the same period was 35.7 million pounds, while the U.S. catch was only 6.8 million pounds.

Mullet are often classified as underutilized fish, but there are more available for commercial utilization than currently marketed. The main reasons for this are the problem of consumer acceptance and the lack of ability to process mullet for food, as discussed in the next section. Also, more accurate information is necessary on the potential production in various areas during various times of the year.

PROCESSING

Until about 25 years ago, mullet and its roe were marketed fresh, stored frozen for later sale, smoked or salted. In 1954, an attempt was made in Miami to process mullet as fish sticks similar to those being processed at the time from cod, haddock, pollock, and other northern species. This was primarily a pilot project designed to test the palatability of mullet in the form of fish sticks. After several taste-tests were conducted for comparison with other types of fish sticks, the concensus was that mullet was inferior to the others, and the proposed marketing never got off the ground. Mullet sticks have a distinctive flavor which is stronger than that of cod, haddock or pollock sticks. This flavor was preferred by some tasters, but many more preferred the milder-flavored fish, perhaps because of greater familiarity with this type. The appearance of mullet sticks, especially the dark streaks in the meat, make this product less attractive to the buyer. Mullet sticks cannot be stored for protracted periods because of their high oil content.

In 1956, as part of a Florida program to expand demand for mullet, processing by smoking was widely promoted. Inquiries were made on the possibility of creating a market for smoked mullet in Milwaukee. Locally-smoked mullet were taken to Milwaukee to demonstrate the quality of the product and several hundred pounds of fresh and frozen mullet were shipped and smoked there. The smoked mullet were marketed through regular channels of distribution. In addition to that effort, questionnaires were mailed to several hundred institutions in the southeastern United States to determine their buying habits. Since that time, smoked mullet has found its way sporadically into fish markets, grocery stores, and convenience stores. Smoked mullet is a popular item in Florida. An easily constructed, relatively inexpensive smokehouse was designed and promoted in

1956 to assist small wholesale distributors and retailers. Methods of smoking mullet were also described and distributed.

Finally, in the early sixties, an attempt was made by a newly formed company in Miami to process mullet in canned form. Great efforts were made to obtain the best quality fish, and the results of taste-tests were favorable. Tall salmon-type cans were used and the product was processed with and without tomato sauce. Although several cases were sold and widely distributed, this project did not succeed. One of the problems was the high price demanded by the fishermen to supply high quality fish. The other problem was the name of the fish, which was generally considered as consumed only by low class people and, therefore, not very good to eat. To solve this problem, the processor submitted the name "lisa", which is mullet in spanish, for approval by the Food and Drug Administration. The FDA approved the name but stipulated that canned lisa could only be sold in the state of Florida. Another reason for the failure of the above attempt was the lack of sufficient financial backing. Prior to this venture, the American Can Company had tried unsuccessfully in the forties to produce an acceptable product. Also, the University of Miami had unsuccessfully tried to introduce canned mullet during the mid-fifties.

Canning perhaps offers the greatest potential for the utilization of mullet, particularly during the peak production season. According to certain studies, the fish could be processed so as to compete with canned salmon or tuna. Most importantly, canned mullet can be held at room temperature for up to two years without appreciable quality changes upon storage.

From the point of view of processing and subsequent public acceptance, further attention and research should be given to the problems listed below.

1. Studies to determine the yield for mullet products from different areas for different times of the year.
2. Solution to the rancidity problem.
3. Consumer profiles and attitudes should be developed by regions of the country.
4. Taste differentials for mullet from different waters should be determined.
5. Use of left-over parts for reduction or fertilizer.
6. The possibility of using minced mullet flesh should be investigated.

MARKETING

Through previous conversations with the convenors of this workshop and other concerned parties, this subject will be covered by Mr. Ed Smith in his presentation.

HARVESTING TECHNOLOGY

About 32 years ago, persistent reports that the striped mullet was becoming increasingly scarce prompted an investigation of fishing methods and gear used in the mullet fishery. This project was conducted by the University of Miami, and it is one of the most comprehensive studies of harvesting technology for mullet. Fishermen and fish dealers, in an effort to explain the causes of the decline, had condemned practically all methods of fishing for mullet on various grounds.

The use of gill nets was less criticized than any other method. This net is selective in the size of fish it takes, because fish too small to be gilled pass through the meshes while fish too large to force their heads through usually are able to back away and avoid being caught. This type of net is probably the least efficient, especially when used simply as a gill net and not as a seine. The only criticism made against gill nets was that so many of them in constant use that mullet have no chance to occur in an area without being disturbed. No harmful effects of this type of net are evident, insofar as damage to feeding grounds or to small mullet is concerned.

The trammel net is more efficient than the gill net because it will catch fish that are too

large to gill so that the range of sizes of fish captured is greater. Small fish are able to go through this net, but in some localities, this gear is used as intensively as the gill net and draws the same criticism. In addition, many fishermen claim that trammel nets are destructive because they take a wide range of sizes. The greater range, however, is in the direction of larger fish, and this net is no more destructive to small fish than is the gill net.

Many fishermen have opposed night fishing. The use of the "flambeau", made by wiring a large bundle of rags or burlap to the end of a pole and igniting it, has been widely attacked. Burning gasoline drips from the flambeau and spreads over the water. Often more gasoline is poured on the water to increase the burning area. Observations showed that the flambeau does cause mullet to scatter, resulting in many of them becoming tangled in the meshes of the net. It is doubtful, however, if it causes the fish to vacate the area for any length of time. A larger number of fish is caught by this method than by the use of ordinary lights. The charge that an oily residue covers the bottom is groundless. The most serious charge that can be brought against the flambeau is that it is exceedingly dangerous to the fisherman and to his boat.

Stop-nets have been much criticized by fishermen even by many who use them. It has been alleged that "stopping" operations destroy feeding grounds because of bottom disturbance. It was claimed that the mullet will leave an area that has been disturbed and not return for days or weeks. The study showed, however, that the alleged disturbance of the bottom has been exaggerated. The scarcity of mullet in an area that has just been "stopped" is probably due to the fact that most of the resident fish have been removed and it takes some time to repopulate the area. Stopping operations can hardly be said to bar the entrance of other mullet into the area after the tide has obliterated all signs of the operation. This usually happens within 24 hours. Mullet are very wary, however, and apparently avoid crossing net marks and tracks of seines as long as they are detectable. Because of its effective blockage to the escape of fish larger than the mesh, the stop-net catches a great variety of fishes other than mullet. These fish are all killed and discarded by the fishermen.

Drag-seining has been criticized because, allegedly, seines damage the bottom and also kill too many fish unnecessarily. Except for the so-called trash fish caught by the seines and left on the shore to die, little damage was done to the bottom.

Gill nets are used in three different ways: run-around, straight set, and half moon. In the run-around or encircling operation, the school of fish is surrounded and the fish are driven into the net. Usually two boats are employed, each with one net. When a school is located, the ends of the two nets are joined and each boat sets a net out in a semi-circle, forming an enclosure. A third boat, when used, either sets the net as a third part of the circle or sets a net inside the circle, adding more net surface for enmeshing. The straight set is often made by one boat and net, by running the net across the mouth of a small lagoon or bayou. This set may be modified by running the net out in a zig-zag pattern from one shore to the other along the course of a creek or canal. This affords a succession of enclosures and considerable net surface in a narrow body of water. Only one boat and net are necessary in the half-moon operation, which is particularly efficient for catching fish along a shore. When fish are located close to shore, one end of the net is held at the shore as the boat approaches the fish. The net is then set around the fish and back to the shore beyond the fish, thus effecting an enclosure. When two boats and nets are used, the nets are joined offshore and set out in opposite directions parallel to the shore, and then towards the shore, one on each side of the school. The net may be set in the reverse order, each boat beginning the set near shore and meeting offshore. In all gill net operations, care is taken to avoid frightening the fish while setting the net. Once the enclosure has been completed, however, the fishermen create a disturbance to frighten the fish so they will strike the net. As a result, many fish are lost because they jump over the cork line.

Beach seines are similar to gill nets in appearance but the webbing is usually of a smaller mesh size. The seine is composed of two ends called wings and a middle section or bunt

which is slightly deeper. A seine catches mullet by impoundment, that is, the fish are encircled and all fish larger than those which escape through the meshes are concentrated in the bunt section. A seine is set in the pattern of an arc from a starting point on the shore around the fish and back to the shore. Usually both ends are pulled manually until until the entire net and its fish contents are hauled out of the beach. Large beach seines are sometimes used which may catch as many as 50,000 pounds of silver mullet in one set. A new twist in an already old fishery was developed in lake Okeechobee about 25 years ago by gill-netting with airboats. An enterprising fisherman reasoned that rowing around a school of mullet was too slow and decided to speed up the operation. A three-foot extension was built on the stern of an airboat to house a 220 yard gill net. The net is usually set at a 40 m.p.h. speed. The net anchor is cast overboard and its drag pulls the net from the airboat compartment as the boat encircles the school. After the circle is completed, the fishermen retrieves the net and during this operation the enclosure becomes smaller forcing the fish to strike the net. This operation takes from 30 minutes to one hour, depending on the amount of fish caught.

As already pointed out, cast nets and hook and line fishing are also used to catch mullet. These methods, however, are too limited for a professional commercial operation and are largely restricted to the artisanal mullet fishery. Another artisanal method of catching mullet is by means of treble hooks attached at the end of a hand line. The weighted hook is cast into a school of mullet and retrieved with rapid jerking motions. A considerable number of fish may be snagged in this manner.

MANAGEMENT

In the past, the mullet fishery, at least in Florida, was managed on the basis of numerous regulations. Most of these regulations, however, have now been abolished as a result of in-depth studies conducted by various groups. A regulation that still remains, although somewhat improved, is the minimum legal fork length for black mullet, which ranges from 9 to 11 inches according to county. Closed seasons for mullet were abolished in 1957. Regulations on the mullet fishery refer generally to the black mullet and no separate consideration is given in them to the silver mullet. In view of the differences in the size and biology of these two species separate regulations have been considered as possibly necessary.

Although black mullet landings have steadily declined since 1964 apparently the fishing effort has also declined at the same rate. The decline in production, therefore, does not necessarily mean overexploitation of the resource but a decline in catch per unit of effort would. Another indicator of overexploitation would be a steady reduction in average size of the fish taken by the fishery and this has not yet occurred. Improvements in the processing, acceptance, and marketing, however, may greatly increase the demand for mullet and lead to overfishing. Because of this, preventive measures should be taken now.

The ultimate goal of fisheries research is to develop a data base for the proper management fisheries. This may be expressed as what I like to call the DAM concept. The acronym DAM stands for DEFINE, ASSESS, MANAGE in that order, because the stock must be defined before it can be assessed and it must be assessed before it can be managed. Many of the parameters needed to construct a data base for mullet are already available but others are still unknown or poorly understood.

As already pointed out elsewhere in this paper, the definition of the stock, or stocks of black mullet in the Gulf of Mexico remains a problem. However, if it becomes necessary to have a stock boundary interpretation, before the problem of multiple stocks can be solved, the entire Gulf of Mexico could be best considered as representing a single stock. This single population may be defined as extending continuously along the Gulf coast from the south tip of Florida to Yucatan. The same definition could be applied to the silver mullet stock.

There are several methods of stock assessment, but in my opinion, assessment by cohort analysis is the most precise and reliable. Cohort analysis gives a reliable estimate of the total number of fish in the population and the number of fish in each year class. The accuracy of the results, of course, depends on the accuracy of the various components of the data base used for the calculations. In addition to previous stock definition, the parameters required for this method may be listed as follows.

1. Life span of the species constituting the stock to be assessed. This is not definitely known for either the black or the silver mullet. Black mullet, however, can be aged through their fifth or sixth year and it is estimated that they do not live much beyond that.
2. The total number of fish caught by the fishery in each consecutive year of a period equivalent to the life span of the fish and immediately preceding the time of assessment. This can be estimated from the total annual catch by the size-age composition of catch samples in relation to the total annual catch. Size-age relation tables are available for the black mullet and suitable annual catch statistics are also available.
3. Natural mortality rate. The total mortality for the black mullet has been estimated from the rate of decrease of the various sized fish appearing in the commercial catches. Fishing mortality has been estimated from the rate of tag returns from the commercial fishery. Natural mortality was obtained by subtracting fishing mortality from total mortality.
4. Rate of cohort-specific fishing mortality during the last year of catch. This can be calculated from items 2 and 3 above.

Another method of stock assessment is the fishery independent quantitative evaluation of egg or larval occurrence and distribution. Identification of black and silver mullet larvae has been possible since 1957.

Finally, yield-per-recruit analysis is a fishery dependent valuable tool for monitoring past, present, and future trends in the fishery. This type of analysis may be considered as an adjunct to stock assessment analyses. Yield-per-recruit analyses provide information on current catches, as compared to possible catches.

Management of the Gulf of Mexico mullet fisheries would be an interstate and international endeavor if the problem ever presents itself. Cooperation among Florida, Alabama, Mississippi, Louisiana and Texas would be required as well as cooperation between these states and Mexico. As to the latter, the current MEXUSGULF cooperative project is a major step in the right direction.

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Table 1. Annual catch in millions of pounds, value in millions of dollars, and value in cents per pound for the U.S. Gulf of Mexico black and silver mullet fishery during the years 1958 through 1978. Data compiled from U.S. Annual Fisheries Statistics. See also figures 2 and 3.

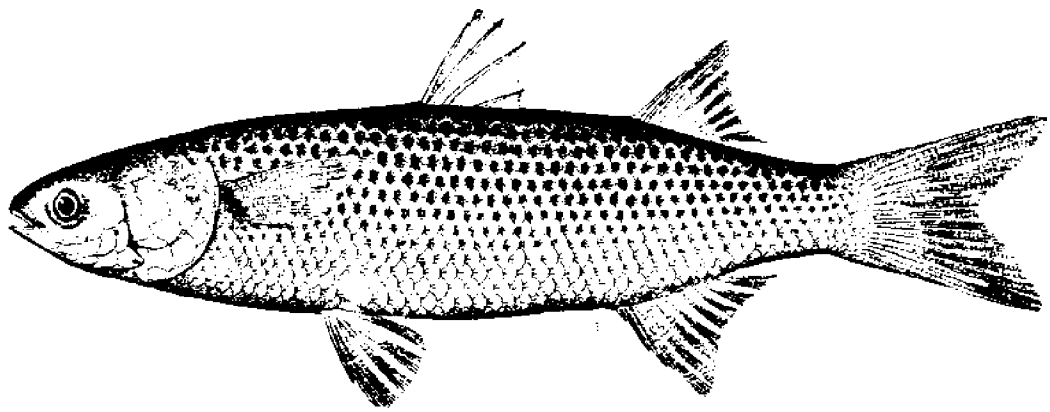
	BLACK MULLET			SILVER MULLET		
YEAR	CATCH	VALUE	PR. LB.	CATCH	VALUE	PR. LB.
1958	34.0	2.1	0.06	1.0	0.06	0.06
1959	32.6	1.9	0.06	0.7	0.04	0.06
1960	32.8	1.8	0.06	0.4	0.03	0.08
1961	34.0	1.9	0.06	0.6	0.03	0.06
1962	34.8	1.9	0.06	0.5	0.03	0.06
1963	34.5	1.8	0.05	0.6	0.04	0.06
1964	36.3	1.9	0.06	0.5	0.03	0.06
1965	33.1	1.8	0.06	0.8	0.05	0.06
1966	29.3	2.8	0.07	0.7	0.07	0.05
1967	28.2	2.0	0.07	1.0	0.07	0.07
1968	24.3	1.9	0.08	1.0	0.07	0.07
1969	29.3	2.4	0.08	0.7	0.06	0.08
1970	26.5	2.2	0.09	0.5	0.05	0.09
1971	26.5	2.2	0.08	0.6	0.05	0.09
1972	28.7	2.5	0.09	0.4	0.04	0.09
1973	30.2	3.2	0.11	0.6	0.08	0.13
1974	27.7	3.4	0.12	0.6	0.09	0.15
1975	25.3	3.6	0.14	0.5	0.09	0.18
1976	18.5	2.9	0.16	0.7	0.10	0.18
1977	21.2	4.0	0.19	0.5	0.10	0.19
1978	26.4	4.6	0.18	0.7	0.10	0.21

Table 2. Annual catch in millions of pounds for black mullet in Florida alone and in the combined other Gulf states during the years 1958 through 1978. Data compiled from U.S. Annual Fisheries Statistics.

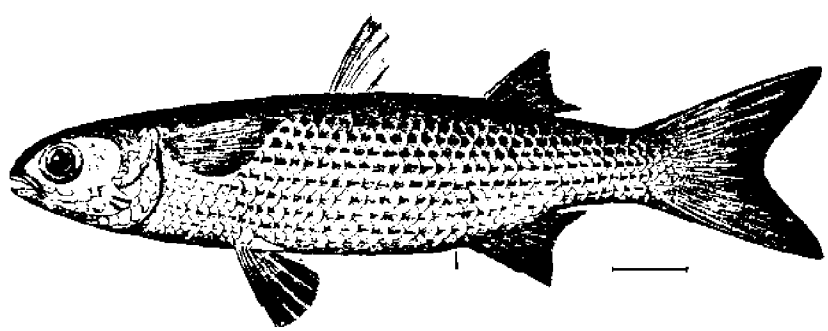
YEAR	FLORIDA	OTHERS	YEAR	FLORIDA	OTHERS
1958	32.3	1.7	1969	25.5	3.9
1959	30.6	1.9	1970	23.1	3.3
1960	30.9	1.4	1971	23.8	2.6
1961	33.0	1.3	1972	26.9	1.9
1962	32.8	2.0	1973	26.7	3.5
1963	32.6	1.8	1974	25.1	2.6
1964	35.0	1.4	1975	23.2	2.2
1965	31.4	1.8	1976	16.8	1.8
1966	27.0	2.3	1977	18.8	2.4
1967	23.3	4.9	1978	22.0	4.4
1968	20.4	3.9			
			TOTALS:	561.2	53.0

Table 3. Annual catch in millions of pounds for the Mexican Gulf of Mexico black and silver mullet fishery during the years 1968 through 1978. Statistics provided by Mexican Team of MEXUSGULF.

YEAR	BLACK CATCH	SILVER CATCH
1968	2.4	1.1
1969	2.6	1.2
1970	1.7	2.1
1971	2.6	3.2
1972	2.9	4.5
1973	2.3	4.6
1974	2.4	2.8
1975	3.9	1.8
1976	3.2	3.8
1977	3.5	4.6
1978	4.6	6.0



BLACK MULLET (*Mugil cephalus*)



SILVER MULLET (*Mugil curema*)

Figure 1. The two species involved in the Gulf of Mexico mullet fishery. The black mullet (*Mugil cephalus*), also known as the striped mullet (above) and the silver mullet (*Mugil curema*), also known as the white mullet (below).

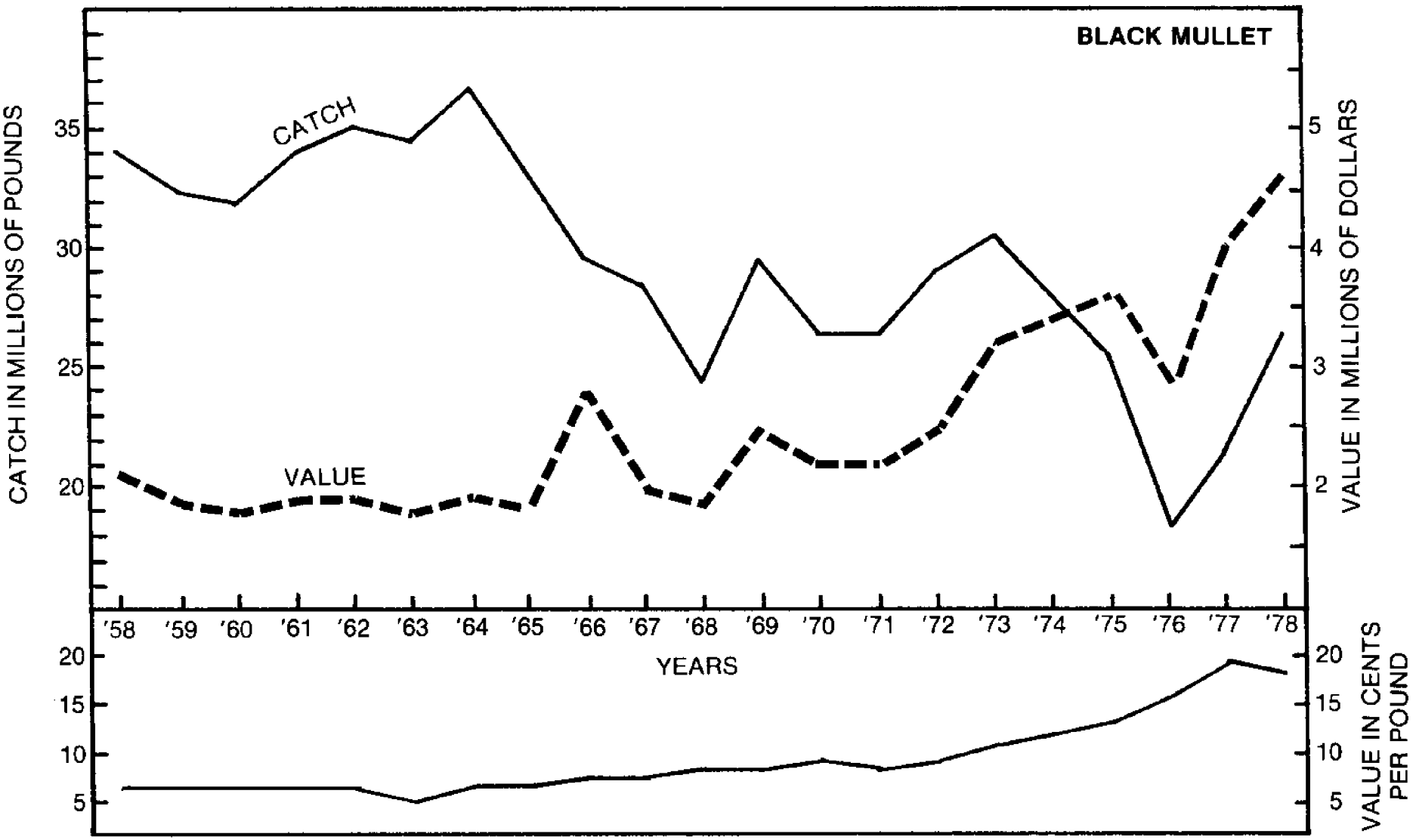


Figure 2. Annual catch in millions of pounds, value in millions of dollars, and value in cents per pound for the U.S. Gulf of Mexico black mullet fishery during 1958 through 1978. Statistics for 1979 not yet available. Based on Table 1.

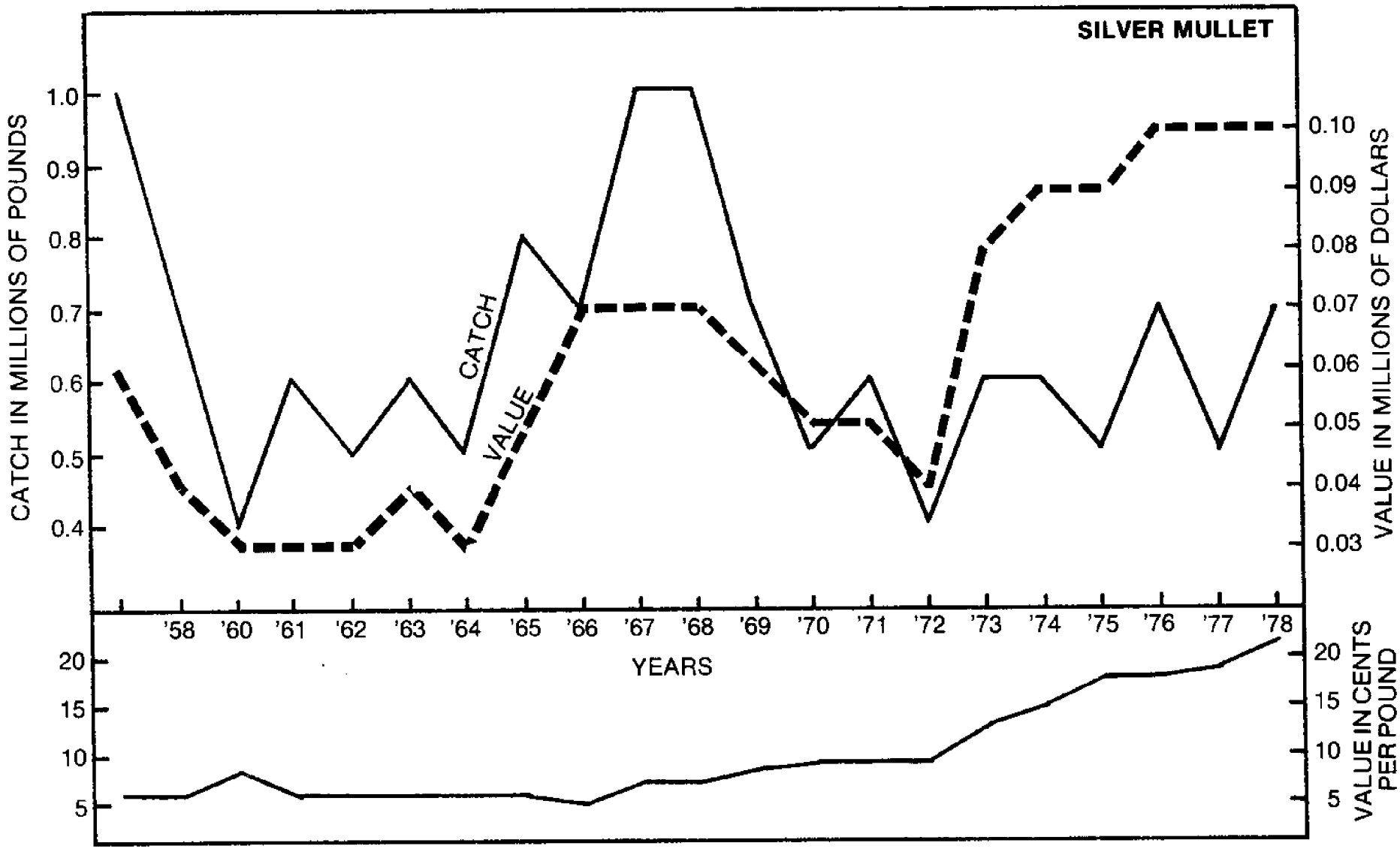


Figure 3. Annual catch in millions of pounds, value in millions of dollars, and value in cents per pound for the U.S. Gulf of Mexico silver mullet fishery during 1958 through 1978. Statistics for 1979 not yet available. Based on Table 1.

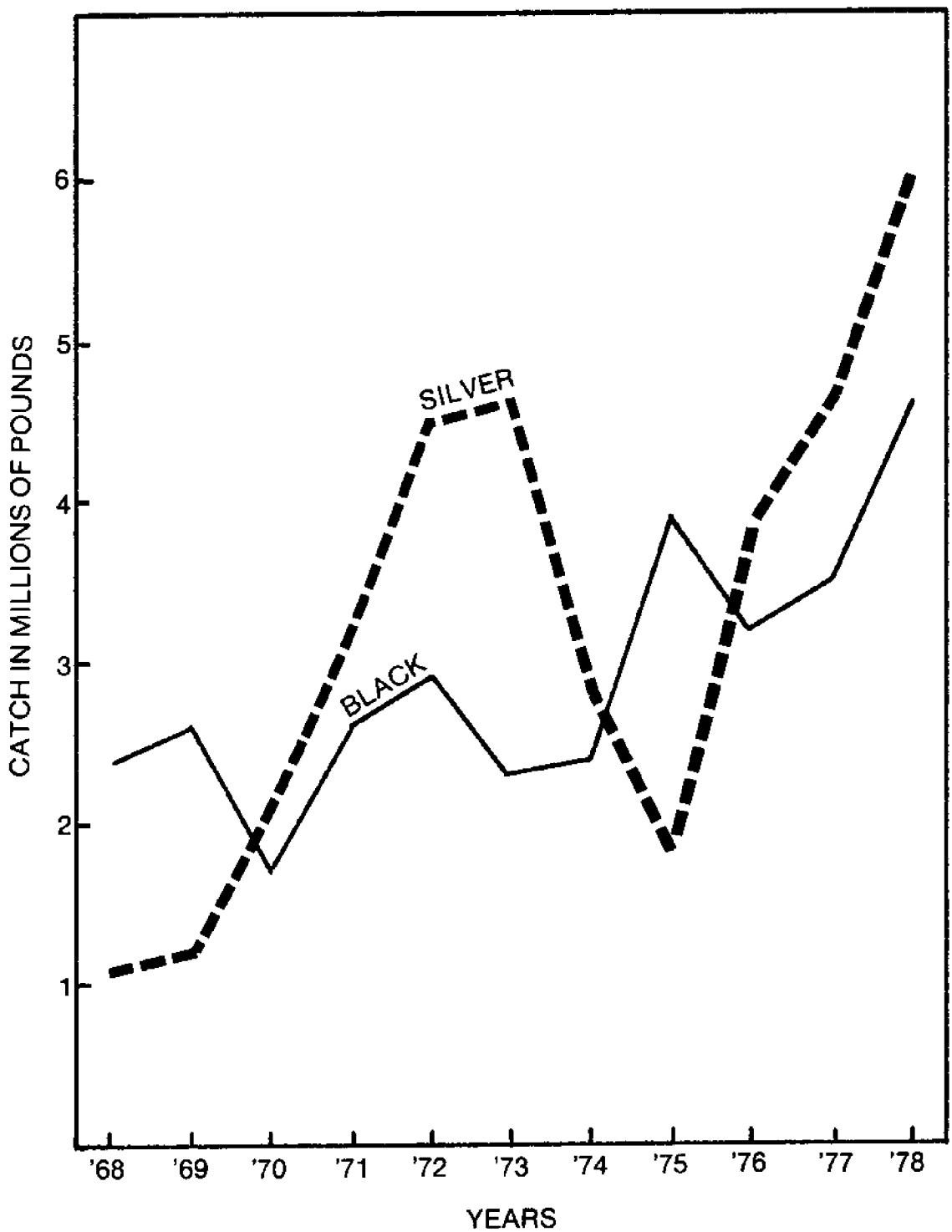


Figure 4. Annual catch in millions of pounds for the Mexican Gulf of Mexico black and silver mullet fishery during 1968 through 1978. Based on Table 3.

QUESTIONS AND ANSWERS

Luis Rivas

Q. The figures in the landings of the Mexican Gulf of Mexico, how much confidence do you put in them?

A. I accept what the Mexicans give us. I don't think it is very accurate, myself.

Q. There are a lot of landings that don't show up in what you have or there is no way to record them. Such as in Louisiana, the amount of mullet that is caught and put in fish meal, by Pogie fishermen is exceptional. Wouldn't Florida produce 80-90% of total landings reported?

A. Yes.

(Gene Raffield): There is a tremendous resource of mullet in the Gulf States, especially in Louisiana.

Q. You mentioned that these mullet go out to spawn and once they do spawn they come back in shore and start the cycle all over again. Is this really known?

A. Yes, it has been known through plankton surveys, etc.

Q. But, I mean that once an adult mullet spawns does it come back and the following year go out again?

A. Yes, presumably so. The circumstantial evidence is strong for accepting that as a parameter in the life history of the animal. Tagging has shown them to return to within 20 miles of the tagging point.

Q. This is an observation from being involved in the business: I don't believe that the mullet that hatches off the coast of Louisiana come to Florida or South America, because there is actually a difference in the body structure of the fish in the back area. The fish in Louisiana look different. They are both black mullet, but they look smaller. In Louisiana, it is common to catch a female with a full roe, weighing 1/2 pound, you never see that in Florida. Fish that are caught in the Florida Keys from Tampa south, are traditionally bigger.

A. Two things apply here - one is the genetic makeup of the animal (genotype), and the other is the external expression of the thing which sometimes if not always is influenced by the environment (phenotype). So you can have, for example, silver mullet that were born in the Carribean, thrown by the Gulf stream all the way to the mouth of the River, and current took some of them to Northwest Florida. Then the rest of them went all the way to South Florida. Because of different temperatures and food, and so forth, the ones of the Northern Gulf of Mexico have a different scientific expression of characters including size as compared to the ones of Florida. I'm not saying this is happening, but there is a strong possibility that this can happen because the larvae of these mullet have been taken all over the Gulf of Mexico and the open Atlantic. Definitely we know that they are planktonic at that stage. They are carried by currents until they reach about an inch or inch and a half, then their instinct or whatever you want to call it, makes them go ashore into the nursery area.

(Gene Raffield): At that point, the food chains must take over, because we have traditionally in 20 years, produced within 10% the same amount of mullet in our local budget because we are the only fishermen there and it has traditionally been about the same thing.

Q. I'm a bit concerned about the expansion of the mullet industry, in that in Texas the primary finfishery is for red drum and spotted seatrout, and that mullet is the primary food source for the spotted seatrout, and I am concerned about how much of the mullet could be harvested and still leave enough to support the spotted seatrout and the red drum. The other concern that I have is that another premise for expanding other fisheries is to take pressure off those that are heavily fished now, such as the red drum and the spotted seatrout in Texas. All of the gear types that you mentioned that are used to catch mullet are also used

to catch red drum and spotted seatrout. So that even if you expand the mullet industry, how are you going to take the pressure off the red rum and spotted seatrout?

A. (Gene Raffield): I can answer that. Change your gear, use purse seines and when you catch trout and red drum turn them loose alive and just save the mullet. That is the good part about that gear, because in the gill net, once you get him, he is caught.

Q. I've heard that purse seines are fairly detrimental and that fish released from purse seines are not in that good condition.

A. (McIlwain): I have had some experience with the purse net fishery, we have a small purse net fishery in Mississippi that has developed over the last couple of years. We have worked with the commercial fishermen purse seining to do some tagging of red drum, particularly. The fish have been in good shape. Another observation is that you can be very selective with purse seining. Normally trout and mullet don't school together. You can spot a school of mullet and set specifically on that school. If the fish are too small, and I have seen this happen, they have actually turned them loose, and I have not seen any dead fish.

POTENTIAL COMMERCIAL SQUID RESOURCES OF THE GULF OF MEXICO — AN UPDATED REVIEW

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INTRODUCTION

The cephalopods — octopus, squid, cuttlefish and nautilus - are one of the living resources of the sea that are not being fully harvested. Many currently fished stocks are capable of sustaining additional exploitation, and additional species of cephalopods are becoming the object of domestic and international fisheries development. For example, in the Northwest Atlantic, Japanese, European, Canadian and United States landings of the squids *Loligo pealei* and *Illex illecebrosus* between Newfoundland and Cape Hatteras have increased substantially during the past ten years (Rathjen et al., 1979). These increases have resulted from the introduction of more efficient fishing methods, a higher quality product due to freezing capabilities aboard ship and the development of overseas and domestic markets.

In the Gulf of Mexico at least 84 species of cephalopods are known to occur (Voss, 1956; Lipka, 1975) and 12 species of squids and octopuses have been identified as having potential for commercial exploitation (Voss, 1960, 1971, 1973; Voss et al., 1973). Currently stocks of these species are unaccessed or only slightly exploited. Along the Gulf coast of the United States, squids are an underutilized fishery resource (Rathjen et al., 1977, 1979). Particular interest in squids is centered in the Gulf shrimp industry (Hixon et al., 1980) which must contend with reduced access to foreign fishing grounds, rapidly increasing fuel and labor costs and decreasing yields from domestic shrimping grounds due to overfishing, pollution and destruction of inshore nursery areas.

This paper represents an update of earlier evaluations of existing and potential squid resources in the Gulf of Mexico. The species and approach that I have chosen are similar to those presented by Voss (1960, 1971, 1973) and Voss et al. (1973) in papers addressing this same question. My specific objectives are to:

(1) Describe the different types of fishing methods used to capture squids in established fisheries worldwide.

(2) Provide a review of the scientific literature available on the potential commercial squid resources of the Gulf of Mexico.

(3) Describe for each species its geographic distribution, distinguishing characteristics, size, life history, seasonal distribution pattern, migrations and existing fisheries.

(4) Describe the current status of the existing squid fishery in the northern Gulf of Mexico and discuss the biological, economic and marketing impediments to the development of this fishery.

(5) Make recommendations for both the short-term and long-term development and possible expansion of the Gulf squid fishery.

SQUID FISHING METHODS

Squids are caught commercially worldwide by various kinds of fishing gear: trawls, squid jigs and several types of nets or seines. Each of these methods exploits a behavioral characteristic of each squid species that renders the squids vulnerable to capture at particular stages in their life history. Therefore, it is necessary (1) to understand why a particular method catches squids, and (2) to know the behavior and life history of the species being sought.

Trawls

Many species of squid undergo a vertical diurnal migration. At night they ascend to the near-surface waters to forage, and during the day they descend to deeper water layers (Roper and Young, 1975). Species that are distributed over the continental shelf congregate near the bottom during the day where they can be captured by a wide variety of bottom and mid-water trawling gear. Some species occur in such large aggregations or schools at certain times of the year that trawling operations can be directed primarily for squids. In other cases the squids are taken as by-catch of trawling directed towards shrimps or fishes.

Squid jigs

Many species of squid can be attracted at night to the vicinity of a light shone on the surface of the sea. The behavioral motivation for this positive phototaxis is not understood. It is partially a feeding response since many species of squid are observed feeding on smaller organisms that are also attracted to the light. Squid jigs are fishing lures armed with circlets of barbless hooks; they are usually fished in long series. The aggressive feeding behavior of many species of squid, particularly oceanic forms, makes this the most effective method for capturing squids in deep water. The Japanese have highly mechanized this form of fishing, and currently about 70 per cent of Japan's squid landings are caught by jigging (Court, 1980). Squid jigging can also be effective for some squid species during the day, and it can also be used to catch species that are found over the continental shelf.

Nets and Seines

During spawning, some species of squid group together in large schools that are often restricted to a small locale. These spawning congregations are exploited by encircling the school with a lampara net or purse seine (Kato and Hardwick, 1976). In some coastal areas set nets or pound nets are used to trap various species of squid that are migrating to feed or spawn. Many variations of this type of net are used now in Japan and along the coast of Newfoundland. On the high seas, drift gill nets have recently been shown to be very effective for capturing some oceanic species that are feeding near the surface.

POTENTIAL COMMERCIAL SPECIES

Six species of squid that occur in the Gulf of Mexico have been suggested to have commercial potential (Voss, 1960, 1971, 1973; Voss et al., 1973). These can be divided into two distinct groups based upon their morphology and life history. Three species are myopsid squids (their eyes are covered completely by an overlying membrane) that inhabit the relatively shallow water over the continental shelf. These are the loliginid (Family Loliginidae) species: *Lolliguncula brevis*, *Loligo plei* and *Loligo pealei*. The other three species belong to the oegopsid squids (their eyes are in contact with seawater and are surrounded by a free eyelid) that usually are found in the open ocean beyond the outer edge of the shelf. These are the ommastrephid (Family Ommastrephidae) species *Ommastrephes pteropus* and *Illex coindeti*, and the onycoteuthid (Family Onychoteuthidae) species *Onychoteuthis banksi*. All six species are currently either fished in the Gulf of Mexico or elsewhere or are close relatives to commercially valuable

species. Keys for identification and detailed anatomical descriptions of each species are presented by Voss (1956), Voss et al. (1973) and Cohen (1976). In the myopsid species reviewed here one of the better characters is the dissected pen, while in the oegopsid species the tentacles are useful for identification.

Lolliguncula brevis (Blainville, 1823)

This small myopsid species is commonly referred to as the brief, thumbstall, bay or white squid. It is a shallow-water species that inhabits the inshore shelf waters from as far north as Delaware Bay (Verrill, 1881) southward throughout the Gulf of Mexico and Caribbean sea to southern Brazil (Palacio, 1977). It is reported from Cuba (Voss, 1955), Curacao (Adam, 1937) and Bermuda (Palacio, 1977). This species is perhaps best distinguished among the other squids in this area by its ability to withstand low-salinity waters (Voss, 1955, 1956; LaRoe, 1967). Laboratory studies (Hendrix et al., in press) have shown that *L. brevis* can survive in salinities as low as 17.5 $^{0}/_{00}$ (parts per thousand), or approximately one-half the normal open ocean salinity. This species can be most readily identified by the comparatively short, wide mantle, the presence of more chromatophores on the ventral part of the mantle than on the dorsum, and the clearly visible gladius or pen that appears as a dark streak down the midline of the anterior half of the dorsal mantle.

Studies of *L. brevis* primarily have documented its occurrence within large coastal embayments, including Delaware Bay (Haefner, 1959), Florida Bay (Tabb and Manning, 1961), Tampa Bay (Dragovich and Kelly, 1962), Apalachicola Bay (Livingston et al., 1975), Mississippi Sound (Moore, 1961; Franks et al., 1972; Christmas and Langley, 1973), and Aransas Bay and the Texas Gulf Coast (Gunter, 1950; Hildebrand, 1954, 1955). Its morphometrics were described by Haefner (1959), and Dragovich and Kelly (1962) discussed sexual maturation, stomach contents and its distribution within Tampa Bay. Other studies of note are those of Dillon and Dial (1962) on morphology and anatomy, Hall (1970) and Hunter and Simon (1975) on egg development, and McConathy et al. (1980) on the chromatophore arrangement of newly hatched young. The long-term maintenance of live *L. brevis* in closed-system laboratory aquaria for studies on live animals has been discussed by Hanlon et al. (1978) and Hulet et al. (1979, 1980).

Lolliguncula brevis is the smallest species of squid considered in this review. Trawl-caught specimens from Texas showed that male and female *L. brevis* reached a maximal mantle length (ML, Figure 1) of 78 (3.1 inches) and 91 mm (3.6 inches), respectively (Hixon, 1980). The average size was smaller; mean mantle length was 42 mm (1.7 inches) and the mean weight was 6.2 g (0.2 ounces) (Hixon et al., 1980). Dragovich and Kelly (1962) reported similar size ranges from Tampa Bay (maximal ML of 83 mm, 3.3 inches, for males and 107 mm, 4.2 inches, for females). Similarly, LaRoe (1967) collected males and fe-

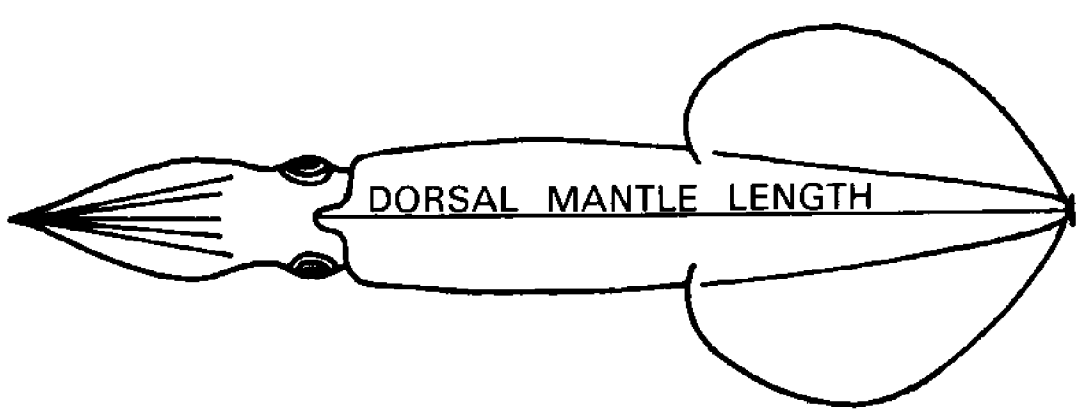

Figure 1. Dorsal view of a squid showing how the dorsal mantle length is measured.

males from Everglades National Park with maximal mantle lengths of 80 mm (3.1 inches) and 101 mm (4.0 inches), respectively. Tabb and Manning (1961) reported this species reached 150 mm (5.9 inches) in Florida Bay, but their measurements were an undefined "total length." The largest specimens of *L. brevis* have been noted by Franks et al. (1972) from the continental shelf offshore of Mississippi. Their specimens ranged from 20 (0.8 inches) to 160 mm (6.3 inches) ML, the biggest being much larger than those reported elsewhere. A study conducted within Mississippi Sound, Christmas and Langley (1973) collected nearly ten times as many squids as in the offshore area sampled by Franks et al. (1972), but the inshore maximal size was only 92 mm (3.6 inches) ML. Therefore, it is possible that the 160 mm (6.3 inches) ML given by Franks et al. (1972) is an error. In the northern part of its range, *L. brevis* does not attain as large a size as reported in the Gulf of Mexico. For example, in Delaware Bay the largest male was only 60 mm (2.4 inches) ML and the largest female was 78 mm (3.1 inches) ML (Haefner, 1964).

Lolliguncula brevis usually is distributed close to shore in shallow water less than approximately 30 m (98 feet) deep (Figure 2), but it has been reported from across the entire continental shelf. In a study conducted along the Texas coast, *L. brevis* constituted over 99 per cent of the squid catch in waters less than 10 m (33 feet) deep, and approximately 56 per cent of the squid catch between 10 and 30 m (33 and 98 feet) (Hixon, 1980). A single specimen in this study was caught from a depth of 131 m (430 feet); however, the occurence of this species at such depths is rare. Similarly, LaRoe (1967) reported five specimens from a depth of 86 m (282 feet), while the remainder of his collections were from less than 18 m (59 feet). Data from the National Marine Fisheries Service research vessel OREGON II show that the majority of *L. brevis* from the northern Gulf of Mexico were taken in less than 20 m (66 feet), but 16 specimens were recorded from 199 m (653 feet) (station no. 22303).

Seasonal inshore-offshore migrations of *L. brevis* in and out of coastal bays are known to occur. Gunter (1950) noted movements of this species near Aransas Bay, Texas. He attributed a fall exodus of squids and other invertebrates from the bay to falling temperatures in the bay. In Galveston Bay, *L. brevis* is excluded in most years from the bay and nearshore area from December through February by water temperatures as low as 7°C (45°F) (Hixon, 1980). This species moves inshore and enters Galveston Bay in March when temperatures rise approximately 15°C (59°F). This inshore movement is probably related to spawning activities; many of the incoming squids are sexually mature. The geographical extent of squid movements into Galveston Bay is determined by the local salinity conditions. High rainfall during the spring and summer in some years reduces the salinity below 17.5 $^{0}/_{00}$ and excludes this species from the bay. Spawning takes place primarily from April through July. In late fall (approximately November) as water temperatures in the bay drop below 18°C (65°F), the squids generally move away from the inshore environment to deeper depths in the open Gulf of Mexico.

Primarily because of its small size, *L. brevis* has been neglected as a fishery resource. Although commonly captured as bycatch of shrimp and fish trawlers, it is either discarded at sea or sold for a low price as bait. *Lolliguncula brevis* and other species of the genera *Lolliguncula* appear in local markets in several parts of the world, and it can be either eaten fresh or canned (Voss, 1971, 1973).

Loligo plei Blainville, 1823

This myopsid species is commonly called the tropical arrow squid because of the slender shape of the mantle. It occurs over the continental shelf and is distributed from Cape Hatteras to southern Brazil. Rare strays have been found as far north as Newport, Rhode Island (Cohen, 1976), and (Palacio 1977) suspected that this species may reach as far south as northern Argentina. It has also been reported from Bermuda (Voss, 1960), several islands in the Bahamas and throughout the Caribbean Sea (LaRoe, 1967;

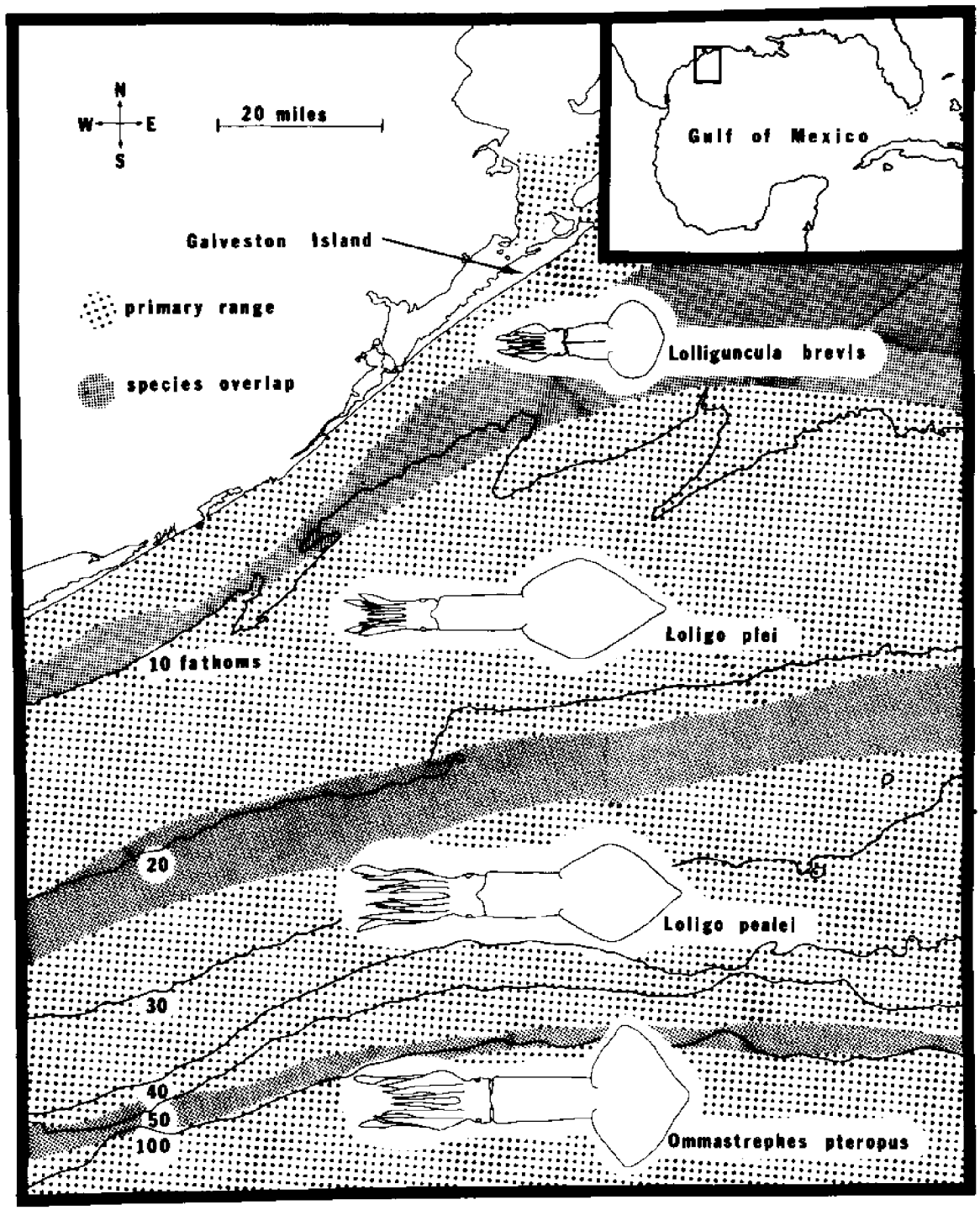

Figure 2. The approximate areal and bathymetric distribution in summer of four squid species of commercial potential on the Texas continental shelf south of Galveston Island, Texas (from Hixon et al., 1980). The two other species reviewed here (*Illex coindeti* and *Onychoteuthis banksi*) occur beyond the edge of the continental shelf (100 fathoms) like *Ommastrephes pteropus*.

Hochberg and Couch, 1971). Whitaker (1978) found that *L. plei* was common south of Cape Hatteras, especially in summer. LaRoe (1967) stated it was the most numerous shallow water squid from both sides of the Straits of Florida, and that it was often collected along the west coast of Florida. He further speculated that *L. plei* seemed to be the most common squid over the continental shelf throughout the Gulf of Mexico and Caribbean Sea. Perhaps the most obvious external character that can often be used to identify this species is the five or more prominent, well-defined stripes of reddish chromatophores positioned laterally on the mantle of large mature males. Females and small juveniles appear superficially very similar to *Loligo pealei*. They can be identified best by measurements taken from gladius or pen that must be removed from each specimen (Adam, 1937; Voss, 1956; LaRoe, 1967; Cohen, 1976).

The scientific literature on *L. plei* is primarily of a taxonomic or zoogeographic nature (Voss, 1952, 1954, 1956, 1971; LaRoe, 1967; Voss et al., 1973; Cohen, 1976; Cairns, 1976; Palacio, 1977) Whitaker (1978) described the occurrence, distribution and morphometrics of *L. plei* from Cape Hatteras to Cape Canaveral. Field observations of this species have been made of spawning activities (Waller and Wicklund, 1968). Studies of live animals under laboratory conditions include those of LaRoe (1967, 1970, 1971) on rearing and laboratory maintenance, Roper (1965) on egg deposition, Hanlon (1978) on growth, behavior and associated color patterns, Hanlon et al. (1978) on long-term laboratory maintenance procedures and Hulet et al. (1979) on skin damage in wild-caught animals. The arrangement of chromatophores of hatchling *L. plei* was described by McConathy et al. (1980).

The largest species of *L. plei* measured 348 mm (13.7 inches) ML and was captured from the Atlantic coast of Colombia (Cohen, 1976). In the Gulf of Mexico this species does not appear to grow as large as it does in more tropical areas. Maximal mantle lengths of male and female *L. plei* collected in Texas were 252 and 165 mm (9.9 and 6.5 inches), respectively (Hixon, 1980). Squids collected with a standard 10.7 m (35 feet) Gulf shrimp trawl were smaller; the mean mantle length was 66 mm (2.6 inches) and mean weight was 6.7 g (0.2 ounces) (Hixon et al., 1978). In the Gulf of Mexico the largest specimens of *L. plei* have been collected from the Bay of Campeche; males had a maximal mantle length of 297 mm (11.7 inches) and females attained a maximal mantle length of 210 mm (8.3 inches) (Hixon, 1980).

In the northern Gulf of Mexico *L. plei* is found primarily midway across the continental shelf (Figure 2) in depths between 20 and 75 m (66 and 246 feet) where the salinity exceeds 30 °/₀₀. On rare occasions it has been collected from within coastal bays and as deep as 270 m (886 feet) (LaRoe, 1967) and 366 m (1200 feet) (Cohen, 1976). Off the Texas coast this species constituted over 62 per cent of the squid catch between 20 and 75 m (66 and 246 feet). On the inshore side of this preferred depth range, *L. plei* occurs with *L. brevis*, primarily between 10 and 30 m (33 and 98 feet). Offshore the depth ranges of *L. plei* and *L. pealei* overlap (Figure 2,), principally between 40 and 100 m (131 and 328 feet) (Hixon, 1980).

Both inshore-offshore and north-south migration patterns have been reported for *L. plei*. LaRoe (1967) noted that large adults in southern Florida moved inshore beginning in March to spawn in spring. Whitaker (1978) associated the occurrence of *L. plei* over the continental shelf south of Cape Hatteras with the annual movement of the 20°C (68°F) isotherm. He speculated that the fall disappearance of large adult *L. plei* from his study area was due to a southward migration. In the Texas study area during winter, small-sized *L. plei* are found primarily in deeper water (30 to 100 m, 33 to 328 feet) over the mid and outer portions of the continental shelf (Hixon, 1980). Beginning in April, large fast-growing mature adult males and females usually appear in shallow water along the Texas coast. The large size of these squids suggests that they may be seasonal migrants from populations of *L. plei* farther south in the Gulf of Mexico, and that they are possibly trans-

ported by a northward-flowing inshore current in spring. Spawning usually begins in May in depths between 17 and 104 m (56 and 341 feet) when temperatures approach 25°C (77°F). Some spawning continues throughout the spring and summer. The hatchlings presumably feed and grow in the mid-shelf environment, although there is no information on the life history of young stages. Between fall and winter, the population, which is composed primarily of the small young-of-the-year, moves offshore. Although a portion of the population winters in deeper water along the Texas coast, it is possible that a portion of the population is transported by the southward-flowing inshore currents at this time of year. Similar migratory movements of this species probably occur throughout the northern Gulf of Mexico.

A small commercial fishery for *L. plei* takes place near Progreso, Yucatan, Mexico in the fall. Fishermen in small boats use lights and tethered live fishes to lure this species near the boat where they are captured with a handnet (LaRoe, 1967; Voss, 1973). Throughout the Gulf of Mexico, *L. plei* is taken in shrimp trawls, but it is usually discarded with the majority of the bycatch. In Venezuela and Brazil this species is taken as bycatch in the shrimp trawl fishery, but it is not an important commercial item at this time (Juanico, 1980).

Loligo pealei (Lesueur, 1821)

This myopsid species is often called the common or long-finned squid. *Loligo pealei* is primarily a temperate-water species that lives on the continental shelf and upper slope; it has a wide geographic distribution from Nova Scotia to the Gulf of Venezuela (Cohen, 1976). Voss (1955) and LaRoe (1967) cited reports of *L. pealei* from several islands in the Caribbean Sea, particularly Cuba, and Cohen (1976) located specimens from the western Bahamas. The largest population of *L. pealei* occurs between approximately Cape Cod, Massachusetts and Cape Hatteras, North Carolina. The populations farther south are less well known. Between Cape Hatteras, North Carolina and Cape Canaveral, Florida, the largest catches reported by Whitaker (1978) were north of 32°N latitude. LaRoe (1967) obtained only a few specimens from south Florida, but he speculated that *L. pealei* likely increased in abundance in the northern Gulf of Mexico. *Loligo pealei* is often difficult to separate from *L. plei* except by removing and carefully measuring the pen. All other distinguishing characters must be viewed with a microscope (Cohen, 1976). Generally *L. pealei* is a heavy bodied squid while *L. plei* is usually more slender.

Early accounts of *L. pealei* remain the basis for much of our knowledge of this species. Verrill (1881) discussed the growth, distribution, reproduction and anatomy of *L. pealei*. A detailed anatomical description of *L. pealei* was given by Williams (1909), and the mating behavior and the morphology of spermatophores were reported by Drew (1911, 1919). Later work includes studies on aspects of the life history and population dynamics of *L. pealei* in New England coastal waters by Summers (1967, 1968, 1969, 1971) and Mesnil (1977). Other noteworthy studies are those on mating behavior (Arnold, 1962), embryology (Arnold, 1965) and the chromatophore arrangement of hatchlings (McConathy et al., 1980). Arnold et. al. (1974) published a general guide to the laboratory use of *L. pealei*, and Summers and McMahon (1970, 1974), Summers et al. (1974) and Hanlon et al. (1978) studied the maintenance of this species in the laboratory.

The largest specimens of *L. pealei* have been reported from the northern part of its range. In New England Verrill (1881) recorded a male with a mantle length of 425 mm (16.7 inches) and Summers (1968) reported a male specimen with a mantle length of 465 mm (18.3 inches). Southern populations do not attain these very large sizes. In Texas the largest male and female *L. pealei* measured 285 mm (11.2 inches) ML and 207 mm (8.1 inches) ML, respectively (Hixon, 1980). Squids collected with a standard Gulf shrimp trawl were smaller; the average *L. pealei* measured 69 mm (2.7 inches) and weight 14.5 g (0.5 ounces) (Hixon et al., 1980). Farther south, LaRoe (1967) and Cohen (1976) noted that the smallest mature specimens of this species were observed off the Caribbean coast of

Colombia.

In the northern Gulf of Mexico *L. pealei* is captured primarily along the outer edge of the shelf (Figure 2). Although occasionally collected in shallow water, its primary depth range is between 40 and 250 m (131 and 820 feet) where the salinity is above 33°/°° (Hixon et al., 1980). Off the Texas coast between 75 and 250 m (246 and 820 feet) *L. pealei* made up over 80 per cent of the reported squid catch (Hixon, 1980). Elsewhere, this species has been reported from the "shore" by Verrill (1881) to a depth of 393 m (1289 feet) (Cohen, 1976). It is very likely that *L. pealei* in the Gulf occurs in deeper depths. Exploratory fishing records of the OREGON II in the northern Gulf of Mexico list either *Loligo* sp. or *L. pealei* from 17 trawl stations in excess of 372 m (1220 feet), including one station from 763 m (2503 feet). Most likely the deep records listed as *Loligo* are actually *L. pealei*. Conceivably the *L. pealei* in these very deep tows could have been collected by the open trawls in transit to or from the bottom.

Loligo pealei populations between New England and Cape Hatteras have been described as undergoing both inshore-offshore and north-south migrations. These movements are attributed to the upper and lower temperature limits of this species. In winter, *L. pealei* is concentrated primarily in canyons along the outer edge of the continental shelf in water temperatures between 9 and 12°C (48 and 54°F) (Vovk, 1969). In the late spring and summer, this species moves inshore to shallow water to spawn. By later summer and early fall the population is scattered over the continental shelf in depths less than 100 m (328 feet) (Serchuk and Rathjen, 1974). The entire population then moves gradually offshore and southward in the fall to avoid water temperatures 8°C (46°F) or less on the shallow portion of the shelf (Summers, 1969). Whitaker (1978) reported that the seasonal inshore-offshore migration of *L. pealei* was reversed south of Cape Hatteras due to different temperature conditions. In winter and spring, the water temperature over the entire shelf in this area is above 8°C (46°F) and *L. pealei* occurs widely across the shelf. Peak spawning also takes place at this time. During the summer and fall, water temperatures above 20°C (68°F) displace this species offshore where it is found along the edge of the shelf in temperatures between 8 and 20°C (46 and 68°F). This species moves back inshore as water temperatures drop in the fall over the shelf.

In Texas the bottom water temperatures vary between approximately 15 and 22°C (59 and 72°F) over the deeper offshore portion of the continental shelf where *L. pealei* is most abundant. In winter the main concentration of this species appears to be in deeper water along the outer edge of the continental shelf. In spring, when temperatures in the deeper depths along the mid and outer shelf reach the annual low, much of the population occurs farther inshore over the midshelf area. The population at this time is comprised mainly of the young from the previous peak fall spawning; therefore, this inshore movement is presumably a feeding migration. These squids grow rapidly throughout the spring and summer and attain adult size in the late summer and fall. The areal extent of the spring and summer inshore movement is limited by the presence of either high temperature or low salinity in the shallower depths and water layers overlying the continental shelf. Peak spawning probably occurs in fall, but it is not yet clear whether any inshore or offshore movements are associated with spawning activity.

Since approximately 1968 several foreign fishing fleets and U.S. fishermen have established a trawl fishery for *L. pealei* between Cape Cod (Georges Bank) and Cape Hatteras (Vovk, 1969; Rathjen, 1973, 1974; Kolator and Long, 1979). Reviews of the fishery have been presented by Voss (1973), Serchuk and Rathjen (1974), Lux et al. (1974) and Rathjen et al. (1977, 1979). Catches reached a high of 37,613 tons in 1973 and have since declined steadily to 10,831 tons in 1978 (Lange and Sissenwine, 1980). A directed trawl fishery conducted by U.S. fishermen occurs in early summer during the inshore spawning migration of this species, but the remainder is taken mostly as bycatch.

Elsewhere around the world similar squids of the genus *Loligo* are the basis of both local

and distant-water fisheries. For example, off the west coast of the U.S. there is a long-standing fishery for *Loligo opalescens* using both lampara nets near Monterey, California and night light attraction in southern California (Fields, 1965; Kato and Hardwick, 1976). In Japan, *Loligo edulis* is captured mainly with trawls year-round and contributes roughly 20,000 tons per year to the total Japanese squid catch (Okutani, 1977). In the eastern Atlantic and Mediterranean Sea the most important commercial loliginid squid species is *Loligo vulgaris* (Voss, 1973). Many other species of *Loligo* also are fished in traditional small-scale fisheries throughout the world (Voss, 1973).

Illex coindeti (Verany, 1837)

This oegopsid species is one of a group of four closely related species (or subspecies) of the genus Illex that are distributed along the east coast of North and South America from Newfoundland to southern Argentina. One of these species, *Illex illecebrosus*, has been reported from within the Gulf of Mexico proper, but taxonomic studies suggest that most specimens from the Gulf are *I. coindeti* (Roper et al., 1969). *Illex illecebrosus* is commonly referred to as the short-finned or arrow squid; the same common names could apply to *I. coindeti* as well. *Illex coindeti* occurs along the continental shelf and upper slope on both sides of the Atlantic Ocean. In the western Atlantic it is listed from the Straits of Florida (Cairns, 1976), the Gulf of Mexico and Caribbean Sea (Roper et al., 1969). Observations on the vertical distribution of this species indicate that it is located near the bottom during the day in depths between roughly 25 and 500 m (82 and 1640 feet), and that at night it rises from the bottom to midwater depths (Roper et al., 1969; Roper and Young, 1975). *Illex coindeti* can be distributed from the other species reviewed here by the presence of eight or nine rows of very small suckers at the tip of the tentacles.

Almost nothing is known about the biology and life history of this species in the western Atlantic and Gulf of Mexico. It has been reported from the stomachs of broadbill swordfish (*Xiphias gladius*) captured in the Straits of Florida (Hess and Toll, in press). More detailed studies on this species have been carried out in the eastern Atlantic and Mediterranean Sea (reviewed by Clarke, 1966) and are probably applicable to western Atlantic populations. The annual distribution, growth, age, life span, sexual maturation, mating, eggs and young stages of *I. coindeti* in the Mediterranean have been reviewed by Mangold-Wirz (1963). Along the West African coast Adam (1952) reported on the body proportions of a collection of over 500 specimens of *I. coindeti*.

Female *I. coindeti* are larger than males. In West Africa the mean female mantle length was 145 mm (5.7 inches) (maximum of 235 mm, 9.3 inches) and the mean male mantle length was 131 mm (5.2 inches) (maximum of 176 mm, 6.9 inches), Measurements of 13 specimens suggest this species may attain a similar size in the Gulf of Mexico and Caribbean Sea (Roper et al., 1969).

Information on the distribution, abundance and migrations of *I. coindeti* in the Gulf of Mexico are not available. Trawl records of the R/V OREGON from the Gulf show that occasional moderate catches of *Illex* occur. The maximal reported catch (station no. 11497) totaled 6986 specimens weighing 943 kg (2078 pounds) and was taken in 290 minutes with a 130 foot trawl at 375 m (1230 feet) along the Florida Panhandle.

Elsewhere in the western Atlantic, two other species of the genus *Illex* are the basis of large and rapidly expanding fisheries. In the Northwest Atlantic, catches of *Illex illecebrosus* have risen dramatically since 1975 and totaled almost 100,000 tons in 1978 (Hurley, 1980). Some are used for cod bait, but most are now exported for human consumption. The fishery is divided into an inshore Canadian jigging fishery conducted largely in waters around Newfoundland and an offshore international trawl fishery that takes place off the coast of Nova Scotia. Off the northeast coast of the United States, American and foreign fishing fleets using trawls have harvested between 18,000 and 25,000 tons of this species from 1972 to 1978 (Lange and Sissenwine, 1980). In the Southwest Atlantic along the Patagonian shelf off the coast of Argentina, catches of *Illex argentinus* by the Argentinian fleet

increased from less than 7500 tons between 1972 and 1977 to 55,000 tons in 1978 and may total 100,000 tons in 1979. (Juanico, 1980). Total catches in this area are actually higher because no information is available on foreign fleets operating beyond the 200 mile limit. In Japan, *Todarodes pacificus*, a species with a life history and biology very similar to *Illex*, is the basis of the traditional Japanese jigging squid fishery (Okutani, 1977). Catches of this species have declined from a high of 668,364 tons in 1968 (Okutani, 1977) to less than 300,000 tons in 1977, principally because of overfishing (Court, 1980).

Ommastrephes pteropus Steenstrup, 1885

This large oegopsid species is commonly referred to as the orange-back squid. It is a strictly oceanic species that is distributed throughout the temperate and tropical Atlantic Ocean. In the western Atlantic it is reported from Nova Scotia and southward from Bermuda, the Gulf of Mexico and Caribbean Sea (Voss, 1956, 1960, 1971, 1973). Although it is usually observed near the surface, it is capable of diving to a depth of at least 1000 m (3280 feet) (Baker, 1957). *Ommastrephes pteropus* can be most readily identified by an oval orange light organ that is prominently located in the dorsal mantle. Counts of the number of rows of small suckers at the tip of the tentacles (Voss et. al., 1973) or careful measurements of the beaks (Wolff and Wormuth, 1979) can also be used.

Studies of *O. pteropus* have generally been concerned with the structure and function of its light organs (Roper, 1963; Clarke, 1965; Girsch, Herring, and McCapra, 1976) or its behavior at night near the surface (Baker, 1960; Clarke, 1966; Vovk and Nigmatullin, 1972). Studies concerned with aspects of the life history of this species include measurements of body proportions (Adam, 1952), estimates of age and growth (Zuev and Zaika, 1977) and evaluations of sex ratio, sexual development, fecundity and food habits (Hixon et al., in press).

Ommastrephes pteropus attains a large size; it is the longest and heaviest species considered in this review. In the Gulf of Mexico a large specimen measured 345 mm (13.6 inches ML and weighed 1.5 kg (3.3 pounds) (Hixon et al., in press). The mean mantle length of 401 specimens was 207 mm (8.1 inches). Females (mean mantle length 216 mm, 8.5 inches) attain a larger size than males (mean mantle length 154 mm, .61 inches).

The distribution of *O. pteropus* in the Gulf of Mexico is not known at the present time. The largest reported catches have been from the Bay of Campeche in the southern Gulf using night lights and jigging (Hixon et al., in press). Sightings of large schools of this species at night have been described from the R/V OREGON and R/V PILLSBURY both in the Gulf of Mexico and Caribbean Sea (Voss, 1973). Migrations of this species have been reported in the eastern North Atlantic for spawning or in response to seasonal temperature differences (Clark, 1966).

The only fisheries for *O. pteropus* have been reported from the coast of Mauritania (Hamabe, 1975) and at Madeira (Clark, 1966) in the eastern North Atlantic. They are used both for bait and for human consumption. A very similar species, *Ommastephes bartrami*, is the basis of an important jigging and drift gill net fishery near Japan (Murata et al., 1976; Murata and Ishii, 1977; Ishii, 1977). As catches of the traditional squid fishery in Japan based upon *Todarodus pacificus* have declined, catches of *O. bartrami* have increased (Okutani, 1977). By 1978 catches of *O. bartrami* constituted almost half of the squid harvest taken in Japan waters (Court, 1980).

Onychoteuthis banksi (Leach, 1817)

This oegopsid species is commonly known as the hooked squid (Voss et al., 1973). It is a purely oceanic species that is distributed throughout the world usually in warm and temperate seas from as far north as Norway to as far south as Cape Horn (Voss, 1956). It is reported from observations made at or near the surface (Clark, 1966), but it also has been taken in midwater from at least 475 m (1558 feet) (Cairns, 1976) and perhaps as deep as 800 m (2624 feet) (Roper and Young, 1975). This species can be distinguished from the other

species in this review by 19 to 23 clawlike hooks on each of the tentacles (Young, 1972; Voss et al., 1973).

Previous studies of *O. banksi* have largely been concerned with taxonomy and zoogeography, and very little is known about the biology or life history of this species. Studies in the North Atlantic suggest this species spawns year-round (Clarke, 1966). In the Gulf of Mexico, Voss (1956) reported that d'Orbigny in 1848 noted this species was found with floating *Sargassum* weed. Although it reaches a maximal total length of approximately 305 mm (12 inches) (Voss et al., 1973), 16 specimens reported from the Gulf of Mexico measured only between 48 and 92 mm (1.9 and 3.6 inches) ML (Voss, 1956; Lipka, 1975).

A very closely related species (or subspecies) from the North Pacific, *Onychoteuthis borealijaponica*, is taken in moderate quantities by Japanese fishermen using squid jigs (Okutani, 1977). Studies of its distribution (Murata et al., 1976; Murakami, 1976) and its young stages (Okutani and McGowan, 1969); Yamamoto and Okutani, 1975) suggest that present fishing grounds cover only a small portion of the total area inhabited by this species (Okutani, 1977).

SQUID FISHERY IN THE NORTHERN GULF OF MEXICO

Current Status

At the present time squids contribute only a very small fraction of the total landings from the states in the northern Gulf of Mexico. Statistics compiled by the National Marine Fisheries Service since 1960 indicate that the total reported squid landings from the northern Gulf between 1960 and 1977 have averaged about 24,000 kg (52,911 pounds) per year. Approximately 90 per cent of the squids are landed in Texas and along the west coast of Florida. In Texas, over 80 per cent of the catch is taken from the open Gulf of Mexico. The remainder is caught in coastal bays, primarily Galveston and Trinity Bays. In Florida, the highest landings are reported from Escambia, Lee, Bay and Franklin counties. Additional smaller amounts of squid are reported by Louisiana and Alabama, and none are recorded from Mississippi. These statistics are incomplete both because an unknown amount of squid that is landed is not reported, and because most squids are probably discarded at sea as trash. An unspecified amount of the West Florida squid landings also inadvertently includes some octopuses.

Seasonally, the highest monthly mean catches from Texas and West Florida are recorded between April and August, and the lowest mean catches are taken between December and February (Figure 3). Although these figures partially reflect seasonal differences in the activities of the Gulf shrimp fleet, studies conducted in Texas indicate that squids are more abundant over the shelf in the spring and summer of most years (Hixon, 1980).

It is not possible to determine the species composition of the catch because the NMFS squid statistics do not separate the catch records by species. Most likely the loligniid squids *L. brevis*, *L. plei* and *L. pealei* constitute almost all of the catch.

Fishery Prospects

The foregoing discussion indicates that commercially desirable species of squid occur in the northern Gulf, but that the existing incidental squid fishery harvests only relatively small quantities each year compared to fisheries elsewhere that capture the same or very similar species. The exact reasons for the present situation are not known; however, several biological, economic and marketing impediments to the development of a squid fishery in Texas have been described (Hixon et al., 1980). It is likely that similar impediments exist for all the states in the northern Gulf.

The magnitude of the possible stocks of each species are unknown at the present time, and no comprehensive effort has been made to generate squid biomass or standing stock estimates for the northern Gulf. Projections have been made of the daytime catch rate of

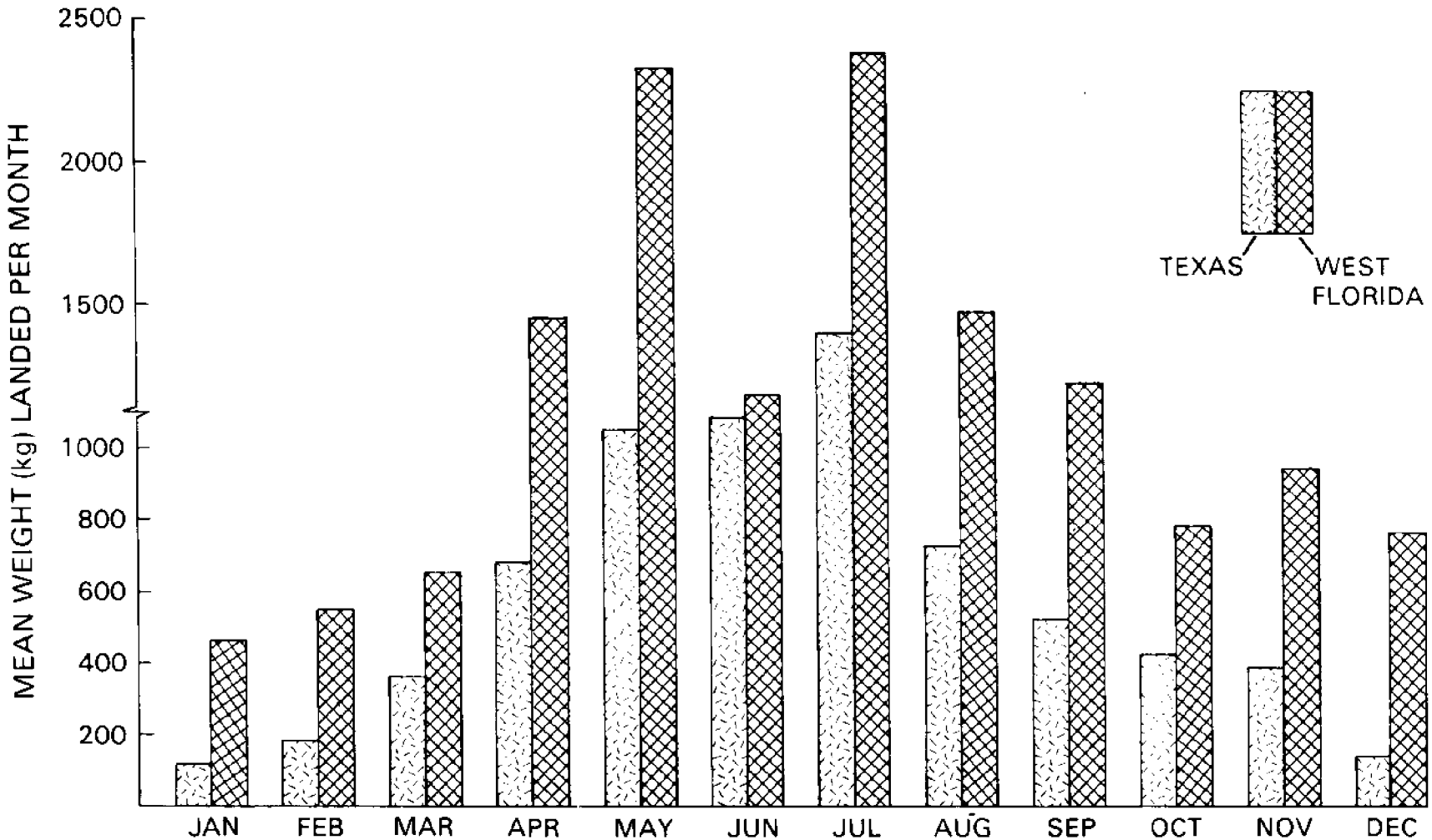

Figure 3. Mean monthly weight (kg) of squid landings reported from Texas and West Florida between 1962 and 1977.

the three loligniid squids taken with a commercial Gulf 10.7 m (30 feet) shrimp trawl over the Texas continental shelf (Hixon et al., 1980). The estimated catches with this type of gear are low; monthly yields were highest (284 kg, 626 pounds, per month) between a depth of 30 and 40 m (98 and 131 feet) and lowest (80 kg, 176 pounds, per month) between 100 and 250 m (328 and 820 feet) deep. Highest trawl catches are projected from the shallow shelf out to a depth of 50 m (164 feet). It is not known whether low projected catches over the outer continental shelf were due to low squid abundance or whether the shrimp fishing gear used for these projections was inadequate for sampling at such depths. Squids, especially the larger ones sought in a fishery, were probably able to easily avoid the small, slow-moving trawls.

A major hindrance to the possible development of a Gulf squid fishery is the low price paid to fishermen for squids. In Texas, squids brought only $0.63 per kg ($0.29 per pound) in 1978. If prices were to rise, a preliminary economic analysis suggests that squids, along with other by-catch organisms, could contribute to reducing the losses suffered by Gulf shrimpers during those months when shrimping alone does not provide a profit margin (Hixon et al., 1980).

If the price paid to the fishermen for squid is to rise, new domestic or overseas markets must be developed. In either case the marketing task is formidable. There are significant obstacles in the domestic market along the Gulf coast: the product name "squid", the perception by consumers that squid has a tough or rubbery texture and the generally unappealing merchandizing method of marketing squid in whole, unprocessed form (Kalikstein, 1974). The most appropriate approach seems to first introduce domestic consumers on a small scale to high quality, processed specialty items made with squid, thereby gradually gaining mass-market appeal (Hixon et al., 1980).

A successful foreign squid marketing venture has two requirements: a quality product and a demonstrated rate of production. The international market for squid is centered in Japan (Court, 1980) and southern Europe, primarily Spain. In these countries squid is imported and merchandized in many forms. The highest quality imports are either fresh squids or processed squids that are virtually undamaged by capture, carefully graded by size and quick-frozen at sea. A reliable source of supply also is needed to fullfill long-term commitments or contracts. Neither of these requirements can be met by fishermen or processors in the northern Gulf of Mexico at the present time.

Recommendations

A small-scale incidental fishery now exists in the northern Gulf of Mexico in shallow water for three species of loliginid squids. A first priority would be to upgrade the handling and processing of the squids produced by this fishery, and present a quality product to domestic consumers on a small scale as a specialty item through local small ethnic markets or seafood restaurants (Hixon et al., 1980). Such an approach would have three results. It would become a source of additional income (although a small contribution at first) for the local shrimp industry. It would also introduce domestic consumers to squid. Perhaps most importantly, it would begin to develop the necessary marketing channels of fishermen, processors, wholesalers and retailers needed for entry into wider domestic or overseas markets.

In order to begin considering any expansion of the Gulf squid fishery, a reliable estimate of the magnitude of the squid resources in the Gulf should be made. Quantitative investigations are especially needed of the squid species of the outer continental shelf and upper slope for *Loligo pealei* and *Illex coindeti* and of the offshore deep-water areas for *Ommastrephes pteropus* and *Onychoteuthis banksi.* Studies along the outer shelf would best be carried out by a modern high-speed trawler that is fully outfitted especially for squid trawling and has a captain and crew experienced in fishing for squids. Similarly,

studies of offshore squids would require a vessel outfitted with jigging and night lighting equipment and an experienced captain and crew. Such vessels are now in use by several foreign fishing fleets catching *Loligo pealei* and *Illex illecebrosus* off the northeast coast of the United States and Canada (Kolator and Long, 1979; Long and Rathjen, 1980). Cooperative investigations could be organized that would include U.S. scientists, fishermen and fisheries management personnel aboard foreign flag vessels. Similar cooperative investigations of squid resources have taken place off both the northeast and west coasts of the United States.

In shallow water over the continental shelf, additional investigations of the concept of night light attraction and purse seining of coastal squid species should be carried out. Similar studies directed at underutilized coastal pelagic schoolfishes have taken place (Wickham, 1970, 1971a, 1971b, 1973) with generally mixed results. The development of such a fishery would most likely depend upon the profitable use of many currently uneconomical finfish species as well as squids.

The end result of a carefully conceived and planned series of investigations would be more realistic assessment of the squid resources of the northern Gulf of Mexico. With this information the fishing industry and fishery managers could make informed decisions about the commercial development of these resources.

It has been ten years since the first comprehensive report of the possible commercial cephalopod resources of the Gulf of Mexico was presented (Voss, 1971). In that time this same question has been reviewed on several occasions, and these reviews have agreed that, from a biological point of view, squid resources of unknown size occur in the Gulf of Mexico. Progress has been made in solving some questions concerning the life history and biology of these species; but much scientific work remains to be done. On the other hand, little progress has been made in solving the economic, sociological, political and marketing questions concerning squids that confront commercial interests along the Gulf coast of the United States. All of these questions must be considered together if we are to eventually exploit the potential squid resources of the Gulf.

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QUESTIONS AND ANSWERS SESSION

Ray Hixon

Q. When frying squid in oil they seem to shrink a great deal and get tough - why?

A. When squid are cooked in that manner, they loose approximately 50% of the water within the muscle tissue. Mr. Steve Otwell, a food technologist at the University of Florida, Gainesville, has done quite a bit of work looking at the muscle structure and the problem of cooking this animal. He believes that there are two things you can do - one is to cook them very fast and for a very short period of time. In cooking them fast you seal that outer tunic around the muscle tissue so that the water that is in the muscles is not lost. You cook them for a very brief time and then stop. At that point the flesh is sufficiently cooked so that it is palatable and very good. If you cook it longer, what you have to do is cook it a lot longer, another 30 minutes or so. Break down the muscle tissue and serve it that way. The University of California and the National Marine Fisheries Service at Gloucester have each produced cookbooks with a whole range of Greek, Italian, Portuguese, Spanish recipes and they all stress this type of cooking.

Q. A species of *Loligo* that occurs off California, has been known to occur in very, very dense concentrations, particularly when they spawn. If this is a characteristic of that genus of squid, it might be well to see if we could find out where and when these things spawn and we could harvest them at that time, because they are very densely concentrated.

A. We don't believe now that the species of *Loligo* in the Gulf form these extremely dense spawning populations. They probably do form groups. They seem to be associated around uneven bottom. We for example will go out in the area off Galveston, an area that we call the Finger. It is irregular and very different from the very flat mud bottom that surrounds it. It seems to be the best place for us to capture this one species *Loligo pealei* and we assume that it has something to do with the attachment of eggs to that particular hard surface.

Q. Two winters ago we had a shrimp fisherman visit us at the Pascagoula Laboratory, who was fishing deep water royal red shrimp off Tortugas. He was unsuccessful catching up with concentrations of deep water shrimp, so he kept on fishing to the north, somewhere between Tortugas and Fort Meyers in about 150 or 200 fathoms of water. He was running into concentrations of large squid with rather high catches and he came up to us and asked if there was a market for these squid at that time. No market was identified for them. Could you comment?

A. I've heard of several fishermen who have experienced the same kind of thing off the Mississippi River Delta and royal red fishermen shrimping somewhere between 100 and 300 fathoms. Also, I have gotten reports from divers working on very deep offshore rigs in 300 feet of water, talking about clouds of squid obscuring their view, just seeing squid everywhere.

A lot of people have noted that if you stop at night in the middle of the Gulf of Mexico and turn on a light you are going to see some squid almost all of the time, and indeed when we do this we almost always see some squid. But we are talking about fairly small numbers, never, do we see more than 100 animals at one time. Of these, we only catch a very small number. Turning these observations into a fishery, I think, will be a big job. There will have to be some other breakthrough involved.

LEGAL ASPECTS OF POTENTIAL FISHERY RESOURCES OF THE NORTHERN GULF

by
MICHAEL WASCOM

LOUISIANA STATE UNIVERSITY SEA GRANT LEGAL PROGRAM

We (the L.S.U. Sea Grant Legal Program) have been studying the legal aspects of developing a fish export industry in those underutilized species of fish found in the Gulf off the Louisiana coast for which export potential has been shown. As a part of this effort, we have been reviewing U.S. government programs that offer incentives to those seeking to engage in such exporting. One such program is the Export-Import Bank, generally known as Eximbank, which provides financing for U.S. exports. Eximbank programs that can assist U.S. fish exporters include cooperation with banks in the U.S. and overseas to help U.S. exporters offer credit to their foreign buyers and the provisions of insurance to U.S. exporters, through the Foreign Credit Insurance Association, that allows them to offer competitive credit terms to their customers and be protected against the risk of payment defaults. This government sponsored association of 50 insurance companies in the United States will also provide the exporter with political risk insurance at a reasonable cost against civil war, acts of nature and acts of God.

A program that could be of potential use to those interested in getting involved in fish exporting is an experimental export credit program being offered by the Small Business Administration (SBA). SBA will allow eligible U.S. companies to borrow up to $500,000 for current expenses, including purchases of supplies, inventories, materials, and working capital needed for manufacturing or wholesaling product for sale overseas. The pilot program is being tested through selected banks in California, Texas, Illinois, and New York. If successful, it will be expanded nationwide.

Two other potential developments at the Federal level could aid in the development of a fish export industry in underutilized species of the Gulf. Both involve the Fishing Vessel Obligation Guarantee (FVOG) and Capital Construction Fund (CCF) programs of the National Marine Fisheries Service. NMFS is currently considering amending its eligibility regulations for the FVOG and CCF programs to make them available for fish vessels operating in underutilized species even though they also operate in what NMFS calls "conditional fisheries", i.e., those fisheries in which NMFS feels too many vessels are operating and would not normally qualify for these programs. Also, legislation that would provide incentives to the U.S. fishing industry to catch and process the underutilized species off our coasts, including extending the coverage of these two programs to shoreside fish processing facilities and refrigeration plants, is currently receiving a good deal of attention on Capitol Hill.

Tax incentives also are available for companies engaged in exporting. The Domestic International Sale Corporation (DISC) is a provision of the Internal Revenue code that allows an exporting company to defer tax on 50 per cent of its income resulting from exports. In this procedure the company involved in exporting sets up a dummy corporation (a DISC) and channels all assets and expenditures from exporting activities through the DISC. The money in the DISC must be reinvested in the company's own export operations or the export operations of another company in the same industry.

EXPORT SALES TRANSACTION

The proper quotation of a price is very important in export sales transactions, including

fish export sales. The two most common ways in which prices are quoted in export sales transactions are F.O.B. and C.I.F. In addition to stating a price, these terms also specify the respective obligations of the buyer and seller.

F.O.B. means "free on board". In export transactions, although the F.O.B. price can be quoted in several ways, it is usually quoted F.O.B. vessel (named port of shipment). Since we are normally talking about shipment by ocean-going vessels in export transactions, the seller's obligation is to deliver the product onboard a vessel at the named port and to obtain the required customers clearance from the country of export, and essentially, this quotation tells the buyer that the price does not include freight costs to the destination point nor the cost of marine insurance. The buyer has to obtain marine insurance to cover the shipment and pay the ocean freight charges to the port of destination.

A C.I.F. (cost, insurance, freight) price is quoted as C.I.F. (named port of destination). Under this quotation, the seller must load the product on board the vessel, provide and pay for transportation of the product to the named port of shipment and provide and pay for marine insurance. The C.I.F. quotation is the one used most often in export sales transaction, including those involving fish.

From the exporter-seller's point of view, the most attractive way to be paid for his product is by cash in advance. In export transactions, however this is not usually a feasible method of payment. The method of payment that is quite often used in export transactions is payment against a letter of credit. In this payment procedure, the buyer has his bank issue a letter of credit in favor of the seller by means of which the bank agrees to pay the price agreed upon in the export transaction to the seller when the bank has received certain documents (usually an ocean bill of lading, an insurance, and required invoices) from the seller within a specified time. From a U.S. seller's point of view, it is advantageous to have the buyer open an irrevocable letter of credit, in his behalf confirmed through a U.S. bank. An irrevocable letter of credit that once the seller has accepted the letter of credit, the buyer can't change its terms without the seller's permission. Having the letter of credit confirmed through a U.S. bank means that the U.S. bank adds its obligation to pay you to those of the bank issuing the letter of credit and the buyer. This gives the seller added protection and allows him to be paid as soon as he presents the required documents to the U.S. bank.

Information concerning the vagaries of export financing, shipping products overseas, insuring the products, and potential markets can be obtained from your local banker, from an insurance broker, a foreign freight forwarder located in the major port nearest you (for many export sales transactions including those involving fish freight forwarders are invaluable), your state trade development office, NMFS, the nearest district office of the U.S. Department of Commerce, and the Gulf and South Atlantic Fisheries Foundation.

I'd like to make a couple of final observations. Developing an export industry to take advantage of the potential markets overseas for underutilized species found in the Gulf is not the kind of undertaking that a small company is likely to be excited about attempting alone but might consider in combination with other companies. Collective action by a number of companies to develop and take advantage of such markets might normally raise antitrust questions, but the federal Webb-Pomerane Act allows companies in an industry to form an export association to represent members in export trade matters, and exempts such associations and agreements made or acts performed in the course of export trade by such association from the U.S. antitrust laws.

Last year's multinational trade negotiations produced several codes of conduct concerning non-tariff barriers to trade such as import licensing restrictions, quality controls, quotas and subsidies given exporters of a foreign country which allows them to sell at a discount here. The potential effects of these codes and the United States government's commitment in bilateral trade negotiations with some of our trading partners to obtaining a reduction of quotas on U.S. fish imported into these countries are matters that should be

of intense interest to anyone interested in the export of underutilized species from the U.S.

QUESTIONS FROM THE AUDIENCE

Michael Wascom

Q. Gene Raffield: In setting up a group with the common cause of exporting, what are suggestions on how not to get into a price fixing situation, how can you know that you can export, and what agency can supply such information?

A. Although the Act does provide an exemption for such a group from the antitrust laws, it does put restrictions on the activities of such association, such as a prohibition on interference with trade within the United States. The Act has been so restrictively interpreted by the courts and agencies such that an export association cannot be absolutely certain which of its activities would be exempt from the Antitrust laws. The Webb-Pomerane Act is administered by the Federal Trade Commission so a group should contact them, but you could also get advice from the International Trade Administration in the U.S. Department of Commerce or the regional Commerce office nearest you, and perhaps, NMFS. Legislation is being considered in Congress that would help clarify what activities of a Webb-Pomerane Association would be exempt from the antitrust laws, including a preclearance procedure for approval or disapproval of the association's activities. The legislation would also facilitate the formation of U.S. export trading companies and provide the same type of preclearance procedures for their activities.

MARKETING

by
E. MORET SMITH

NATIONAL MARINE FISHERIES SERVICE
PASCAGOULA, MISSISSIPPI

A 20-year involvement with the domestic market pointed to the futility of trying to sell surplus fish to Americans who consume only 12 pounds (edible weight) of fish per capita. As a result in 1970 National Marine Fisheries Service - South East Region decided to explore foreign markets. Our first experience was exporting Louisiana crayfish for the first time to Sweden and France in 1957. It was a well known fact that people in other parts of the world appreciated fish and of these the people of the Far East were the leaders. The 80 pounds (edible weight) per capita of consumption for the Japanese was impressive, so this was the market we studied. We found that if a dealer could satisfy demands of the Oriental market, he could measure up in any other market. There are specific guidelines for successful marketing in the Far East.

First, a dealer must know his customer. Cultures are different; ways of preparing and eating food are totally different from ours; and an exporter will not make a sale until he understands these differences. Orientals, for example, are not interested in whole mullet but only in the roe, the caviar of Japan. It is made into karasumi, a product that looks and tastes something like American cheddar cheese. Karasumi is priced up to $45 a pound during Oriental holidays.

A U.S. dealer looking at the 80 pounds per capita consumption figure might think Orientals eat large portions of fish. Actually, they serve small amounts but eat it often. For that reason they want 100, 150 and 200 gram (1 lb. = 454 grams) portions. In packing fish sizes should not be mixed, each restaurant will buy one size; the elite restaurants serving slightly larger portions. The Orientals are not toned to large servings which explains why 3/4 and larger servings of a product are never seen.

Orientals have deep concern about the fat content of a fish. We are often asked, "What season of the year does this species have the fat?" It is important to be able to supply that information because they may want that particular fish only during the fat season. They will probably pay more for it during that season.

Another cultural characteristic emerges in business transactions. The Japanese do not make snap judgments. They will consider a proposed purchase and after six months or a year the exporter will hear from them that their studies are completed. This means a U.S. producer must practice patience with the Japanese. In contrast, the Taiwanese will see a product, say "I like it, how much is it, I will buy it/will not buy it."

We must eliminate the words trash fish from our vocabulary. In the international world of business there is no such thing as a trash fish, unutilized or underutilized fish. Who wants to buy someone's trash? We use the word surplus. American fishermen have a surplus of a fish in the Gulf, and somewhere there is a market for it.

Exporting fish to foreign markets is selling on a seller's market. But with foreign demand as great as it is, if United States fishermen do not catch the fish to sell to foreign nations someone else will. Foreign fishing interests can get permits to come within the Fishery Conservation Zone and fish for products United States fishermen refuse to produce or completely utilize. Should this occur there will be a foreign fishing fleet off our coast and there is little American fishermen can do about it. Exporting is a way to solve present and future problems the U.S. commercial fishing industry has and time to accomplish this is running out. The situation on diesel fuel and inevitable belt tightening is going to force

such a change.

Exporting can increase a company's sales volume without the usual problems associated with expansion, without adding more vessels and fishermen. Sales will increase by just using present production and improving technology.

Most shrimp boats could bring in a myriad of other fishes that would fit into an export market. This is an ideal situation as no changes are necessary. As the product comes across the line, the various items can be separated.

Successful exporting requires access to the resource and imagination. There are numerous instances of opportunities to land products while pursuing others. A commercial fisherman might see skipjack or cravelle, but they are passed up. Usually it was because of the need of a market. In the export business, however, there is a place for almost everything that can be produced. Sea cucumbers, urchins and jelly-fish are an example. There is no known market for these in the U.S. In Japan these products are a regular fare. As to where you can sell a particular fish, see my book *Handbook for Exporting Seafoods to the Orient*.

Technology is another prime factor in exporting. The Japanese knowledge of fish is very sophisticated with freshness uppermost in everyone's mind. The epitome of good eating is serving a live carp, killing it right before the diner and eating it raw-sashimi. Needless to say, that would be the ultimate in freshness, and fresh is where the big money is in Japan. A live fish commands top dollar.

Right below that are fish in rigor. This means if someone picks a fish up by the tail, it will stand up like a board. That same fish in rigor and frozen on board ship is the next degree of quality and still demands a high dollar. The American probably questions why so much emphasis on so little difference but to the Japanese it is great. The drop in price for fish frozen ashore is even greater. There is a market for fish sold below these three conditions, but the price is even lower and hardly worth an exporter's consideration. That is why a key word to the Oriental market is quality.

Quantity is also an element of exporting requiring considerable reserve collateral. Orders are for tons or containers of products, not pounds. A container is 38,500 pounds, and exporters usually talk about four, five or six containers. While this would baffle a small fisherman, collectively it should not. There is a place for the small company in international trade. A knowledge on how to transport the product to the market plays an important role and it is here that the services of a freight forwarder must be employed. He can expedite a shipment from the point of production to its destination.

Another necessity is attention to regulations by foreign governments. Packaging and markings are very explicit and regulations are subject to change. It is difficult to keep up with them, and it is best to pin the buyer down on what kind of marks he wants on the cartons, etc. If the marks are not correct, chances are good the product will be detained upon arrival in a foreign country.

Trace metal contamination seems of no concern to the Japanese. They shrug off the issue of heavy metal contamination.

Contracts constitute a sensitive area. Unfortunately fish are not like nuts and bolts or television sets that can be counted on a daily basis, and most U.S. producers will not agree to signed contracts for a specific amount. The Japanese will, however, accept a verbal agreement that a producer will work toward getting a specified quantity.

U.S.D.C. Inspection is protection for the buyer and seller. Most shipments to Japan and Taiwan require inspection of one kind or another. An export certificate issued by the National Marine Fisheries Service is good insurance that problems will be avoided. An inspection on a container will run from $300 to $500. In this case a quotation will include approximately a cent more per pound for the fish. The seller includes the inspection fee in the price he quotes.

The possibility of an embargo or change in quote is the reason a seller should never

sacrifice a domestic market for a foreign market. In Japan, for example, a foreign seller cannot ship cod-like, herring-like or mackerel-like fishes and other fish could be added to the list. Dealers must also understand the significance of a product entering a country under a quota. An example is king mackerel, which the Japanese call Spanish mackerel. Large quantities are currently flown in fresh from Korea under a quota. Japanese importers try to establish a monopoly by getting a large share of the quota and by doing so, can control the market.

The preferred procedure at this time is for a U.S. producer to deliver a shipment to a bonded cold storage warehouse in the United States. This is accomplished by selling to a foreign company that has an office in this country. The producer collects at the time of delivery. Beyond this, U.S. sellers prefer quoting an FOB (free on board) or FAS (free alongside ship) quotation for delivery to a specified point. This procedure differs with most transactions in international trade which usually requires a C.I.F. (Cost Insurance Freight) price. These terms are new to most producers, in fact international trade has a vocabulary of its own. Much of the difference in vocabulary is outlined in our glossary of international selling. For additional helpful information on letters of credit, ways of providing quotations, etc., see our booklets listed below.

Shipping by air freight is worth examination. If a dealer can get a product to Japan super fresh, the return will justify the effort. There is a Pan Am air freight liner, for example, that leaves Houston, Texas, each Wednesday at midnight and 19 hours later lands in Tokyo. With good air freight connections and packing there is no reason why live crabs can not be shipped overseas. Fresh fish can be shipped with excellent results in ice in styrofoam containers. Needless to say ice should be held to a minimum. There are times when demand and value of a product would warrant chartering a plane.

QUESTIONS FROM THE AUDIENCE

E. MORET SMITH

Q. What was the problem with mullet that you mentioned?

A. The U.S. mullet industry was becoming an old man's industry. When older fishermen died, youngsters did not step into their place. Catches were limited; the market was weak; it was inevitable that the industry would die. When the United States became involved with exporting mullet, catch restrictions were removed and the industry prospered. The Far East market is not as good for selling mullet as some countries. The Japanese and Taiwanese want roe and have no use for the carcasses of the fish which is ground as food for eels.

Q. Do you mean that they do not like the flavor?

A. No, mullet has a stigma. Japanese mullet are infested with worms. I suppose the Japanese automatically think mullet from the United States also have objectionable worms.

Q. The problem in reference to the mullet brings up what can be done with mullet carcasses?

A. Crab bait. We have tried to introduce mullet carcasses to the school lunch program in Japan. They are in desperate need of an economical fish for the school lunch program which serves fish everyday. A 40,000 pound sample shipment of carcasses intended for this use wound up in southern Japan as eel food.

Q. How about canning the mullet here and exporting it canned?

A. We have fought that battle before. The economics of canning mullet is not especially good. If you pay 20 to 25 cents per pound for mullet and consider the amount of lost weight, consumer cost is suddenly quite high. It is not as high as salmon, but does not have the prestige either.

Gene Raffield (from the audience): Last year 95 to 100 per cent of mullet carcasses left from the extraction of roe for the primary Japanese-Taiwan market was used for crab bait. In the 1979-80 mullet roe season, I have had only five per cent go into crab bait. By taking the roe from the soft part of the fish instead of the back and freezing the fish back together whole, we have had a market; and that took a lot of pressure off. This fish still has tons of potential. At one time we were going into canned fish because we were not looking at a 20 to 25 cent cost. We would love to get rid of the fish fresh at about 10 to 12 cents.

Q. How about the market in Taiwan or China for mullet? The Chinese who live in Hawaii steam mullet, and it is expensive there.

A. You are right. Hawaiians are having mullet flown in from New Zealand. In the last year or two, we have also flown fresh mullet to Hawaii from Tampa, Florida. But in the Orient duty on mullet is high. The Taiwanese have a shrewd way of discouraging their people from eating mullet roe. They impose a 100 per cent tariff on the product. If the product is processed and shipped to Japan, they get refunded 85 per cent of the tariff.

Q. In your export handbook you mention grey trout but not our Gulf of Mexico white trout.

A. It would be the same category. I could not stimulate interest in grey or white trout in the Far East. Now they are culturing rainbow trout using American methods, but I have never seen a trout in the Tokyo market in the many times I have been there.

Q. What are they paying for surimi (minced fish) over there now?

A. The last I heard was $1 for pollock surimi. The Cadillac of the surimis is croaker. But in negotiations the Japanese try to discredit this by saying that the price of pollock surimi is $1 and they do not want to talk about a different price for croaker surimi. They add a little croaker to pollock to make the pollock better, yet they still want to discuss croaker surimi in the same price range as pollock.

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MONEY AND FOREIGN TRADE

by
Peter Kenyon

Senior Vice President
Merchants National Bank of Mobile
Mobile, Alabama

The major objective of the National Fisheries Development Program is to enhance the export of seafood products not used in this country. The move into exporting has been described as a new era for the seafood industry. This country has been domestically preoccupied for centuries, self-sufficient with only minor exceptions. The circumstances have changed significantly, however.

Last year the United States ran a deficit on the trade account of approximately $25 billion. In January of 1980 the deficit was $4.76 billion. That is an annualized rate of $57.12 billion. These figures mean that there are more dollars overseas. When there is an abundance of dollars there, the value of those dollars decreases, and the prices we pay for imported goods increase. Familiar examples - Toyotas, Volkswagens, Fiats and Datsuns, pocket calculators, radios, televisions, etc. We now export 100 per cent of our chrome and tin; 90 per cent of our cobalt, manganese, nickle and platinum; 80 per cent of our asbestos, bauxite and aluminum; 66 per cent of our potash; and close to 50 per cent of our oil. We can no longer be domestically preoccupied. We must significantly increase our exports. The only thing we have exported in the last 10 years of any consequence has been our standard of living!

Numerous services are available from international banks to assist in the exporting process. We can help to establish relationships with suitable sales agents abroad; develop credit information on individual buyers; collect export drafts and finance export drafts so that an exporter can receive payment sooner. We can process and verify documents presented under export letters of credit, issue letters of introduction to correspondent banks if an exporter wishes to travel overseas to meet with potential buyers or agents. We can handle the purchase or sale of foreign currency and issue drafts denominated in every currency in the world. We issue a traveler's package with appropriate foreign currency, travelers checks and terms of foreign language. Most international departments now carry a bilingual and in some cases trilingual staff. We also have good entree to consular corps officials.

Most international banking facilities are located in major seaport areas - New Orleans, Houston, Mobile, Tampa and on around the coast. In the last decade there has been a move inland in recognition that international activities are not necessarily restricted to the movement of goods. Places such as Birmingham, Atlanta and Denver now have sophisticated international departments concentrating on offshore financing, syndicate loans, and third country financing. Principal action for Gulf Coast international departments, however, is trade financing, the financing of imports and exports.

Each department works closely with the Export-Import (EX-IM) Bank of the United States. This bank offers unique services to exporters directly or indirectly through the international department of a bank. EX-IM Bank will discount the exporter's paper through the bank or will extend bank guarantees covering the handling of that paper. EX-IM Bank recognizes that central banks and related type institutions in other countries have taken a strong role in behalf of their exporting communities. The United States exporting community has not had this assistance in the past, but there are some fine programs through EX-IM Bank now to help exporters be competitive in the international market.

The Foreign Credit Insurance Association (FCIA), an affiliate of the EX-IM Bank, is made up of 50 commercial insurance houses, and provides a process to take the risk out of exporting. For a nominal premium based on particular countries, commodities, etc., the exporter can be insured against 100 per cent of the sovereign risk. Such risk is involved when the local importer pays in local currency but payment does not come through due to action of that government, unavailability of dollar exchange, etc. FCIA will insure the exporter up to 90 and sometimes 95 per cent on commercial risk - a loss resulting from the inability of the buyer to pay.

A technique for establishing an overseas relationship that has been effective for us is to bring the potential exporter and overseas sales agent into contact. We contact a bank overseas with information on the exporter, the product he has available, the quantity and an indication of prices based on specified types of quotations. The correspondent bank's representative searches his file for agents active in that exporter's particular field, makes contact, asks if they are soliciting additional representatives. If they are, he supplies us with names of individuals or firms, biographical data and financial information. The information is relayed to the exporter for analysis and consultation with the bank. When things are in order, the exporter can decide to deal with the individual sales agent by mail, go to that country and deal in person or get that individual over here or a combination of both. These relationships work extremely well in the lumber business, and the possibility for the fisheries industry is excellent. Benefits are that a man is on the spot to inspect merchandise when it arrives and handle any problems. With knowledge of the marketplace, he is in a position to talk to local bankers if problems arise and to negotiate for the exporter.

Development of credit information on individual buyers is a step in the process that should precede any agreement or contract an exporter enters in to. This service is offered free of change at most institutions. Most of the people are highly reputable, but that needs to be verified. Working through a correspondent bank relationship, we can establish a buyer's standing in the community, his financial strength, his expertise, his management depth, etc. Through Dunn and Bradstreet International we get outside agency reports that are good but not as timely because of logistical problems involved. They do, however, add to the composite picture that seldom falls to point out any weaknesses that might exist in the transaction.

When the export transaction has been put together, the exporter presents bills of lading, commercial invoices, U.S. or customs invoices of the country of import and other required documents to his local bank with the request that the bank review them to insure that they conform with shipments into that country and to effect payment for the exporter. Terms of payment have been agreed on earlier. If the terms are documents against payment, for example, the exporter's bank would present that documentary collection to the overseas bank with instructions that the title documents be released to the buyer only against payment. Upon payment the bank is to convert into U.S. dollars and either credit the New York account of the exporter's bank or remit a U.S. dollar check directly to the exporter's bank according to prior arrangements. Another aspect of documentary collection is that the bank will, in effect, buy the title documents to the shipment and give the exporter immediate credit with a prearranged interest rate. When the bank gets payment, it will compute the number days the collection has been outstanding and charge the applicable rate plus normal fees.

A letter of introduction to correspondent banks is helpful if an exporter wishes to make a selling trip abroad. He carries the original with him and copies are sent ahead to tell the bank something about him, about our credit knowledge of him, the reason for the trip and even extending check cashing facilities. The letter might specify that the dealer would like to meet sales agents or direct importers. The exporter should give his bank three months planning time prior to the trip to account for mails and give opportunity for the overseas

bank to review the letter and establish contacts on his behalf.

Major international banks can handle any currency that United States banks are permitted to handle. Foreign currency travelers checks can be helpful. We recommend U.S. dollar travelers checks along with Tip-Packs to get you into the local community where you can exchange travelers checks at one of the local bank's main offices. Tip-Packs are packages that contain the equivalent of 20 dollars in the currency of the country you plan to visit. It also includes a data sheet showing the various currencies, what the equivalent value are, tipping procedures of that country and how much to tip taxi drivers, hotel porters, etc.

The letter of credit is a vehicle to accomplish payment in international trade. A key word to watch for is "irrevocable", which means that the commitment cannot be altered without an official amendment. An exporter does not want to accept a revocable letter of credit because the buyer can revoke the letter at any time. The first step when an exporter receives a letter of credit is to review it and be sure it confirms the agreement that he has with the buyer. He must make sure every detail is there, because the exporter is dealing only in documents and if the documents call for the wrong circumstance he has lost recourse. Although we have stressed weaknesses, the letter of credit is also an extremely good and strong document for the exporter if negotiations were correct initially, communicated to the foreign bank correctly and the letter of credit drawn correctly. A good freight forwarder can save time and money getting consular invoices, certificates of origin and other documents involved in the letter of credit.

We recognize that letters of credit are unique and have no basis in legality. They are not a contract. The International Chamber of Commerce (ICC) Uniform customs and Practice for Documentary Credits, Publication #290 is the bible that controls international bankers' actions under letters of credit for the exporter's account. Become familiar with this document to insure negotiations and agreements with buyers in order and in accord with covenants under which banks handle letters of credit.

Before undertaking exporting, the exporter should talk with his banker at length, negotiate with the freight forwarder, talk with the U.S. Department of Commerce representative, the local Chamber of Commerce and people within the industry. The rewards are handsome; but hard work and much time and money are part of the commitment. At least two years will be required to really get moving. If the exporter does the research, service organizations are ready to help.

For an explanation of terms and for clarification for just where in the physical movement of goods these terms apply, see publication (1) below. Another source of information is UNZ and Company, (2) below. This company does a fine job in preparation of export documentation and puts out an excellent brochure that shows an example of each type export form that is used and some explanation. Certificates or origin, bills of lading, insurance certificates, dock receipts, consular invoices, shippers export declarations, all these buzz words will be clarified if the dealer spends time with these documents.

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FREIGHT FORWARDING AS AN ASSET TO MARKETING FISH

by
C. Martin Taylor

C. Martin Taylor & Co.
Freight Forwarders
Jacksonville, Florida

We are in a world market situation today. As the United States dollar drops, consumers in other industrialized countries can compete for the same products we buy. Our standard of living is not dropping so much as theirs is rising. That dollar drop has special significance for the fish exporter. He can now price his product into places overseas that he could not a few years ago. Twelve cents a pound in today's dollar is actually cheaper in some instances than it was several years ago. Another plus is that the American product represents quality, an abundance of freezer space to keep a product fresh, a good product.

Another factor is that more people and industry are moving into the sunbelt area as the energy situation continues. Steamship lines which favor the northeastern United States are going to start calling South Atlantic and Gulf ports more. As service increases, freight rates to move products from Gulf ports will probably drop.

The freight forwarder can do a number of things for the exporter. First, he is a source of export shipping information that is updated on a daily basis. If an exporter does not get a 100 per cent correct answer to questions on anything from soup to nuts, then that exporter should seek another freight forwarder. In the past we followed our own advice to use a forwarder in the port from which a dealer is making the export. We often received such poor documentation back that we do not say that any more. Now we recommend using a forwarder in the port of export if the exporter is careful that the forwarder is one who is going to pay attention to what the letter of credit says and is going to get the documents back in shape so that the exporter can cash his letter of credit. Nothing substitutes for the exporter knowing what he is doing. He should know precisely what is going on with his documents. Then he is in a position to protect himself in the transaction when talking with the overseas buyer.

The freight forwarder should be an expert on overseas documentation. Many foreign countries require specific things to be done in specific ways. If regulations are not met to the letter, a customs tie-up could result. With refrigerated products the ship has the option of putting them on the pier and letting them warm up during the customs fight, putting them in public storage which is always costly, or bringing them back with shipping costs charged to the exporter. The forwarder can give advice about necessary documentation but it is best to get a list of requirements from the buyer. If an exporter's banker or forwarder, however, says a certificate of origin is needed to get the product into a particular country and the buyer has not asked for one, provide a certificate of origin. If the buyer suddenly finds he needs one, he has it.

The freight forwarder acts only in behalf of his client, the exporter. He helps arrange and coordinate trucking, locate ships, points out good and bad ports. For example, Jacksonville, where our main offices are, is not a good place to export frozen products. The forwarder can book space and compute space needed. He can give advice on the letter of credit and the terminology that is essential to negotiating transactions. We have had calls to explain the difference between FAS (Free Along Side) and FOB (Free On Board). FOB, in our terminology, means on board the vessel. FAS is at a point of rest below the ship's tackle, literally where the ship's tackle can come down and pick up the product and put it on board. If someone is considering FAS as warehouse and FOB as the pier, negotiations

break down because there is no agreement of terms. The freight forwarder can also find hidden charges in wharfage, handling, trucking, pending freight increases or pending bunker fuel surcharge increases.

The freight forwarder can arrange for marine insurance. We usually do not do that and recommend that the exporter have the carrier of his business insurance issue a marine insurance policy on the shipment. If he shops among three different reputable companies he usually will find a cost variation that can save him money. If a shipment is of sufficient size, a forwarder can arrange charters, an area for extreme care because it is strictly a verbal agreement by telephone.

There are things the forwarder cannot do. He cannot split forwarding fees or freight brokerage. These are the ways he gets paid. It is not legal for him to rebate any of this fee, and he would lose his license if convicted of doing so. Your forwarder cannot divulge what your competition is doing. Neither can he divulge your business affairs to anyone else. He cannot make a sale for the exporter. Occasionally, if there is no conflict of interest, we will put together a buyer and a seller of a product; but we do not take a finders' fee or a sales commission for doing so. If you freight forwarder does take finders' fees or commissions, he may be moving into a conflict of interest and you should be careful.

Freight forwarders learn by experience. There are a few seminars on freight forwarding but no schools. The UNZ Catalog (listed below), although a sales catalog, is helpful with examples of forms used in exporting. The best method of choosing a freight forwarder is to find one you can trust, are comfortable with, can talk with and have confidence in his expertise. Talk to him early in the exporting process - when you get a sales lead or an offer from overseas. The forwarder can point out problem areas to watch for before you get to the point of having the accumulated product ready to ship.

Beware of impossible shipping requirements and letters of credit with ringers written into them specifically to foul the documentation process so that the exporter cannot get paid. In the letter of credit situation, the dealer must have all the "i's" dotted and the "t's" crossed. If there is a local banker he can deal with, he can straighten out minor errors in documentation that could cause major delays if the exporter mailed the documents into a New York bank. Be aware that an exporter's money may be routed through a Miami division then to New York, for example. Make sure you know how your money is going to come to you to avoid such delays.

Refrigerated products pose additional problems. Coordinated trucking or alongside cold storage are necessary to insure fast, safe handling. Strong cartons are necessary that fit the product with minimum wasted space. Buying conditions - what people want - are also integral to packaging decisions. Hazards of refrigeration equipment malfunctioning on board ship can be minimized by using a ship with known, good refrigeration machinery or the ship itself certified or insured by American Bureau of Shipping, the Lloyds Registry or other certifying organizations.

The cost of getting your product to the foreign market is another way an effective freight forwarder can help. The frequency of ships, how many ships are going to a particular place, how full they are, and if they are going out empty, affect the price. An exporter should know what he can afford to pay for ocean freight before he pursues a deal, or he may price down into a no-profit situation. The bigger the shipment, the better, as far as pricing. Pricing moves for small 20 ton movements, for example, are rare except in cases of sustained move such as 20 tons a week over the next year. Large tonnages into the 400-500 ton categories often get a better freight rate. At 13,000 tons and up the exporter can obtain charter vessels and save a fortune.

The exporter does not have to take the steamship line's first offer. The lines can take independent action on rates if they are forced to or if business looks attractive enough to them. If the freight rates run over 20 per cent of the product's price, question it. Usually 15 per cent is not bad and 10 per cent is acceptable.

In all dealing stay away from absolutes, requirements of proof such as "no trace of mercury" or "proof that the product was frozen within 12 hours of catch and has been maintained to 0 degrees ever since." If such requirements worded "always", "never" or "none" come in a letter of credit, send back a notification that you cannot accept that. The words "approximately" or "about" are acceptable. The exporter should always maintain control of the product until he can collect his own money in this country, by his own efforts. The product can sail, but he should make sure the letter of credit is issued in his name and that he knows what he has to perform, how he has to perform it and the time frame involved.

QUESTIONS FROM THE AUDIENCE

C. Martin Taylor

Q. Do freight forwarders handle both air and surface shipments?

A. Forwarders can handle air but international airline rates tend to be predicated out of Miami and New York if you are going east, and it is difficult to price products unless somebody does a specific thing for you. We handle some air freight out of Jacksonville. Another thing to watch for - airlines will accept dry ice but they loathe it. It is CO^2, expands faster and can cause things to blow up. A product called blue ice, nitrogen, is more acceptable to the airlines.

Q. What is a maximum size shipment for air? Where would the break even point be?

A. The maximum would probably be 250 to 300 thousand pounds if you wanted to get your own airplane. The break even point is individualized as to location of seller and market and product price. Air freight is more conducive to high value items such as electronics and clothing.

Q. What is the smallest shipment needed to charter a ship with refrigeration?

A. There is a range of ships that can handle 1,000 to 1,300 tons of frozen fish. After that the vessels go to a larger size and the charter operator seeks to fill his whole vessel.

Q. Could you go into the mini-land bridge?

A. The mini-land bridge is a movement that incorporates either rail or trucking and the steamship line. The steamship line assumes liability for the entire movement and pays the railroad as a method for developing greater volumes of freight. But it is risky in shipping refrigerated products by use of the mini-land bridge. Most of the time the steamship line will not take such products because the railroad will not take any responsibility for equipment.

Q. Are forwarders bonded?

A. A performance bond is on file with the Federal Maritime Commission. If your forwarder doesn't fulfill his obligation you can go against the performance bond.

Q. Is it preferable to ship frozen foods in a container or in the hold if you have enough to fill the hold?

A. There is probably more container space available, and containers are generally safer for your product. Quantity is a factor. At 500 tons bulk shipping is better. At 20, 40 or 100 tons, containers are better because container refrigeration units are servicable on the spot; the containers are insulated; and you have the advantages of eliminating one handling charge at the pier.

Q. Is there a list available of schedules for shipping by container or shipping by hold?

A. Brandon's and Shippers Digest, both out of New York, provide ship schedules; and Brandon's gives reefer capability. The freight forwarder is the best person to rely on because often the service is not publicized as coming into Mobile or New Orleans.

Q. Are there ports in the northern Gulf that are more capable of handling frozen food products?

A. If you get alongside cold storage you are usually better off doing it. Gulfport has alongside cold storage split in two with room for 1,000 tons in one warehouse and 4,000 tons in the other. The 1,000 ton storage is tied up all the time, but with the right contacts the 4,000 is a possibility.

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OVERVIEW — WHERE DO WE GO FROM HERE?

by
Gene Raffield

Raffield Fisheries
Port St. Joe, Florida

The value of a workshop such as this is evident in the experiences of our small fish company. We love the fishing industry; we go after it aggressively; and we have some of the best fishermen in the Gulf. We produce a lot of fish, around 15 million pounds of fish last year. We got into the export business in 1970-72, after meeting Ed Smith (National Marine Fisheries Service). At that time we were not working much over 30 to 40 per cent of the fishing season. Our methods of catching fish were antiquate compared with world standards, and when we had fish we couldn't sell them. We were basically dependent on a fresh - domestic market.

From 100 per cent fresh 12 years ago we have gone to 98 per cent frozen, 2 per cent fresh. Before, we were always at the mercy of the buyer when pricing our fish in the fresh market, because we didn't have a specialty item. The frozen aspect gave us a certain amount of control. Other changes have come about. Mullet, once almost unacceptable in the domestic market, is now viable. We pack fish in five-pound cartons that are sold in chain stores such as Winn-Dixie.

When we first talked about export, I didn't know the language at all. FOB, CIF, they were Greek. I paid the price; I bought a lot of education. I had no idea what a letter of credit was until I started to receive some, and they didn't work properly. I had a letter of credit opened one time for $257,000. We put the fish on the ship, and everything was fine. The check was issued to me and I deposited it. One day my secretary came in with checks from people who owed us. I thought she had a strange look on her face. There was a $257,000 check stamped PAYMENT STOPPED. My heart stopped beating. In a few seconds I was functioning again. I told her, "Fine. Put it down, and we will face that problem in the morning." I retreated to my original habitat and took my boat sportfishing for the day. A year later we are still trying to get all our money. There were a lot of problems created from misunderstanding, from not knowing. The people on the other end were not 100 per cent wrong. So many people become involved in a shipment of fish from here to Nigeria that you don't need to do anything in a hurry. You must catch all the details and bring in good people to advise you. Martin Taylor, representing the freight forwarder, does work for us; and I depend on him more than my local lawyer because he understands the terminology.

A simple thing Martin (Taylor) discovered is about the carton fish go into. The box acceptable in the United States is totally unacceptable in a country like Nigeria. There, for instance, they will unload a million pounds of fish in a day. Mostly women take three boxes and stack them on their shoulder above their head and walk out into the population and sell the fish - had to see it to believe it. They prefer a Russian box that fits the shoulder and is long with little handles at the ends. A woman can leave the ship with a good payload of about 44 pounds. The American pack - 23 inches wide, 4 inches deep and 20 inches long - cuts her efficiency by 1/3 because she can't balance it on her shoulders. Of course she prefers the Russian fish unless we make a change in the box. I have been hard to change. I said I was never going to the metric system. But, we have found out we are over here trying to dictate to people who are using our product, and we are wrong. If they want fish in wooden boxes with a red ribbon around them and they are willing to pay the price, I am going to sell them from now on.

We have a wide range of markets now. It's time we pull back as far as exploring new markets and learn how to take care of existing markets. The industry is dealing with

Nigeria, Egypt, Saudi Arabia, Kuwait, Taiwan, and Japan. Out of those there is a market for any kind of seafood I know of that can be produced in the Gulf or the South Atlantic. For high priced products don't go to Nigeria or Egypt but Taiwan, Japan, Germany or Holland. But I am interested in the fish that is considered surplus and are abundant and have few people catching them.

If a fisherman is only fishing two days a week and selling domestically and he can go fishing five days a week and sell all that he can, still meeting the needs of the domestic market, he should be smart enough to take those other days. Instead of staying at the dock he can fish at a lower price and compete on an international market. We have two prices - one for frozen export market, another for domestic sales. Sometimes they might be the same; other times there is quite a difference. Mackerel, king fish, mullet - all these fish that are produced in such quantities are migrant fish. You may have a lot of them today and none tomorrow. There are always going to be times when you have to tie your boats to the dock. The export market helps reduce that.

We have been having about a 10 to 15 per cent increase in sales for 15 years. We got into exporting and our sales jumped 90 per cent. Our fishermen were able to catch more fish instead of sitting at the dock.

Methods of catching fish are high and controversial. It is tough for me to deal with the sports fisherman who looks me square in the eye and says, "I hope you go out of business and starve to death, if you are going to go out and catch our fish." I don't hope he can't get gasoline to go out or that he starves, but I'm inclined to do battle. For me to exist, I have to be able to produce my product as best I possibly can. As a fisherman, a producer, I don't ever want to see any species jeopardized. We don't want to meet here a year from now and say, "They didn't control the sardine market and there are no more sardines."

I want my children's children to be in the sardine fishery or any other fishery. That is my reason for coming to these seminars, to bridge the scientific people with the commercial people and hope we can bring in the user groups at some point. I hope to see all fisheries under management some day with good statistics kept on all catches, recreational and commercial. If it takes not catching a fish for a year in order to keep that species out there for 100 years, so be it. But it must be done fairly. Don't have commercial fishermen tie up their boats for a year but tell other fishermen to go ahead and do whatever they want to.

Exporting has been good to us. We are sitting on orders for somewhere around 5 or 6 million pounds of mullet. Warehousing is a major problem with large shipments. For one shipment I had fish in five different warehouses. We had to find trucks that would pick up all that fish. We were told the ship would be in on Thursday. Then a phone call set it at Friday, then Monday. You have to coordinate 25 or 30 trucks. You call everybody and they are all agreeable to the delay the first time. The second time it is a little harder. The third time you get your secretary to call. Shipping large amounts of fish has an advantage in freight rates. Foreign buyers buy in such large quantities, it is hard to grasp. A 40,000 pound sale is good domestically. In foreign sales, all of a sudden you are dealing in a million pound shipment. We have plans in Port St. Joe now to build a seafood industrial park with a tremendous warehouse that will cater to fish and chicken.

In 1961 I quit fishing and started running the family business. If I really had my choice, I would be a fisherman. That is why I am interested in helping and promoting the industry. I do not see many people in the industry who look far down the road. Please don't look down on them for that. They work hard and can't afford days to come to meetings. If the fisherman acts like he doesn't care about your export program, don't think less of him. He doesn't understand. You people in government have to look at the broad view of what is good overall, and our industry certainly needs help. We are the most backward nation as to fishery knowledge, but we still have the best place to live in the world and fortunately a lot of resources.

QUESTIONS FROM THE AUDIENCE

Gene Raffield

Q. What about arrangements in foreign commerce where you cannot do business unless you establish a relationship with someone who takes a commission off everything that is done?

A. By law that is the way it is done in Egypt. There are a lot of things that happen in export that we don't like to talk about because we frown on them in the United States.

Q. How can you identify someone reliable to handle the product on the other end?

A. You have to feel him out. Ed (Smith) and I have a term, "a real one." "A real one" is one who can perform with dollars. If he can open that letter of credit in your bank and your bank tells you when you do certain things, it is your money, he is a real one and we go with him. If we have two real ones, we try to go with the one in the fish business because I am not interested in selling it just one time. We want a revolving sales type thing.

Q. We periodically hear rumbles that all the mullet, for example, are fished out in Florida, even when experts testify the resource is in good shape. How do you overcome such resistance to commercial fishing?

A. We have gone through two stages. When I would run into one of these hard nuts I would just tip my hat and slide off. The other day, however, I caught myself being too aggressive with a friend because some statements sounded just like some journalist asking negative questions about the fishery. My theory now is to try to educate people. If we are armed with the facts, I think we will win out in the long run. We need proper data. We need to know, and we need some kind of management program, state and federal, so we can go in and dehorn somebody. But if he is right, we should look at the situation and address it.

About eight years ago we went into Louisiana and laid all our cards on the table about how we wanted to catch mullet. We did that for four years with just two boats. Then three or four more boats and more people became involved. During that time a resistance to catching mullet arose for no other reason than they just don't want them caught, I guess. Certainly we are not catching all the mullet, and there is not a remote chance of a shortage.

Q. Would you touch on roe mullet and the Japanese market?

A. Normally I have contracts for any amount of roe that I could pack. Last year the season started with zero orders. Three weeks into the season, zero orders. The Japanese and Taiwanese had overbought in 1978 and were waiting to see if their mullet season produced enough fish so they wouldn't have to buy from us. They came out strongly the last three weeks of the season. We cleared out our mullet, but at 1978 rather than current prices. In 1979, mullet sold whole for as low as 48 cents alongside ship to 55 cents for two-pound and up mullet. Roe sold cut out, 4 ounces to 6 ounces, at $2.80 to $3.00. Six ounces and up sold for $3.15 to $3.25. We don't make the $45 a pound Ed (Smith) talks about.

Q. What in your experience is the ratio of male and females in catches of thousands of fish when they are full grown?

A. I can give you three illustrations. The roe mullet that are caught in Louisiana will be 75 per cent female. Females in Florida are larger fish and for Port St. Joe and Panama City the average would be 35 to 40 per cent females. In south Florida they fish basically only for bigger females with 4-3/4 gill nets during roe season.

Q. Where can I buy mullet roe in Miami?

A. East Coast Fisheries, America Seafood and several others should have it.

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