

**The COMMERCIAL FISHERIES  
of the  
GULF and SOUTH ATLANTIC REGION  
and THEIR NEEDS**

**Circular 181**



**UNITED STATES DEPARTMENT OF THE INTERIOR  
FISH AND WILDLIFE SERVICE  
BUREAU OF COMMERCIAL FISHERIES**



The Regional Office at St. Petersburg Beach occupies the 6th and 7th floors of the Don CeSar Federal Center, a former luxury hotel on the Gulf of Mexico. The building in the lower right corner is the Biological Field Station.

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The M/V Oregon, a 100-foot converted tuna clipper and first offshore research vessel of the Bureau of Commercial Fisheries in Region 2, has been engaged in exploratory fishing and gear development activities since mid-1960.

UNITED STATES DEPARTMENT OF THE INTERIOR

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Region 2

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Washington, D.C.  
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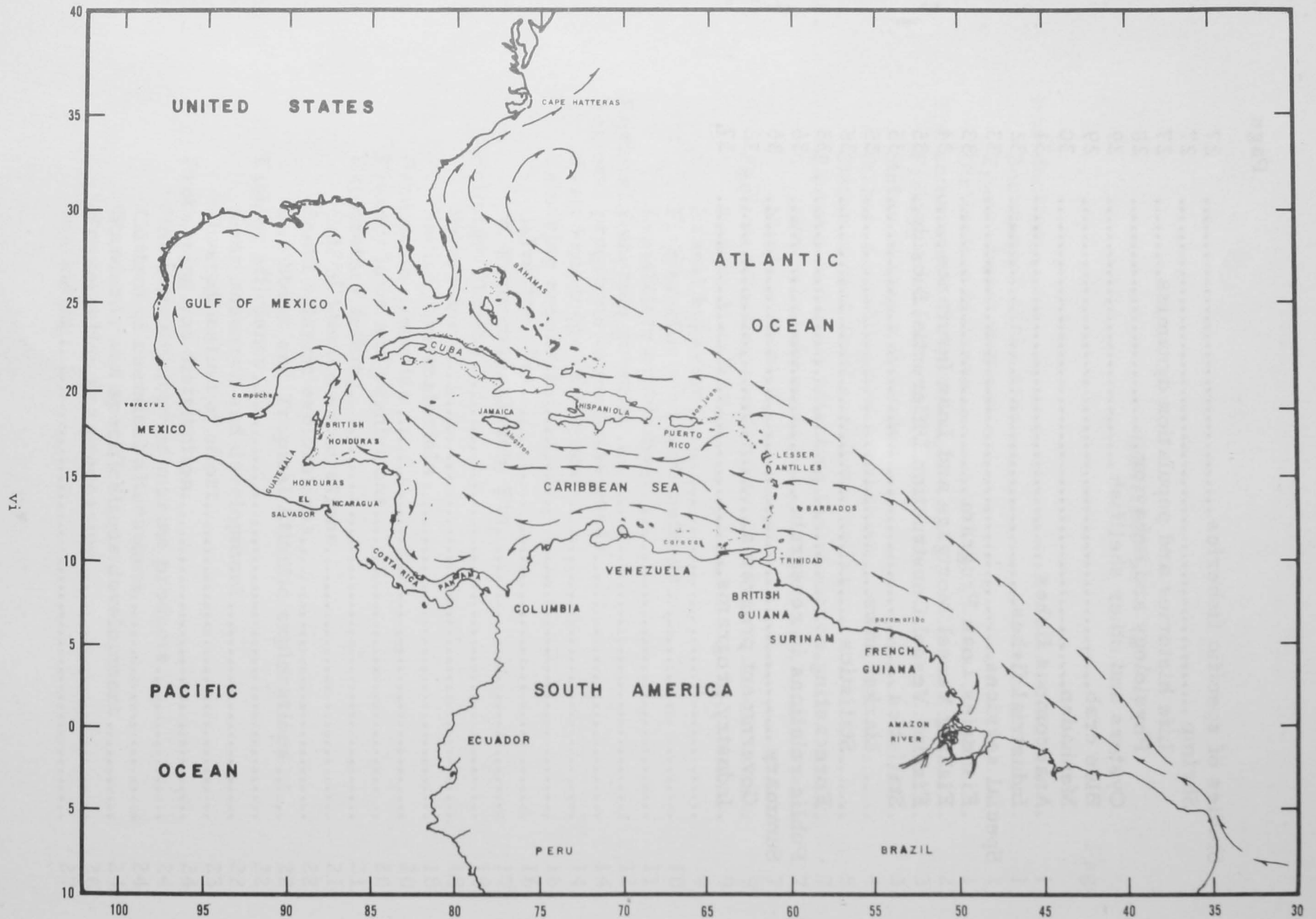


Figure 1.--Marine areas of interest to Gulf and South Atlantic fishing industry.



# The Commercial Fisheries of the Gulf and South Atlantic Region and Their Needs

by

Bureau of Commercial Fisheries Region 2

## INTRODUCTION

### BOUNDARIES OF THE AREA

The fishing industry of the Gulf and South Atlantic States has an interest in a tremendous expanse of waters. From Cape Hatteras on the north, these waters extend hundreds of miles seaward and thousands of miles southward to encompass the waters off our own South Atlantic coast, those surrounding the Bahamas, the Gulf of Mexico, the Caribbean Sea, and the high seas off the northeast coast of South America to Natal, Brazil, where the South Equatorial Current strikes the coast. Included in this interest are the bordering mainland and insular land masses, and especially the coastal estuarine and shelf areas (fig. 1).

### TYPES OF ENVIRONMENT

The three general categories of waters may be recognized as: (a) Estuarine--which includes all of the salt and brackish water bays, sounds, rivers, creeks, and marshes, (b) shelf--which extends from the outer beaches to the 100-fathom line, and (c) oceanic.

The estuarine environment is the most complex, is subject to more drastic natural fluctuations, lends itself most easily to change by man, and is either the nursery grounds or the principal habitat for majority of commercial species now exploited. We can expect ever-increasing problems in maintaining the estuaries in a condition favorable to continued high production. Encroachment by man through dredging, filling, reduction of fresh-water inflow, and the like, is already well underway in many places.

The Continental Shelf is particularly broad off much of the South Atlantic coast of the United States, the eastern, northern, and southern coasts of the Gulf of Mexico, and along most of the northeastern coast of South America. The shelf can be separated into three general categories:

1. The inner shelf, which extends seaward from the beach line to about 10 fathoms, is closely linked to the estuarine environment. Here the rivers strongly influence the salinities, bottom sediments, and nutrients--the three factors that determine the extent and

diversity of the biological communities inhabiting the waters. In many species, there is considerable exchange between populations of the inner shelf and of the estuaries.

2. The mid shelf, which lies between 10 and 50 fathoms, is a transitional zone much less affected by land conditions than the inner shelf, and, therefore, is a more stable habitat. Here are found many species that pass part of their life in the estuaries and part on the inner shelf.

3. The outer shelf is comprised of that portion of bottom and overlying water between 50 and 100 fathoms, frequently lying on the steep slope at the edge of the Continental Shelf. The outer shelf may be only a few miles wide, or, as on sections of the Campeche Bank in the southern Gulf of Mexico, the shelf is nearly 200 miles in width. In this transition zone from shelf to oceanic conditions, abrupt changes in fauna may be expected.

The oceanic environment includes all areas seaward of the Continental Shelf. Here pelagic species are predominant, but certain bottom forms also are of interest and importance.

### DISTINCTIVE FEATURES

The area under consideration has many features that distinguish it from most other areas of interest to the fishing industry of the United States. Among these are the following:

1. Climatic zones are temperate in the north, subtropical over large portions in the center of the area, and tropical in the south. This variation in climatic conditions provides a wide range of ecological conditions and results in a great variety of fauna.

2. The South Equatorial Current, originating off the west coast of Africa, sweeps across the South Atlantic Ocean and strikes the coast of Brazil just below the equator. There the current divides--a portion flows southward as the Brazil Current and the remainder continues along the northeast coast of South America to redivide upon reaching the Lesser Antilles. The main current resulting from the latter division flows into the Caribbean Sea and toward the Gulf of Mexico where it again divides; a portion



Biological Laboratory of the Bureau of Commercial Fisheries on Pivers Island, Beaufort, N.C. Not shown is the adjoining Radiobiological Laboratory.

flows into the Gulf and a portion continues through the straits of Florida and then northward. The secondary current flows in a northwesterly direction seaward of the Antilles and the Bahamas, combines with the North Equatorial Current, and rejoins the main current north of the Bahamas to become the Gulf Stream (fig. 1). The entire area from Cape Hatteras to the northeast coast of South America, therefore, is part of one vast oceanographic unit.

3. An estuarine environment extends thousands of miles from Cape Hatteras southward to the tip of Florida, around the Gulf of Mexico and the western Caribbean, and along South America almost to the equator.

4. The adjoining Gulf of Mexico and Caribbean Sea are quite different in nature, and

manifest conditions distinctive to each and different from the oceanic areas to the eastward.

5. The Greater and Lesser Antilles and the Bahamas, classed as oceanic islands, as distinguished from continental islands, have also been termed a fringing archipelago. They are tropic to subtropic in nature. On these islands occur some of both continental fauna and fauna endemic to insular areas.

6. Tropic and subtropic waters are noted for the number of genera and species of animal life, but, in general, the number of individuals per species is less than in cooler climates. Most of the families of shallow water marine fishes and invertebrates are represented in the tropics and subtropics, and some are limited to these climatic zones.

## THE COMMERCIAL FISHERIES

Major commercial fisheries of the region are established only along the South Atlantic coast of the United States and in the Gulf of Mexico. Of these, shrimp, menhaden,

oysters, and crabs are the most important. Developing fisheries, chiefly for shrimp, are found off central and northeastern South America.



Fishery Laboratory of the Bureau of Commercial Fisheries, Pascagoula, Miss. It houses activities concerned with fisheries exploration and gear development, fisheries technology, and biological research.

### FISHING METHODS

Harvest of the region's fishery resources is realized through various operations and gear developed for specific purposes. The shrimp fishery is carried out by a trawler fleet operating in the estuaries and on the inner and mid shelves. Shrimping also produces large quantities of industrial fish and crabs and relatively small quantities of edible finfish. Menhaden are caught almost entirely by purse seine, mostly over the inner shelf and to a limited extent in the estuaries. This type of gear is well suited for exploitation of other abundant schooling species found in the area. Seines and other types of nets are employed in inshore waters to catch mullet, Spanish mackerel, pompano, trout, and bluefish. Special dredges are used to harvest clams, scallops, and oysters in the estuaries and on the inner shelf. Oysters are also taken by tonging and picking by hand. Pots and traps, fished in inshore waters, are used to capture stone crabs, spiny lobsters, and a great number of blue crabs. Offshore fisheries for groupers, snappers, and king mackerel are done by handlining and trolling.

### STATUS OF MAJOR FISHERIES

The shrimp fishery is the most valuable fishery in the region. In 1961, landings of approximately 154 million pounds were worth nearly \$51 million to the fishermen. Thirty years earlier, landings totalled 96.5 million pounds, worth \$2.7 million. In recent years, larger and more powerful vessels have fished farther offshore where shrimp of larger average size and greater value have been taken. At the same time, improved packing and freezing techniques have extended the market area for shrimp, further aiding economic growth of the industry.

The menhaden fishery has grown remarkably in the past 25 years, owing largely to greater utilization of fish meal by the poultry industry. Annual production increased from about 300 million pounds in the late 1930's to over 1-1/4 billion pounds in 1962, worth about \$800,000 and \$13.7 million, respectively, dock-side value. Although the accompanying increase in the number of plants and vessels has raised fishing intensity, this resource is not fully utilized in the Gulf of Mexico.

The oyster fishery has remained fairly stable for the past 15 years with an annual average production of approximately 17 million pounds of oyster meats.

Growth of the blue crab fishery in the Gulf and South Atlantic has been phenomenal. Commercial landings have increased during the past 40 years from 1-1/4 million to 75 million pounds. The resource even now is not fully exploited because of inability to market larger quantities of crab meat at a profitable price. The distance of the Gulf from major marketing centers, coupled with failure to develop products for the modern market, has undoubtedly curtailed the fishery.

The red snapper has long been regarded as one of the most palatable of finfishes. The fishery for this species, conducted mainly on offshore reefs and banks, annually produced 10 to 11 million pounds between 1915 and 1930. This yield declined to 6 to 7 million pounds early in the 1930's and remained at about that level until 1950. Since 1950, there has been a steady rise in production, and now the catch once again approximates 10 million pounds annually. The increase in landings is attributed to catches made by shrimp vessels, because the fleet of snapper schooners has decreased in the past decade. During periods when shrimp are not abundant, shrimp vessels, using hooks and lines, make occasional trips to the snapper banks. In addition, catches of small red snapper, caught incidental to shrimp trawling, have supplemented the landings.

The production of the mullet fishery in the Gulf and South Atlantic has fluctuated between 27 and 42 million pounds over the past 40 years. The principal factor affecting production is a supply larger than the demand; the fishery could be expanded if a larger market could be established. In recent years, the New England fillet industry, utilizing principally cod, haddock, and ocean perch, has taken over a substantial portion of the former mullet market. Studies to improve the keeping quality of mullet must be undertaken. Another problem in some regions is the need for more efficient gear; in most areas there has been no improvement in four decades.

Figures 2 and 3 depict the developed and potential fisheries of the area, and the trends in the industry.

### STATUS OF HANDLING AND PROCESSING

Methods of handling and processing fishery products in the region range from the most antiquated "cook pot" procedures to the most modern application of freezing and dehydro-freezing. Automation in shrimp peelers, in continuous cookers, in breading machines, and

in blast freezers is equal to automation in other food industries. Frozen prepared seafoods such as breaded shrimp, shrimp creole, crab meat casserole, and stuffed shrimp are produced in new plants under good quality control. These firms are expanding their processing facilities to keep pace with increasing public demand for convenience foods. Likewise, processing improvements for Spanish mackerel fillets and similar items have created stronger marketing situations for species of fish previously sold in unprocessed form.

Much of the frozen-breaded, peeled, and deveined shrimp is sold under United States Department of the Interior (USDI) grade labels. This voluntary Federal inspection service, which was made available to the industry in 1958 offers the consumer assurance of consistent quality. As more grade standards on fishery products are developed, wider use is being made of the USDI Inspection Service. Even for products without grade standards, the USDI inspection and certification services offer a continuous inspection shield for products which meet high sanitation and wholesomeness requirements.

By contrast, some segments of the fishing industry employ out-moded methods. Thus, fresh-iced seafoods are often handled by the methods used a half century ago. The advance of public health and sanitation surveillance in recent years help focus attention on some of these antiquated processing and handling methods, particularly for shellfish. The pasteurization of fresh crab meat represents some progress made in answer to demands of public health officials for a product in compliance with better bacteriological standards. The oyster industry is turning from fresh to fresh-frozen and frozen-breaded products. The fresh-iced method of handling fish and shellfish will probably always be used to distribute some products locally.

Research on processing and technology is increasing, especially in the shellfish industry. This industry is interested in applying bacteriological, chemical, and engineering principles to plant production. The major portion of the industry now employs some form of quality control. A few firms have staff technologists, others employ consultant services, and many more seek the services of the Bureau of Commercial Fisheries. Thus, the shellfish industry is calling for more technological research on product development requiring study of modern methods such as dehydro-freezing. Processing methods require more automation to keep fish and shellfish economically competitive with other foods. Some segments of the industry need basic education in well-established principles of sanitation and food handling.

**ESTIMATE OF UTILIZATION OF ESTABLISHED  
FISHERIES AND "AREAS OF POTENTIAL"**

Fishery Or Potential	Sou. Atl.	E. Gulf	N.&W. Gulf	Sou. Gulf	Carib.	N.E.Sou.Am	Open Atl.
Shallow Shrimp	Fully Utilized	Fully Utilized	Fully Utilized	Fully Utilized	Partly Utilized	Big Potential	None
Deep Water Shrimp	Big Potential	Big Potential	Big Potential	?	?	?	?
Crabs	Big Potential	Big Potential	Big Potential	?	?	?	?
Spiny Lobster	Fully Utilized	Fully Utilized	None	Partly Utilized	Partly Utilized	?	None
Scallops - Bay	?	Partly Utilized	?	?	?	?	None
Scallops - Shelf	Big Potential	Big Potential	Big Potential	?	?	?	None
Clams	Big Potential	Big Potential	Big Potential	?	?	?	None
Oysters	Big Potential	Big Potential	Big Potential	Partly Utilized	Partly Utilized	?	None
Shad	Fully Utilized	None	None	None	None	None	None
Mullet	Big Potential	Big Potential	Big Potential	Partly Utilized	Partly Utilized	?	?
Mackerel	Big Potential	Big Potential	Big Potential	Partly Utilized	Partly Utilized	Big Potential	?
Snapper & Grouper	Big Potential	Big Potential	Fully Utilized	Partly Utilized	Partly Utilized	Big Potential	None
Bluefish	Big Potential	Big Potential	Big Potential	?	?	?	?
Sciaenids	Big Potential	Big Potential	Big Potential	Partly Utilized	Partly Utilized	Big Potential	None
Menhaden	Big Potential	Big Potential	Big Potential	?	?	?	None
Thread Herring	Big Potential	Big Potential	Big Potential	?	Partly Utilized	?	None
Other Clupeids	Big Potential	Big Potential	Big Potential	Partly Utilized	Partly Utilized	Big Potential	None
Anchovies	?	?	Big Potential	Partly Utilized	Partly Utilized	Big Potential	None
Tuna	Big Potential	Big Potential	Big Potential	Partly Utilized	Partly Utilized	Big Potential	Big Potential
Industrial Species	Big Potential	Big Potential	Big Potential	Partly Utilized	Partly Utilized	Big Potential	None
Carangids	Big Potential	Big Potential	Big Potential	Partly Utilized	Partly Utilized	Big Potential	?




Fully Utilized   
 Partly Utilized   
 Big Potential   
 Potential Unknown ?

Figure 2.--Estimate of utilization of established fisheries and "areas of potential."

**STATUS OF DISTRIBUTION AND  
MARKETING**

Marketing of fishery products in the region is typically a short-radius, day-to-day operation. One exception is shrimp, for which the industry has developed processing, packing, and distribution methods that enable it to reach a nationwide market in successful competition with other protein foods.

Because many small producers are scattered along the 11,600 miles of shoreline, marketing methods remain much as they were 50 years ago. Sales radius is generally limited to about 300 miles because of the short saleable life of fresh-iced fish, sold chiefly "in the round." Distributors, brokers, sales organizations, and modern merchandising methods are employed only in isolated instances. Prices received by producers vary with sharp daily fluctuations in

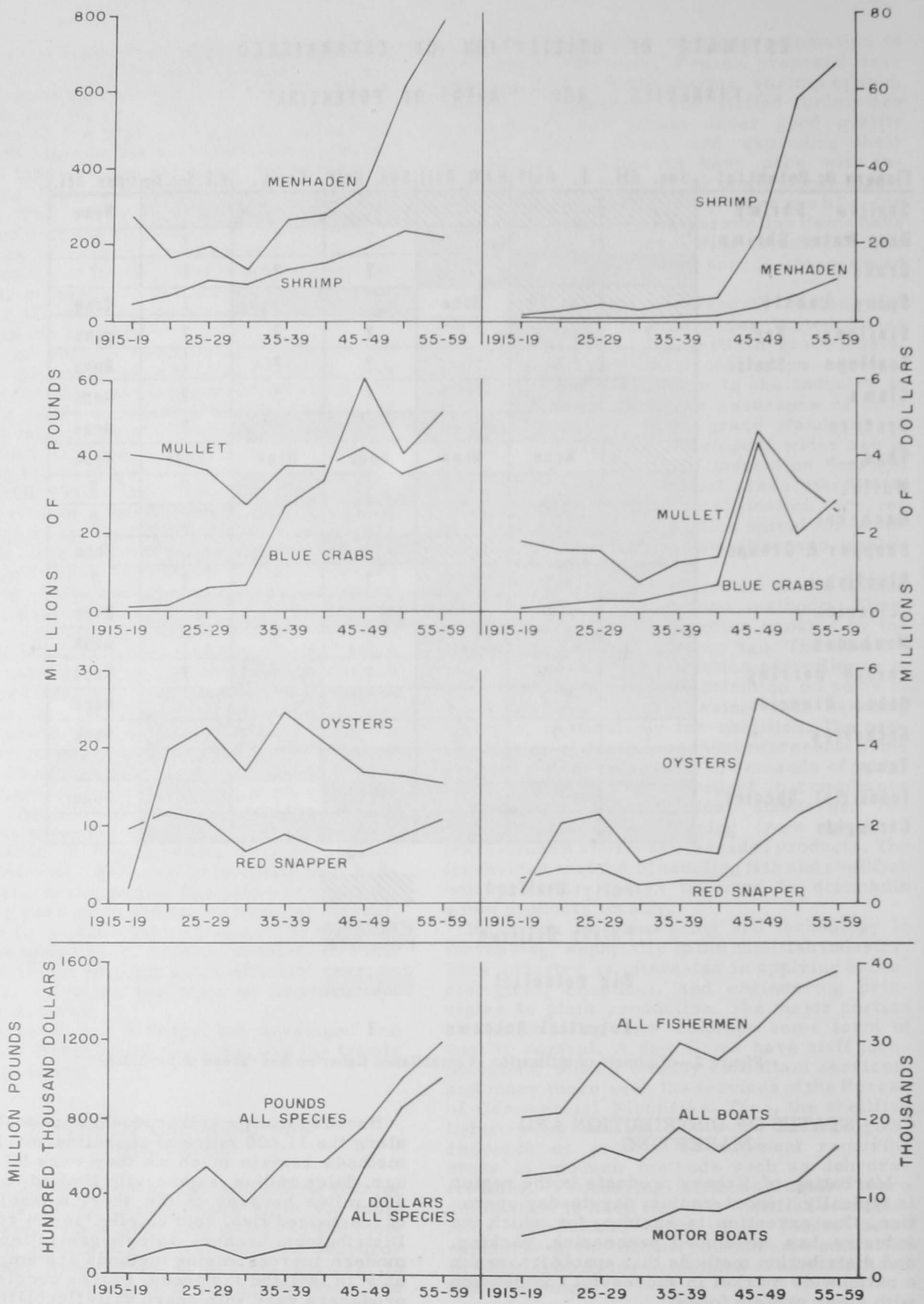


Figure 3.--Trends in the commercial fisheries of Region 2 based on 5-year averages, 1915-59.

supply, caused by weather conditions, and insufficient shore facilities.

Under our free enterprise system, the buyer is king - or rather - queen. The modern trend toward convenience foods, the "heat'n eat" package, and "less work for Mother" has been recognized by the commercial fishing industry in several parts of the nation--notably the New England and the Pacific Northwest. Similar progress has lagged in this region.

Radical changes in marketing methods are needed to compete successfully against seafood produced in other regions and in other countries. For example, the red snapper, Spanish mackerel, and mullet fisheries need the market-stabilizing influences of (1) a processed form of fish, such as fillets, steaks, portions, breaded products, or other convenience packs, (2) an extension of saleable or shelf life by freezing, canning, or smoking, (3) a greatly expanded geographical market area which would result from the two foregoing changes, and (4) an increased dollar yield through use of modern merchandising techniques.

While the industry has struggled, with occasional success, to stimulate sales through carefully planned sales promotion programs, the amount of effort and cost is relatively less than that spent on behalf of competing foods. Although promotion is recognized as a dominant factor in capturing markets, many segments of the fishing industry have been unable to afford the cost. Promotional programs, some supplemented by Federal Government efforts, have been rewarding. While the promotion of fishery products in this region, both by industry and Government, is still inadequate, groundwork has been established for future expansion and resultant acquisition of a larger share of the food market.

## FACTORS SERIOUSLY AFFECTING THE RESOURCE

### Natural Phenomena

Many environmental changes that occur sporadically and are mostly of limited scope may have a drastic, but usually temporary, effect on geographically restricted fish and shellfish populations.

Periods of cold weather may strike suddenly, lowering water temperatures to near and occasionally below freezing in shallow estuarine areas. Then mass mortalities of fish, shrimp, and other organisms occur. Severe cold weather was experienced during the winter of 1939-40 when vast quantities of fish, shrimp, and other organisms were killed from North Carolina to Texas. Several less intense spells of cold weather have since killed large quantities of shrimp and fish along sections of our coasts.

Very high salinity is found principally on the Texas coast. In Laguna Madre, a shallow lagoon over 100 miles long and about 4 miles wide with no fresh-water rivers emptying into it, the salinity may increase to three times that of sea water and result in extensive fish kills.

Red tide, occurring almost exclusively along the west coast of Florida, is the sporadic and massive blooming of a microscopic, planktonic organism (dinoflagellate) which exudes a toxic substance that kills fish and other organisms in a catastrophic manner. One outbreak may cover hundreds of square miles and temporarily destroy parts of the animal communities in the affected area.

Other natural phenomena, frequently catastrophic, occur periodically. Floods, tidal waves, and hurricanes cause drastic changes in the estuarine environment. Abnormal rainfall or prolonged droughts also affect water quality in the estuaries and on the inner shelf, and may have great influence on the population size of many species.

### Man's Activities

Although man-made changes directly affect only the coastal area of the seas, the impact of man's activities on the total resource is far out of proportion to the area affected. In this region, species such as shrimp, menhaden, and oysters, which account for about 90 percent of the total value and 80 percent of the total catch, are highly dependent on maintenance of favorable conditions in the estuaries. Several species, including mullet, menhaden, and the commonly exploited penaeid shrimp, are "quasi-catadromous," the adults spawning offshore and the very young moving inshore to less saline estuarine waters.

Man affects this estuarine area in three ways: (1) by destroying habitats, (2) by changing the natural habitat, and (3) by making the quality of the water undesirable.

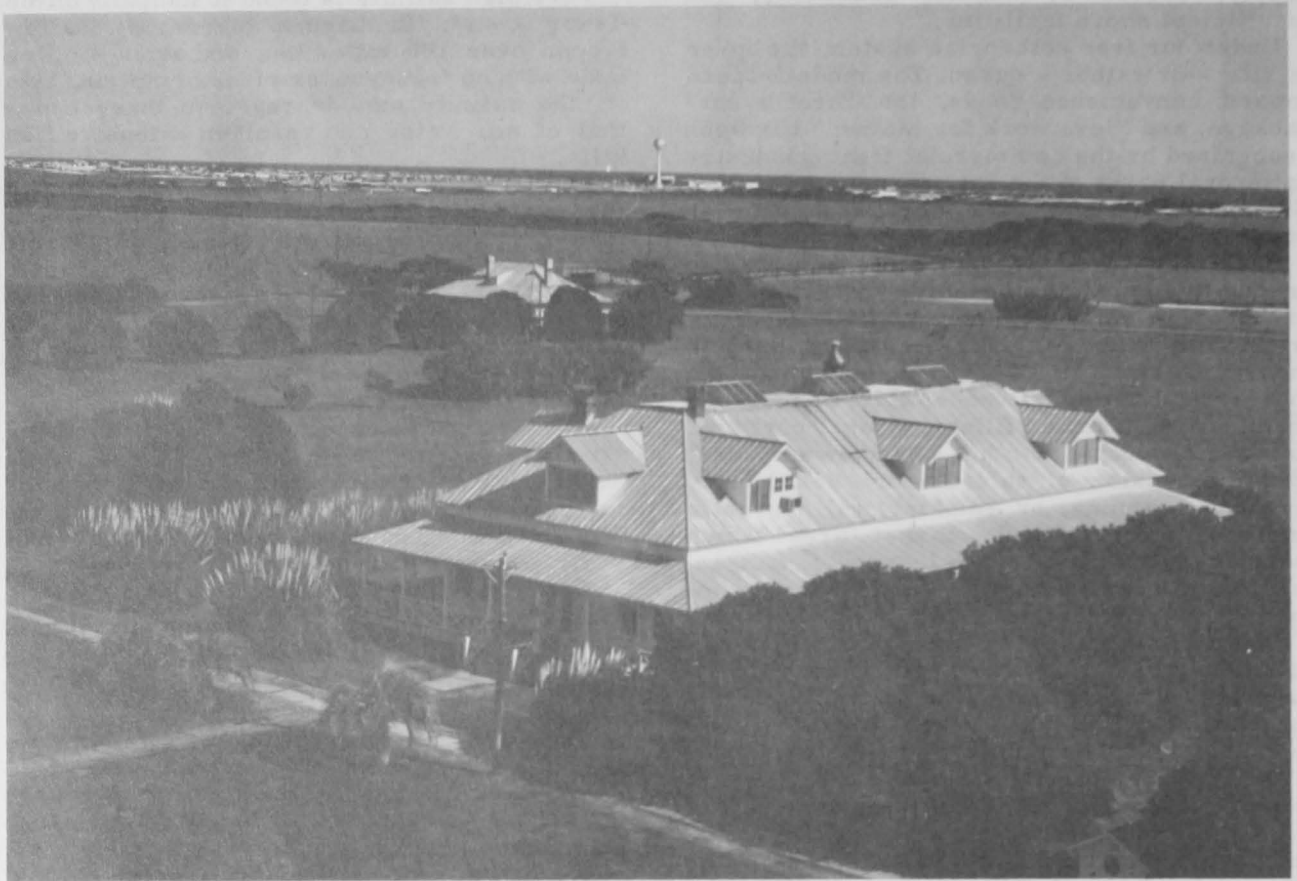
Permanent loss of estuarine habitat occurs principally by:

1. Drainage of marsh and shallow areas. This may even be accomplished without dikes, merely by ditching to drain the marshes.

2. Bulkheading and filling of shallow areas. These activities pose a difficult problem, for although each individual fill may be insignificant in area, the number of such fills is so large that the total loss of habitat is appalling.

3. Low-level impoundments of marsh areas for mosquito control or wildlife use, when not provided with tidal gates to maintain brackish water conditions.

Regardless of the means employed, the permanent removal of portions of the estuarine environment is an alarming development for which we must seek a solution.



The Bureau of Commercial Fisheries Biological Laboratory at Gulf Breeze, Fla., is located on a small artificial island. Beyond are the barrier sand dunes separating it from the Gulf of Mexico near Pensacola, Fla.

Undesirable changes in natural habitat, short of permanent loss, can result from changes in the hydrography of an area. Thus, dredging of channels through shallow estuaries and adjacent marshlands, accompanied by the erection of spoil banks, can result in hydrographic changes--in salinity, temperature, and current--that can seriously impair the value of these natural nursery areas.

Changes in habitat may also result from the control of stream discharge. Streams bring nutrients into the estuaries and create brackish water areas favorable to the growth and survival of many species. These low-salinity areas are especially required for survival of seed oysters since low salinity reduces abundance of oyster drills. Seasonal and diurnal changes in stream discharge are sometimes favorable through the prevention of extreme conditions; however, curtailment of total discharge, either through diversion or consumptive water use, can be a serious problem.

Stream discharge can have an important bearing on available nutrients and rate of sedimentation, as well as salinity. Even such effects as oxygen deficiency can result if water is withdrawn near the bottom of an impoundment too close to the stream mouth

to allow time for aeration. Our basic knowledge of nutrient cycles and productivity in estuaries is insufficient to predict with assurance the results of changes in the discharge regime of a stream.

Pollution is a third manner in which man can and does impair the environment. Domestic pollution is usually the least harmful, since, if sufficiently diluted, it serves merely to enrich the waters. Because of the health hazard, however, domestic pollution can prevent the utilization of oyster, clam, and bay scallop grounds, which may be just as effective as destroying the area itself.

Industrial pollution, long a serious problem in the Northeast, is rapidly becoming more prevalent as this region becomes industrialized. This is a problem of special concern in the Gulf and southeast Florida, for the shallow bays of this area, with their limited tidal range, have a very low flushing rate.

Another form of pollution is the chemical poisoning of these shallow waters with pesticides and herbicides. Some of these chemicals are introduced directly by careless spraying of shorelines; others are washed by heavy rains into the streams and marshes from agricultural areas. This type of pollution could create one



of the more serious fishery problems of the region.

The use of marine waters for the dispersal of radioactive substances and disposal of other dangerous waste materials deserves serious study because the inshore waters of the region are shallow and the offshore currents imperfectly known.

## FACTORS AFFECTING AVAILABILITY

### Faunal Distribution

The distance of the fishing grounds from a port where the catch can be processed and a fleet supplied and maintained is an important factor in the development and full utilization of a fishery resource. The shrimp grounds of the northern Gulf, for example, are excellent in this respect, the Gulf of Campeche grounds much less so, while the rich undeveloped high seas grounds off northeastern South America present major problems because of the distance from essential shore facilities. Distance from port also dictates the size of vessels that can operate. Fish close to shore are available to smaller vessels. A species that occurs in a limited inshore area is likewise readily accessible. Those that are fished only when ascending fresh-water streams to spawn are many times more accessible than species that roam over thousands of square miles of open sea and must be located before fishing can begin. Shellfish that are sedentary and confined to estuarine waters are easier to harvest than those which can move and which occur over many miles of open ocean bottoms.

Bottoms presenting difficult fishing conditions also limit availability. Certain species prefer rock or coral reefs and require special gear for capture. Some of the grounds inhabited by pink shrimp in the Tortugas area are so covered with loggerhead sponges that trawling is virtually impossible.

Depth is important to availability--in general, the shallower the depth, the simpler the gear and vessels, the more available the shore facilities, and the less the interference from weather. This is especially true of the trawl fishery for shrimp and the purse seine fishery for menhaden. Harvesting the royal red shrimp resource, found mostly in depths from 175 to 300 fathoms, presents problems because much heavier gear is required than in the regular shrimp fishery. Some of the abundant herringlike fishes of the Gulf, which occur in vast quantities at a variety of midwater depths, are less available than the menhaden, which can be taken near the surface with purse seines.

Availability of many species is seasonal. For example, the shrimp fishery on our South Atlantic coast operates year-round, but about 80 percent of the annual catch is made in the months of August to November; shad are taken

only during their spawning period; oysters are available all year, but man regulates the harvesting season.

### Faunal Behavior

The behavior pattern of fishes plays a prominent role in man's ability to harvest them. Movements of fishes occur for the purposes of feeding, reproducing, and finding a more favorable environment; such factors as temperature or salinity influence the migrations. Some movements are well-defined and involve great distances; others are short and may consist merely of inshore-offshore seasonal movements.

Many fishes can be harvested profitably only because they tend to form dense schools. Menhaden are typical of these; immense numbers occur in the late spring in the Middle Atlantic coastal area, heralding the start of the commercial fishery. The larger fish migrate northward off New England where they may be harvested during midsummer. The major part of the menhaden fleet, however, remains in the Chesapeake Bay and the Middle Atlantic areas where schools are most abundant. In early fall, the large schools slowly move southward, and by mid-November the fishery is concentrated off the coast of North Carolina. About the end of December, menhaden disappear from the surface waters and are not available to the purse seine fishery during the winter and early spring. Gulf of Mexico menhaden appear in dense, near-shore schools in the early spring, and their harvest continues throughout the summer. They move gradually offshore in the fall and disappear until the following spring.

Anadromous fishes--such as striped bass, river herring, and shad--spend most of their lives in the ocean and enter rivers to spawn. These species usually can be fished profitably only when they are concentrated near the mouths or within the streams in which they spawn. Shad are typical of these fishes; sexually ripe adults enter their native streams in the spring. Shad that are native to the streams from Chesapeake Bay and northward may escape the fishery and then migrate to the Gulf of Maine where they remain during the summer and early fall. Young shad leave the rivers in the fall and probably spend the winter in the Middle Atlantic area with adults. When mature, they return to their native streams to spawn, thus completing the cycle. In addition to being caught near and within the rivers during spawning migrations, shad are harvested occasionally in the Gulf of Maine in the summer where the young and adults form huge schools.

Concentrations of the three principal species of commercial shrimp--white, brown, and pink--are related to their reproductive cycles. Shrimp spawn offshore; and their eggs, extruded



The M/V Silver Bay was formerly based at Brunswick, Ga. This 96-foot trawler from the New England area was under charter for exploratory fishing operations in the South Atlantic.

directly into the water, drift with the current as they hatch and develop. Postlarvae move into estuarine nursery grounds where they settle on the bottom and grow rapidly. As they grow larger, seaward migration occurs. Small shrimp of a few months old may be harvested in the inshore waters, but larger and more mature shrimp are usually taken in offshore areas.

Many fish--such as sea trout, bluefish, scup, croaker, spot, and king and Spanish mackerel--make seasonal migrations that appear to be related to water temperature. For example, Spanish mackerel are most abundant in southern Florida from November through February. During the spring, they move up the Atlantic coast, reaching North Carolina during April, Chesapeake Bay in May, and Narraganset Bay, R.I., by late July. They remain in northern areas until September when they begin to migrate south. By November, they have usually disappeared from the coast of North Carolina, and by mid-November are abundant off Cape Canaveral. An intensive fishery develops at West Palm Beach about December 15. This fishery moves southward with the abundance of fish and terminates at Marathon in the Florida Keys by the end of March.

### Fishing Efficiency and Methods

Fishing efficiency is momentarily adequate if an individual, a crew, or a fleet can harvest a crop profitably, but the long-term survival of the industry is dependent upon the continuing development of trained personnel and well-designed gear.

Our regional fishing fleet has shown an overall steady increase through the years with resulting increased competition between vessels. The problem of producing a catch profitably has been met by increasing the efficiency of individual vessels through development and adoption of such gear and equipment as navigational aids, depth recorders, and electronic fish detection equipment. Also, the increase in size and power of vessels in certain fisheries has enabled the fleet to utilize grounds previously unavailable and to employ larger and better gear.

The effect of increased efficiency of individual vessels on exploitation of the shrimp resource has been pronounced. The present shrimp fleet can work grounds farther from home port, fish on rougher bottom and in adverse weather, use larger gear and land the

catch in better condition. There are many small coastal areas that cannot be trawled with gear now in use. These areas include coral and rock bottom, mudlumps, and loggerhead sponge zones. Midwater trawling operations have provided some progress to overcome these hazards. It can be assumed, however, that most shrimp congregations in shallow water are subjected to some degree of exploitation. The catching efficiency of a shrimp trawl (the percentage of the shrimp in the path of the net actually caught) is still unknown. Except for a small number of vessels fishing for royal reds, all shrimp trawling in the region ceases at a point slightly beyond 50 fathoms. Although brown shrimp may reach depths of 90 to 100 fathoms in their offshore movement, they are usually too scarce to fish profitably with the present gear in waters deeper than 40 fathoms.

In the menhaden fishery, improvements such as synthetic twine, larger vessels, refrigerated holds, power blocks, and fish pumps for unloading have played an important role in boosting production to new records with moderate reductions in sea-going manpower. Attending these mechanical improvements has been a gradual lengthening of the fishing season and, recently, successful attempts at offshore fishing.

Some fisheries show little change in gear, methods, or vessels. Thus, in the snapper fishery, handlines or hand reels fished from schooners show virtually no change over the decades. Somewhat larger engines reduce the dependence on sail power, while Loran and depth recorders are used to locate traditional fishing spots. Recent experimental trawling for snapper by the Bureau reveals the presence of several closely related species of snapper on the regular grounds that apparently are unavailable to the handline fishery.

Future improvements in gear and methods will probably result in significant expansions to greater depths. Beyond the present 50-fathom depth limit of the trawl fishery are important potential resources, including royal red shrimp, rock shrimp (also abundant in shallower water), and industrial fishes, that await changes in present gear and certain technological advances, coupled with changes in the basic philosophy of the fishing industry seemingly geared to shoal-water operation.

Methods of harvesting the fish crop can have a serious effect on profitable yield. For many marine species, the fishery is unlikely to reduce the spawning stock below the levels necessary to furnish sufficient young. The rate and means of harvest, however, may determine the ultimate total profitable yield from any particular brood of young fish. By accumulating knowledge of growth and mortality rates under varying degrees of population density, it may

eventually be possible to obtain greater harvests from the same initial supply of young fish. This can be accomplished by taking the fish at the correct sizes and ages, and at the proper season of the year. For example, one of the important regional questions is to discover the growth and mortality rates of shrimp. These rates are needed to determine the best sizes at which to harvest shrimp to obtain the maximum yield from each brood.

## Legislative Problems

There exists a body of legislation that sometimes interferes with reasonable resource exploitation by the fisherman. Purse seines, for example, are prohibited in certain areas because of the usually erroneous belief that these nets catch significant numbers of sportfish; the use of haul or beach seines is likewise restricted in many States. Legislation, such as limitations on net size, has been sponsored by minority groups within the commercial fishing industry that fail to realize their own needs.

Other legislation with national security as its paramount purpose may seriously affect fisheries. In recent years, areas of coastal waters, including valuable fishing grounds, have been withdrawn for the national defense program.

Legislation is also enacted unilaterally by countries, States, and local agencies to protect vested rights of the inhabitants, although most regulatory statutes have been enacted ostensibly to protect or conserve natural resources. Pre-eminent in this category are statutes which either prescribe closed seasons to protect spawning animals or closed areas to protect the young.

Depending on the mobility of the species and its location at the time it reaches a harvestable size, restrictive legislation may be enacted at the local, State, or Federal level. International commissions have been created to ensure more intelligent exploitation of mutually shared resources.

Restrictive legislation is presumably designed to produce benefits; when it fails to do so, the biologist has a clearly defined responsibility to assess the situation. His responsibility lies in two fields, either evaluating existing research and knowledge which concerns the legislation or devising research programs to provide required information. Where legislative changes are needed, interstate commissions provide unusual opportunities to initiate action. These organizations, which are nonregulatory, are in a unique position to correlate information from private, State, and Federal research agencies and make recommendations to the proper authorities.

## REGIONAL FISHERIES POTENTIAL

A prediction of possible future production of relatively well-exploited species can be made on the basis of recent harvests, conditions of fishing pressure, markets, and facilities (table 1).

Fisheries in the Gulf were established much later than those along the South Atlantic coast and should be expected to furnish a larger percentage of the future increase. To illustrate this point, table 2 shows the square nautical miles of the shelf at certain depths in the Gulf, and an estimate of the percentage now exploited for shrimp and industrial fishes.

In predicting future production of these species, advances in technology and marketing have been assumed. Estimates of potential increases in production are shown in table 3, and the basis of these estimates is shown under remarks in the tabulation. For shrimp, we expect that technological advances will permit utilization of such species as the rock or stone shrimp, very abundant in some areas but difficult to peel. Better management through increased knowledge or shrimp growth and mortality rates, perhaps coupled with use of savings gear, should increase the yield from currently exploited stocks.

Oyster production could be increased considerably by private leasing of uncultivated areas, with attendant better management.

The increase postulated for mullet is probably considerably underestimated, since the

species is extremely abundant along the whole perimeter of the western Gulf where it is scarcely fished at all.

The fishery for industrial species is expanding rapidly and may eventually far exceed our estimate, since we have not included the amounts that may be harvested in depths exceeding 20 fathoms.

Some of the most abundant fishes inhabiting the Gulf and South Atlantic region--anchovies, clupeids, sciaenids, and sharks--are relatively less exploited than those above. Some of these could be harvested in greater quantities, but market demand at present is limited and the catch is usually held to what can be profitably sold.

Potentially great ocean shellfish resources have only recently been discovered along the South Atlantic coast. Explorations have disclosed new beds of clams and scallops which previously were not known or harvested. Some of these already have shown promise of greatly expanding production. Another underdeveloped resource is the spiny lobster taken now only along the Florida coast. Exploratory fishing operations show that they occur rather abundantly in many shelf areas, particularly among the islands of the West Indies. The blue crab is very abundant throughout the region. They are being fished intensively in Chesapeake Bay, but only moderately in the Gulf and South Atlantic. These and many other species

Table 1.--Catch of certain relatively well-exploited species (thousands of pounds round weight except for oysters which are in thousands of pounds of meats)

Species	1959-1961 average		1962			Record regional landings	Underexploited areas
	Gulf	South Atlantic	Gulf	South Atlantic	Total		
Shrimp	177,674	25,656	141,726	26,078	167,804	265,799 (1954)	30 - 100 fathoms
Oysters	16,020	3,873	18,840	3,850	22,690	41,996 (1908)	Non-leased areas
Crabs	33,914	41,468	26,801	38,927	65,728	80,695 (1960)	Entire coast
Menhaden	871,059	266,681	1,056,625	157,169	1,213,794	1,274,938 (1961)	Texas and Florida
Mullet	33,590	7,816	35,301	7,697	42,998	43,137 (1902)	Entire coast
Red snapper	10,774	713	11,880	650	12,530	13,763 (1902)	Probably all of shelf
Shad	--	1,552	--	2,167	2,167	11,268 (1897)	None
Industrial fish	81,483	7,949	96,906	8,508	105,414	105,414 (1962)	Most of shelf

Table 2.--Square nautical miles of bottom of certain depths in the Gulf of Mexico and estimated percentage exploited by certain U.S. fisheries

	Fathoms:	Off U.S. coast			Off Mexican coast			Total		
		0-10	10-20	20-45	0-10	10-20	20-45	0-10	10-20	20-45
		Square miles:								
		23,200	25,320	26,945	10,915	14,255	29,765	34,115	39,575	56,710
Shrimp		90	80	20	70	70	10	84	76	15
Industrial fishes		10	6	0	0	0	0	7	4	0

Table 3.--Potential increase in production of certain species

(In thousands of pounds)

Species	Gulf	South Atlantic	Total	Remarks
Shrimp	40,000	5,000	45,000	25% more in Gulf by fuller exploitation, use of new species, deeper fishing.
Oysters	10,000	6,000	16,000	Vast areas of bottoms now unleased could almost double present production.
Crabs	30,000	10,000	40,000	Abundant crabs in western Gulf should double Gulf production within few years.
Menhaden	100,000	50,000	150,000	Removing restrictions on seining in Texas and Florida should increase production.
Mullet	100,000	10,000	110,000	At least two-thirds of Gulf coast with very abundant mullet is not fished. Technological and marketing problem.
Snappers	10,000	?	10,000	Use of newly developed trawl fishing should easily double production.
Shad	--	1,000	1,000	Careful management should easily obtain this increase.
Industrial fish	668,000	50,000	718,000	Now producing nearly 100 million pounds from 4,000 sq. miles 0-20 fathoms, or 25,000 pounds per square nautical mile, or about 30 pounds per acre. At an average of only 15,000 pounds for remainder of 0-20 fathoms U.S. Gulf area can expect an increase of 668 million pounds.
Total	958,000	132,000	1,090,000	

can be harvested in much greater abundance than at present.

The large number of unexploited species of fish and shellfish in areas under the jurisdiction of this region makes it difficult to estimate the commercial potential. A few selected examples can be cited to indicate the future production potential. Thread herring occasionally enter the menhaden catch along the Gulf and Atlantic coasts. Thread herring are usually avoided as "low oil" fish during the summer when menhaden are high in oil, but technologists recently have found that thread herring have a high oil yield in the winter. Observations of surface schools, seine sampling of schools, and experimental midwater trawling now indicate that this species is probably more abundant throughout the Gulf than menhaden. Estimates of year-round quantities available along the west coast of Florida alone run from 500 million to 2 billion pounds. Surface schools of several species of anchovies abound along the Gulf coastline, with the exception of Florida, during most of the year. Except for incidental utilization in the industrial fishery, these anchovies are untouched, and little is known of their availability. Many other pelagic species are likewise abundant, but less information is on hand concerning them. These include the Spanish sardine,

round herring, gizzard shad, bumpers, butterfish, two species of scad, pilchard, and chub mackerel.

Unutilized species of bottom dwelling fishes which appear to be present in large quantities include several snappers, a deep-water flounder, and the long-spined porgy.

The little tuna appear year-round in large schools over most of the shelf area, as well as offshore, where large stocks of several other species of tuna also have been discovered in the Gulf by exploratory cruises. The apparent richness of the Atlantic tuna stocks has been demonstrated in recent years by Japanese and some U.S. exploitation.

Exploration has revealed various species of shrimp and other crustaceans that are presently untouched commercially and offer good prospects if found to occur in sufficient numbers.

Hake, whiting, tilefish, scorpaenids, clams, scallops, and many other species may be cited as examples of further chances for expansion.

These examples show the almost unlimited scope for fishery expansion in the region. The basic inventory of species is being forcefully pursued so that attention can be directed to the more promising species.

## REGIONAL PROGRAMS TO MEET THE NEEDS

### BASIC KNOWLEDGE OF THE SEAS

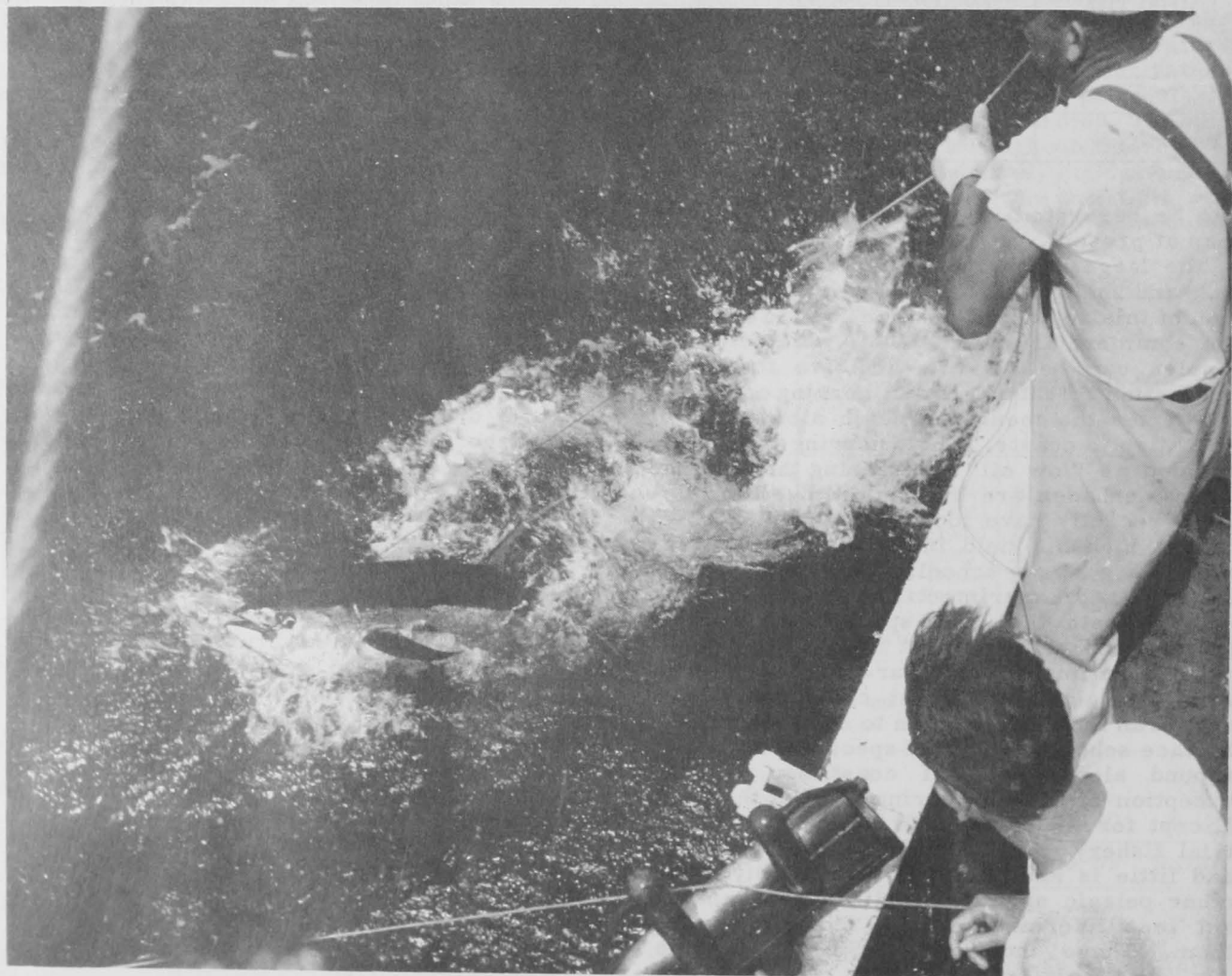
Most of our research efforts entail the application of known principles to the solution of specific problems. In defining these problems, however, we are severely limited by insufficient knowledge of the marine environment and the forms of aquatic life associated with the species we are studying. Possibly we are completely overlooking problems and marine forms, the study of which could add greatly to a larger and more profitable harvest from the sea.

This is a plea not to allow ourselves to become so engrossed with the solution of specific problems that we neglect to broaden our horizons by learning as much as we can of the seas and the life they support. Without such an input of new facts, our output of scientific information will inevitably diminish and our research will become sterile and stultified. In

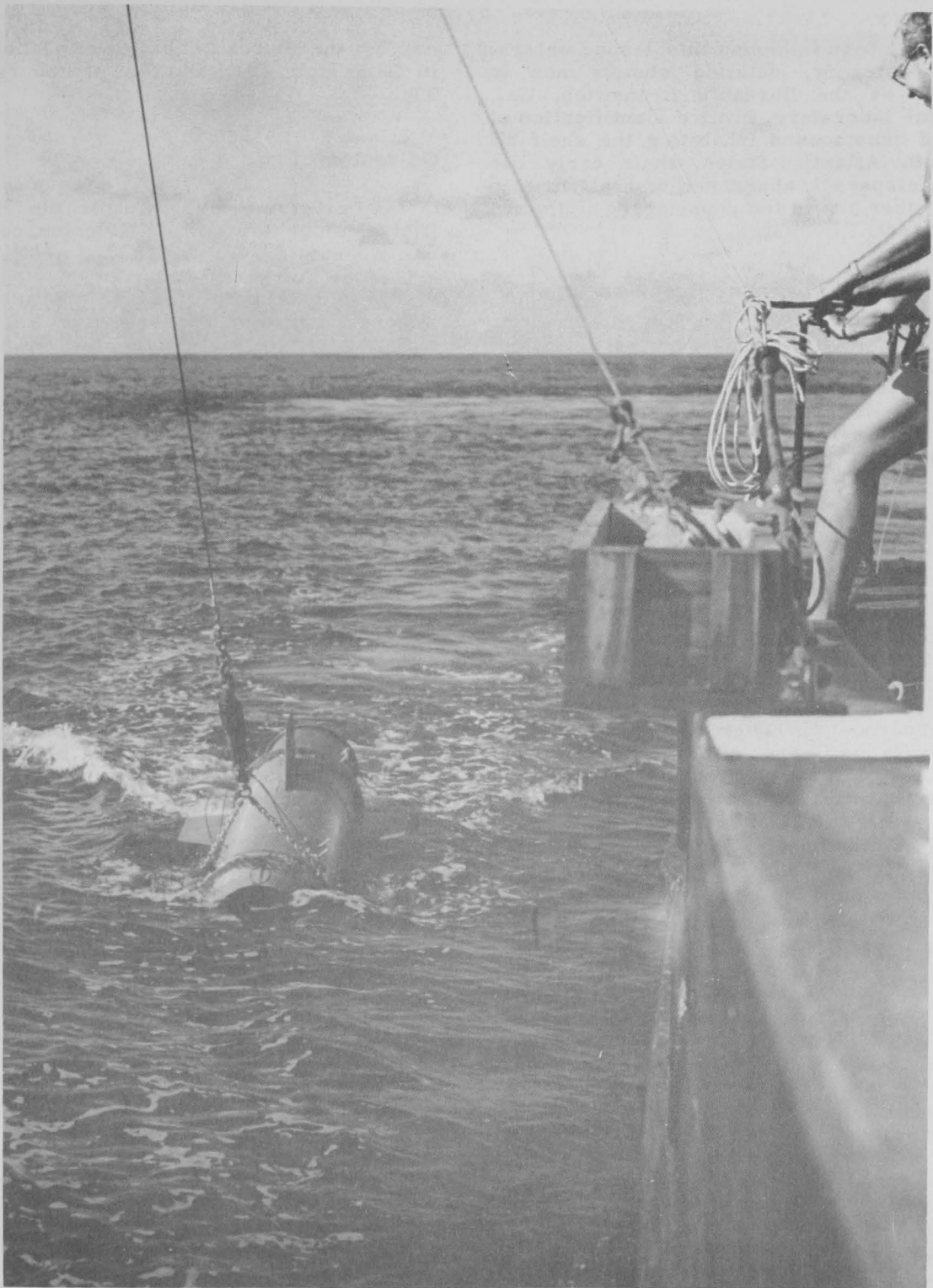
order to satisfy this need for basic knowledge of the seas, we must include in our program enough long-term projects to ensure the necessary flow of new facts and new ideas.

Our estuarine program must include more critical studies of how various physical, chemical, and biological conditions affect first the basic productivity and then the populations of marine life. There is some evidence, for example, that fluctuations in the shrimp harvest may result, in part, from mortality of their eggs and larvae at sea, before the larval shrimp reach protected nursery areas.

It should be of more than academic concern that while we plan on a gigantic scale to explore outer space, we do not possess anything like a complete inventory of the marine species occurring almost at our very door. An inventory is only a beginning, but research is only partially accomplished by funds; time is an essential element in assembling missing facts



A yellowfin tuna being brought alongside for tagging during an exploratory longline cruise of the M/V Oregon.



Preparing to make an oblique tow with the Gulf III all-metal plankton sampler on a T. N. Gill cruise. Designed by Bureau personnel, this sampler can be towed at speeds up to 5 knots and is thus able to capture forms that could avoid conventional nets.

and material. The region therefore must not become so engrossed in solving short-term problems (especially those that appear at the time to be "practical" problems) that long-term research without an immediate apparent objec-

tive is wholly neglected. Somehow, we must achieve a balanced and imaginative program so that as the shallow estuarine and shelf areas become better known we will have accumulated the knowledge required for gradual

expansion of our fisheries into deeper waters. In this category, detailed studies now in progress at the Bureau's Brunswick, Ga., biological laboratory, involve identification of fish and crustaceans inhabiting the shelf off the South Atlantic States, their early life history, dispersal, abundance, and relationship to each other and to the physical and biological environment.

### ESTUARINE RESEARCH

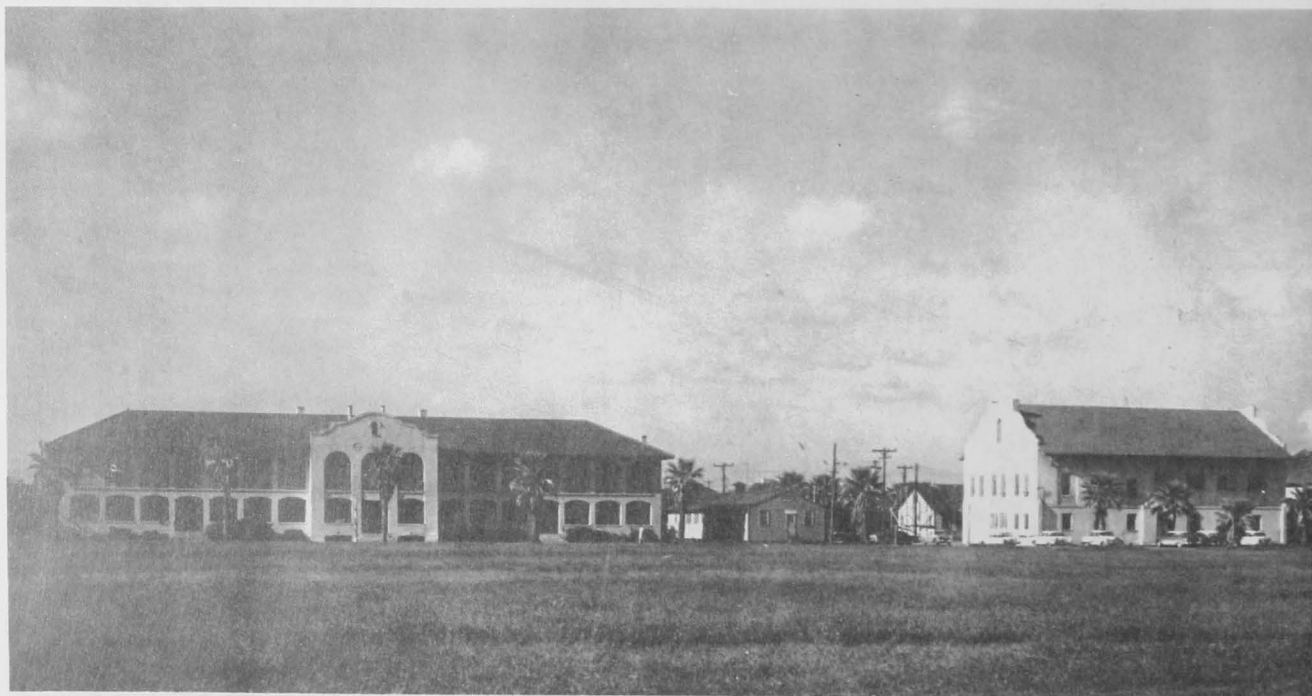
Fish and shellfish that represent most of the important commercial fishery resources spend at least part, and, in some cases, all of their lives within the estuaries, and may be described as estuarine dependent. The shrimp and menhaden fisheries, for example, rank first in value and first in volume, respectively, in the United States. The need for maintaining nursery grounds for such species can not be overestimated. Demands upon estuarine areas and their water supplies for purposes of navigation improvement, flood control, hurricane protection, mineral exploitation, and agricultural, residential, and industrial development are rapidly changing or destroying this extremely valuable habitat. Studies on the effects of these activities on marine environment throughout the region are closely coordinated with the Branch of River Basin Studies (BSFWL) and with the States involved. In addition, specific studies are being carried

out by the Bureau's biological laboratories in Galveston, Tex., and St. Petersburg Beach, Fla.

### Galveston, Tex.

The estuarine program at the Bureau's Biological Laboratory at Galveston, consisting of two parts, is designed to (1) provide knowledge and better understanding of the organization of estuarine communities and the interrelationships between species and perhaps individuals; (2) determine the influence of measurable and changing environmental factors on the estuarine community; (3) develop methods for predicting the effects that natural and man-induced changes in estuarine habitat will have on fishery resources; (4) develop practical means for reducing anticipated resource damage which could result from undesirable habitat change; and (5) provide for resource improvement, if possible.

The first part, an ecological field study, secures biological and hydrological data to determine the relationship between measurable environmental characteristics and species composition, size, and relative abundance. Previously, this project involved studies on the life histories of the more important fish and shellfish in three selected types of estuarine environment. The project has been recently expanded to include the entire Galveston Bay estuarine system.



Biological Laboratory of the Bureau of Commercial Fisheries at Galveston, Tex., in 1959. Subsequent expansion has added another main building; a closed, circulating sea-water system for controlled experiments; and a field laboratory on the shore of East Lagoon, Galveston Island.





Landing a small-meshed beach seine on an open ocean beach during a biweekly collecting trip for juvenile fish near Brunswick, Ga.

The second part entails our review of proposed and authorized water development projects to predetermine their effect on fishery resources. This project includes a review and cataloging of basic, published information concerning Texas estuaries.

Future plans call for experimental field studies to document the effects of environmental changes brought about by water development projects. A study will also be initiated to inventory, organize, and evaluate available estuarine data from each of the major estuarine systems.

The objectives of the foregoing plans are to assure that fishery resources receive adequate consideration in multiple-use planning and development of water resources and estuarine basins, and insofar as possible, to secure a maximum sustained fishery harvest.

#### St. Petersburg Beach, Fla.

Investigations at the St. Petersburg Beach laboratory are designed to determine (1) the present capacity and value of estuaries in terms of biological production, (2) the relationship between developing young forms in the estuary and fisheries in the Gulf, (3) the

effects that modification of estuaries have on the marine resource, and (4) standard working procedures for the biological investigation of estuaries through a combination of fundamental and applied research.

The program has been operative for approximately 1-1/2 years. The four projects, which are staffed, equipped, and underway, deal with chemical environment, hydrology-plankton, bottom ecology, and estuarine fauna. Research thus far has produced enough analyzed data for 10 scientific manuscripts. The subject matter deals with plankton volumes, estuarine species and their relation to Gulf of Mexico fisheries, biology of indicator species, ecology of invertebrates, a newly developed estuarine fishery, and calcium-chlorinity relationships.

Future plans will include two additional projects: (1) The development of a full study sufficiently diversified to fulfill the total objectives and (2) the coordination with other estuarine research in the Bureau. The two projects will consider engineering and estuarine circulation.

At present there is no yardstick to measure any loss or gain in the marine resource resulting from natural or man-incurred estuarine modification. Therefore, after a study of



Hauling a small otter trawl aboard the Tommy Box, a 40-foot, diesel-powered boat, used by the Galveston laboratory for biological collections and hydrographic observations in the estuaries.

the complex of nutrients, food chain, and environment the objective of the program is to offer guidelines, based on the results of research, for the equitable use and management of estuaries.

## POLLUTION STUDIES

### Pesticides

Despite all of the research on the toxicity of chemical pesticides to aquatic and terrestrial animals, their effects on marine species are still relatively unknown. The use of these chemicals presumably will increase until effective substitutes are found. It is necessary to understand clearly the extent to which these chemicals enter and modify the marine environment as well as their specific toxicity to marine life.

The tolerance of commercially important marine species to the approximately 100 common pesticides has been determined. Concentrations causing death or serious irritation

have been established for adults, juvenile or larval forms, and phytoplankton or the primary food supply. These observations have been made under controlled laboratory conditions.

Similar evaluations must be made under field conditions to determine the extent to which levels of toxic concentrations are modified by the changing physical and meteorological conditions during commercial applications.

In the laboratory the screening of chemicals must continue to evaluate new products and to assist in the selection and development of pesticides that are species specific.

The objective will be to obtain sufficient data so that we will know how to protect and preserve the marine environment from harmful polluting agents. We need to be able to advise agencies that regulate the use of pesticides and to suggest less harmful control measures.

### Radioactive Materials

The radiobiological program was initiated because it was feared that waste radioactive



At the Bureau's Radiobiological Laboratory at Beaufort, N.C., the utilization of radioactive food by the larvae of shrimp is measured. The larvae are placed in the scintillation detector located at immediate left of control panel. Gamma rays emitted from the larvae are detected and recorded on the panel of the radioactivity counter.

materials would find their way into the estuarine and marine environments where they would be accumulated by organisms and returned to man in his seafood. Also, it was realized that these materials when used as "tracers" would provide many new research possibilities in the field of fishery biology.

The current research program is concerned with the following: (1) Accumulation of radionuclides by sediments, plankton, mollusks, crustaceans, and fish, (2) cycling of radioactive materials in selected marine environments, (3) estuarine radioecology, (4) sensitivity of marine organisms to radiation, and (5) radiobiological consulting and evaluation of hazards associated with the construction of nuclear reactors near streams and estuaries. This research has produced the following results: (1) A knowledge of the chemical and physical states of radionuclides in sea water and their availability to the aquatic life, (2) accumulation rates, levels of concentration, and retention time of radionuclides in many marine plants and animals, (3) application of radioisotope

techniques to shellfish nutrition, (4) new concepts relating laboratory data to field conditions through continuous flow systems and experimental environments, and (5) effects of ionizing radiation upon embryological and postlarval development of fish.

Future plans will include more emphasis on (1) cooperation with other groups in the Fish and Wildlife Service, the Public Health Service, Atomic Energy Commission, and Corps of Engineers, (2) an expansion in the application of radioisotope methods to studies of estuarine ecology, (3) in situ measurements of radionuclides in selected estuaries, (4) the use of tanks and ponds in following the pathways and cycling of radionuclides of nutrient elements, (5) the duplication of the natural environment for growing animals in the laboratory, by designing better flow systems, and (6) the use of ionizing radiation in breeding more resistant species and in controlling obnoxious species.

The objectives of the research program are (1) to be able to make accurate predictions and

recommendations concerning potential dangers of radioactive contamination in estuarine and marine environments and (2) to develop and apply radioisotope techniques to fishery biology in order to obtain answers to problems which might otherwise be very difficult, if not impossible, to solve.

## POPULATION DYNAMICS

The preservation of the inshore nursery areas and their protection against the hazards of pesticides and radioactive materials are pertinent to all but a very few of the commercial species of the area. The management of these resources also entails a knowledge of the dynamics of each stock. [This implies far more than a simple knowledge of the abundance of a species at any given time.] For instance, it is important to know which inshore areas are the nursery grounds for which offshore stocks that we are fishing. For the pink shrimp, extensive marking of juveniles on the nursery grounds has revealed that the Everglades and Florida Bay are the principle nursery areas for the adults fished on the Tortugas grounds. Also, the young marked in Pine Island Sound were all recaptured on the Sanibel fishing ground. Similar studies on migration are needed for other species of shrimp, for menhaden, and for blue crabs.

Population dynamics includes knowledge of survival rates at all stages of life history. For shrimp, extensive offshore sampling of spawning populations has commenced to determine areas, seasons, and depths of spawning. The proportion of each brood of larval shrimp surviving to reach the inshore waters may determine the commercial success or failure of the fishery in ensuing months. We therefore are sampling intensely the postlarvae entering the Galveston Bay system to determine the expected extent of fluctuations in survival. This implies an ability to distinguish the larvae and postlarvae of the several species of shrimp in the area so identification studies are being made.

The determination of abundance trends depends upon the ability to obtain accurate and fairly detailed statistics of catch, distributed both by time and space, by some unit of fishing effort. These are being collected for the shrimp fisheries of the Gulf of Mexico, but other fisheries of the region are not adequately covered. Thus, whenever statistics, other than bare yield, are needed for some fishery, special canvasses must be made to gather data from past years.

In addition to the statistics of catch in weight by locality and fishing effort, information is needed on sizes of species taken in order to determine survival and growth rates. For some species, this information is unattainable from the commercial statistics; for others, as the shrimp, the commercial size grades have

proven useful in detecting the presence and approximate growth rate of broods, but are not sufficiently precise nor uniform to permit the accurate separation of the catch into its component broods so that mortality rates can be calculated. For this reason, it has proven necessary to measure samples of the shrimp landed. This type of biological sampling for size and age is also carried on for menhaden along the Atlantic coast.

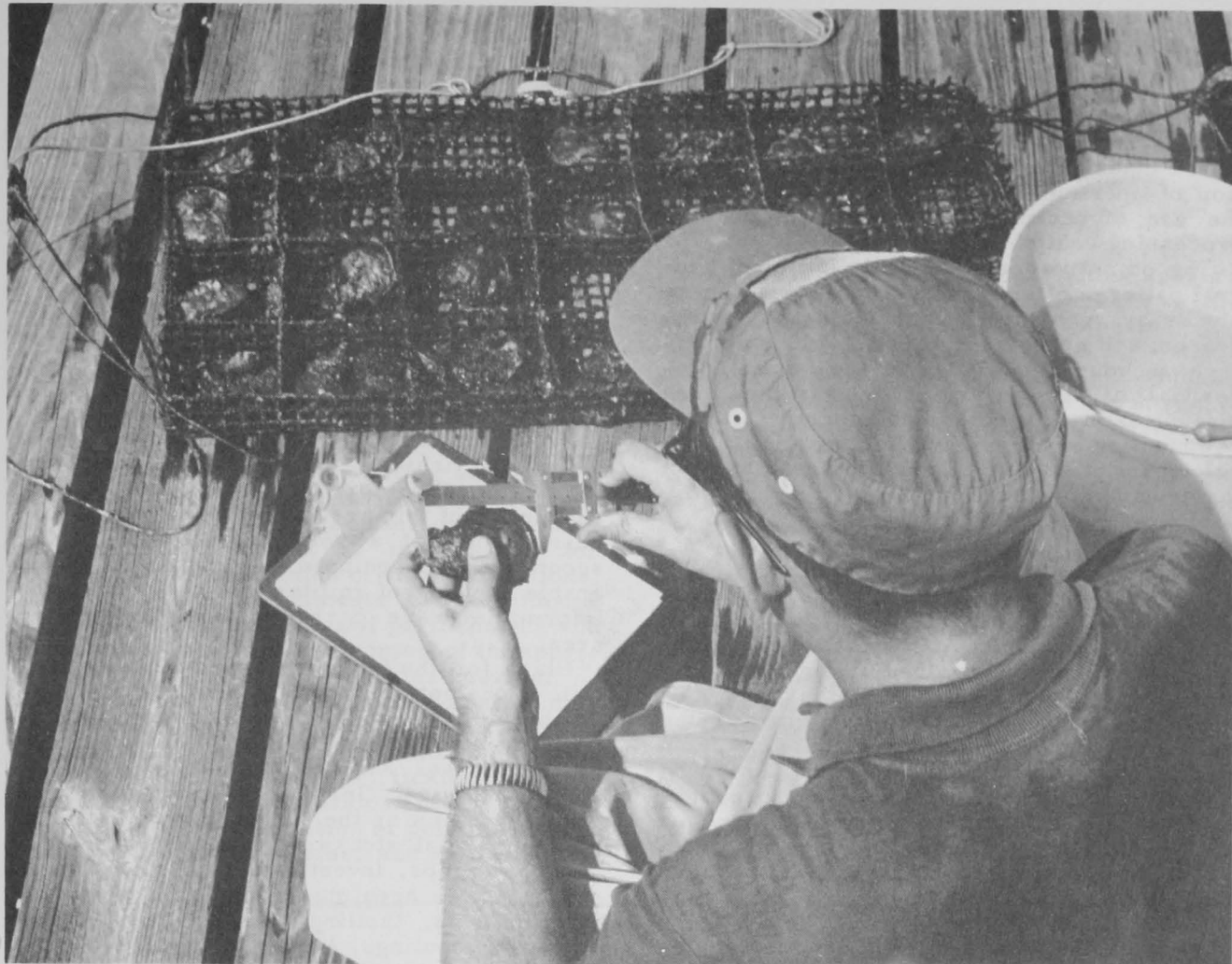
Any adequate study of population dynamics attempts to determine the causes of both short-term variations and long-term trends in abundance. Additionally, a determination needs to be made as to whether or not any management measures are indicated, and, if so, what measures. The failure to obtain the largest or most valuable harvest from a species may be due either to a lack of sufficient recruits to the stock because of poor reproduction or to unwise harvesting methods. In the first case, if the lack of recruits is due to natural conditions affecting the survival of young to the recruit stage, there is usually no recourse; if the lack is due to too great a reduction in spawning stocks, then action may be beneficial. In the second case--unwise harvesting--there must be accurate estimates of both growth and mortality rates in order to know when, where, and at what size the species should be taken. Furthermore, when mixed sizes occur together, savings gear often can be the only solution to selective harvesting. Savings gear needs to be studied for the shrimp fisheries, in which, on some grounds, large numbers of small shrimp are culled from the catches and discarded.

Adequate statistical records are essential to a study of population dynamics. Detailed statistics by species, size, depth, area, gear used, and effort expended for the Gulf of Mexico shrimp fisheries are being obtained, but are still lacking for shrimp in the South Atlantic and for all other species. Until we can obtain more complete biostatistical coverage, we are handicapped in determining the areal and seasonal distribution and the actual and potential yield from other species.

Lack of complete statistical coverage necessitates intense and expensive short-term work whenever a situation calls for any detailed knowledge. Such short-term collections from records kept for other purposes tend to be misleading. The statistical program should be increased to cover all species of either present or potential importance. Without complete statistical coverage, it is difficult to evaluate properly the long-range results of many of the current biological research programs.

## FISHERY LAWS AND REGULATIONS

Laws and regulations differ from State to State, and although represented as conservation



In order to determine the environmental factors controlling oyster quality and production, careful periodic checks are made on individual oysters held in trays at the Biological Laboratory in Gulf Breeze, Fla.

measures, they are seldom based on sufficient biological knowledge, and rarely is the fishery observed scientifically before and after application in a manner to prove or disprove their value. While fishery regulation is a State responsibility, there is machinery for effective coordination and cooperation in the Gulf States Marine Fisheries Commission and in the Atlantic States Marine Fisheries Commission. These interstate compact organizations probably will have a more important role in the regulatory field in the future.

### EXPLORATORY FISHING

Economic hazards usually discourage the fishing industry from extending its operations into new or relatively unknown areas. The region's exploratory fishing program is designed to inventory present and potential fishery resources within its boundaries, to determine the extent and availability of these resources with parallel considerations of gear

and capture methods, and to provide this information to the industry. Activities, often in international waters, are carried on aboard the Bureau's exploratory vessels Oregon and Silver Bay, operating out of Pascagoula, Miss., and Brunswick, Ga., respectively.

### Gulf of Mexico Explorations

Present operations include shellfish, bottom-fish, and pelagic fish explorations. Emphasis within the program is determined on the short-term basis of immediate needs of the industry, as expressed by its members, particularly through the Gulf States Marine Fisheries Commission, and on the long-term basis of the need for a comprehensive faunal inventory. The short-term activities carried out are fitted into the long-term objectives.

Discovery of important food fish and industrial fish stocks within the operational area, followed by published reports on one location, extent of fishing grounds, and estimated abundance of species involved, have done much to

aid and stimulate present commercial interests. Similar treatment of unutilized stocks of deep-water finfish and shellfish and pelagic finfish, including tunas, provides an outlet for future industry expansion. Planning and execution of operations will be effectively aided by the use of recently installed automatic data processing equipment.

The objectives include (1) definition of general patterns of size and availability of fishery stocks by such distribution factors as depth, season, and geographic range, (2) development of a thorough knowledge of the faunal composition of the waters of the assigned area through faunal inventory and consideration of contributing environmental factors, and (3) development of special or modified gear to meet the demands of future fisheries.

### South Atlantic Explorations

Recognizing the need for exploratory fishing in the South Atlantic area and complying with a request from the Atlantic States Marine Fisheries Commission, the Bureau established an operating base at Brunswick in September 1959. Subsequent explorations were made in the waters of the Continental Shelf and slope from North Carolina to south Florida, following essentially the basic patterns and procedures for Gulf of Mexico explorations.

What has proved to be the largest known calico scallop bed in the world was discovered off Cape Canaveral. Other potentially commercial stocks of hard clams, deep-water shrimp, and finfish have been and are continuing to be discovered and reported according to locations, extent of fishing grounds, seasonal occurrence, and estimated abundance. Suitable gear for harvesting these stocks has been developed.

Program plans, basically similar to present operations, will be implemented in future activities, with additions and refinements depending upon results obtained. The objectives of this program are the same as those for the exploratory program of the Gulf.

### Caribbean and Tropical Atlantic Explorations

Since 1957, the research vessel Oregon has made at least one cruise a year to the international waters in this area. Results to date include (1) establishment of a commercial shrimp fishery on the shelf off the Guianas, (2) demonstration of commercially valuable longline tuna stocks in the Caribbean, (3) preliminary indications of valuable snapper stocks off the Nicaraguan and Guianan coasts, and (4) preliminary indication of valuable deep-water shrimp stocks off Brazil, the Guianas, and Central America. Additional large areas have been investigated and found not suitable for trawling by conventional methods. Finally, the data accumulated formed the basis for a

long-term zoogeographical study of the area, which will lead to a better understanding of the distribution of aquatic life in the western North Atlantic.

Since July 1962, the Bureau, in cooperation with the Agency of International Development, has been exploring for spiny lobsters in Panama. A variety of traps have been used in Panamanian waters, on both Atlantic and Pacific sides of the Canal. Best fishing to date has been on the Pacific side near the Parida and Belanos Islands of the Chiriqui Gulf, where catches have been definitely of commercial size.

Broad expansion of the Caribbean and Tropical Atlantic program is vital to the well being of the U.S. fishing industry and the security of the nation. Foreign interest in the fishery resources of this area is increasing daily and is currently at a very high level. Foreign scout vessels, equipped with instruments that enable plotting of military as well as fishery information, are currently operating in the area.

Plans for the future call for an intensification of the bottom trawling projects (shellfish and bottomfish) into the unexplored area off the north coast of Venezuela, the little known areas in the Lesser Antilles, and off central and southern Brazil. In this category, also, are plans to follow up the preliminary indications of commercial stocks of snappers and deep-water shrimps. Investigations of the pelagic stocks of the area must also be initiated with longline sets, trolling cruises, purse seine sets, and scoutings. Aerial surveys of the area in cooperation with the Navy are being considered.

The objective will be to obtain a comprehensive and up-to-date inventory of the fishery resources of the Caribbean and Tropical Atlantic and knowledge of the natural factors that would favorably or adversely affect industry operations.

## FISHING EFFICIENCY

Expansion of our fisheries to meet the gradual but continually increasing demand for marine proteins cannot be accomplished merely by increasing fishing effort on species already fully exploited. Neither can the demand be met by continuing to fish with a few types of gear, which, although successful within limits on some species, obviously must be modified or replaced for many species not now utilized.

### Gear Research and Development

The fishing gear research and development program is a scientific study of aquatic harvesting devices and techniques. Information derived from this endeavor is distributed to the fishing industry and fishery scientific

community with the aim of contributing toward improved utilization of commercial marine resources. Programs of this nature are intended to improve the competitive economic status of the various fisheries.

Currently, the program is composed of a shrimp gear research project, inshore fishing gear research and development project, and a pelagic species gear research project. Because of pressing economic considerations, emphasis is now centered on the various aspects of shrimp gear work, and pelagic gear development temporarily is being held in abeyance. Field activities are carried out aboard the George M. Bowers, based at Panama City, Fla.

Accomplishments to date include preparation of a 30-minute film illustrating actual performance of shrimp trawls in the Gulf of Mexico; a 12-minute film on shrimp burrowing behavior; development of instruments for measuring the mechanics of trawl operations; development of instruments and techniques for the observation of trawl performance and shrimp behavior; and development of an experimental electrical shrimp "tickler" device.

Future plans call for completion of a comprehensive study of standard shrimp trawl mechanics; development of shrimp trawls using electrical or sonic tickler devices; expansion and intensification of natural shrimp behavior studies; initiation of pelagic species gear and behavior studies; and refinement of

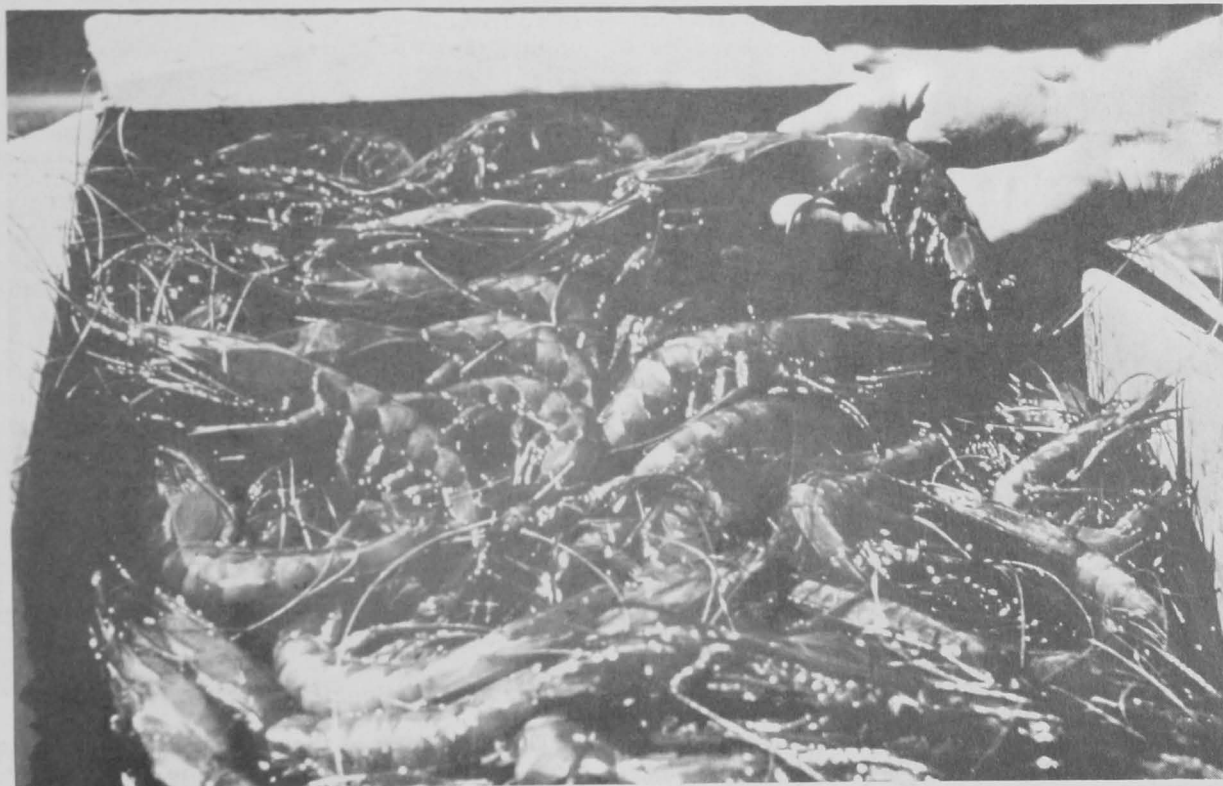
required instrumentation of gear and behavior projects.

The objectives of the program are to develop more efficient harvesting devices and techniques and to demonstrate their use.

### Diversification of Effort

Diversification of fishing activities appears to be the only immediate answer to the important problem of reduced fisherman income. There are some 4,500 fishing vessels above 5 net tons in the regional fleet--mostly shrimp trawlers. This fleet is too large to fish profitably for shrimp alone, considering the supply of shrimp on the southeastern Atlantic and Gulf grounds. Two approaches are possible--the location of new grounds beyond the present limits of the fishery, or the assistance and encouragement in shifting to new or underexploited fisheries.

Concerning new grounds, most of the shallow-water areas of the region are accessible and known to fishermen. Deep-water fishing cannot provide significant additions to the present brown, white, and pink shrimp landings because commercial trawling is being practiced over nearly all of the abundant bathymetric range of these species. Development of fisheries for royal red shrimp and other crustaceans may be a partial answer, but the principal hope of extending the grounds



Deep-water shrimp found chiefly in depths greater than 100 fathom.

available to fishermen of the region lies in the Caribbean-South American area. Some work has already been done in this area by the Bureau, and results have been heartening. Much work remains to be done in areas where shrimp and other fishery resources are believed to occur in commercial quantities outside the continental limits of bordering countries.

The typical cabin-forward shrimp trawler is easily adaptable to multipurpose fishing, using such gear as scallop and clam dredges, purse seines, and midwater trawls. The current objectives are to demonstrate potential fisheries where these different types of gear may be employed and to encourage and assist a large segment of the existing shrimp fleet to diversify along these lines. Encouragement will require practical demonstrations of potential catch rates, usage of gear, and vessel modifications, as well as market acceptability of the product.

## PROCESSING AND DISTRIBUTION

The variety of fish, crustaceans, and mollusks available to the fishing industry, the wide dispersion of landing ports, differences in production methods, and in many instances antiquated processing procedures create problems of handling, processing, and distribution out of proportion to the volume of production. In some fisheries, the basic problem lies in technology--for example, better handling aboard vessels, more efficient processing, or processing seafoods that are tastier and more attractive to the consumer. In contrast, other fisheries have marketing problems which can be overcome only by introducing the product outside a "local" distribution pattern.

### The Microbiology of Marine Products

Marine microorganisms and their accompanying enzymes are present on all raw marine products, while microorganisms of terrestrial origin, along with their enzymes, are introduced in catching, handling, processing, and storage. These two groups of microorganisms have many drastic effects on the desirability of the finished products. Proteins are degraded and decomposed; oils are oxidized into rancidity, undesirable color, odor, and flavor; and appearance may be affected. The fishing industry in general is aware of these problems.

A program of microbiological research is planned to study the problems presented by the industry. Experimental studies will show how microorganisms bring about these changes in seafood and how they can be excluded.

The objective is to obtain full knowledge concerning occurrence, effect, and prevention or control of microorganisms on marine products of commerce. Conceivably, this could

lead to development of new products through controlled use of enzymes and microorganisms, on marine substrates, much the same as in the dairy and fermentation industries.

### Control of Chemical Alterations

There is a dearth of information on the chemical composition and nutritive value of fish and shellfish, and the changes these components undergo during storage and processing. Recent investigations at the Bureau's Technological Laboratory in Pascagoula have yielded some pertinent information of use to the industry. The proximate composition of the commercial species of industrial fish from the Gulf of Mexico and the South Atlantic coast has been studied on a seasonal and geographic basis with the result that the oil content of each species of fish now can be predicted when the moisture content and the general geographic location are known. A method has been developed to retard rancidity and mold growth in smoked mullet fillets by application of BHT (butylated hydroxy toluene) and potassium sorbate. The mechanism of iron sulfide discoloration in canned shrimp has been determined, and partial remedies have been recommended.

Planned programs include determination of the biochemical composition, that is, trace mineral, amino acid, lipid, etc., of the commercially important seafoods of the region. In addition, evidences of the correlation among constituents or between composition and seasonal, geographical, and inherited racial characters will be established by means of currently available sophisticated methods. The effect of various methods of storage and processing in relation to changes in quality (such as metal ion binding, ion-release, texture change) of shrimp, crab, and other seafoods will be determined. Particular attention will be paid to the effect of bacterially induced changes in biochemical constituents, and the consequent effect on quality.

The objective of the program is to provide information on (1) the nutritive value of seafoods, (2) the changes in biochemical constituents during storage and processing, and (3) the biochemical changes in seafoods leading to loss of quality. The data obtained for the satisfaction of these objectives will enable the wise and knowledgeable choice of seafoods for specific nutritive feeding purposes and the more effective solution of processing problems which face industry.

### Standards and Specifications Development

The purposes of the standards and specification program are to upgrade the quality of fishery products and promote their orderly and efficient marketing. Quality is upgraded by furnishing the producer a guide by which he





A dredge load of calico scallops being dumped on the deck of the M/V Silver Bay during exploratory fishing activities. One of the world's largest known beds of this mollusk was discovered on an earlier cruise.

can make and maintain the highest quality product possible. Guidelines are determined through the examination of hundreds of samples physically, organoleptically, and sometimes chemically to establish certain limits. Many problems arise that must be solved before a sound, workable standard can be written. Therefore, preliminary work to determine origin or adversity of certain factors of quality are necessary.

Complete revision of the Frozen Raw Breaded Shrimp Standard has been made and is awaiting acceptance by industry. In-plant testing of the Frozen Raw Peeled and Deveined Shrimp Standard has been completed, and tabulations of the results are being made. Studies continue on the development of quality indices on calico scallops. It has been determined that 7 days is the maximum storage life of iced scallops and 3 months for frozen calico scallops.

A survey of the seafood industry will be made to determine the necessity and value of additional standards for such products as fresh crab meat, frozen raw breaded oysters, frozen

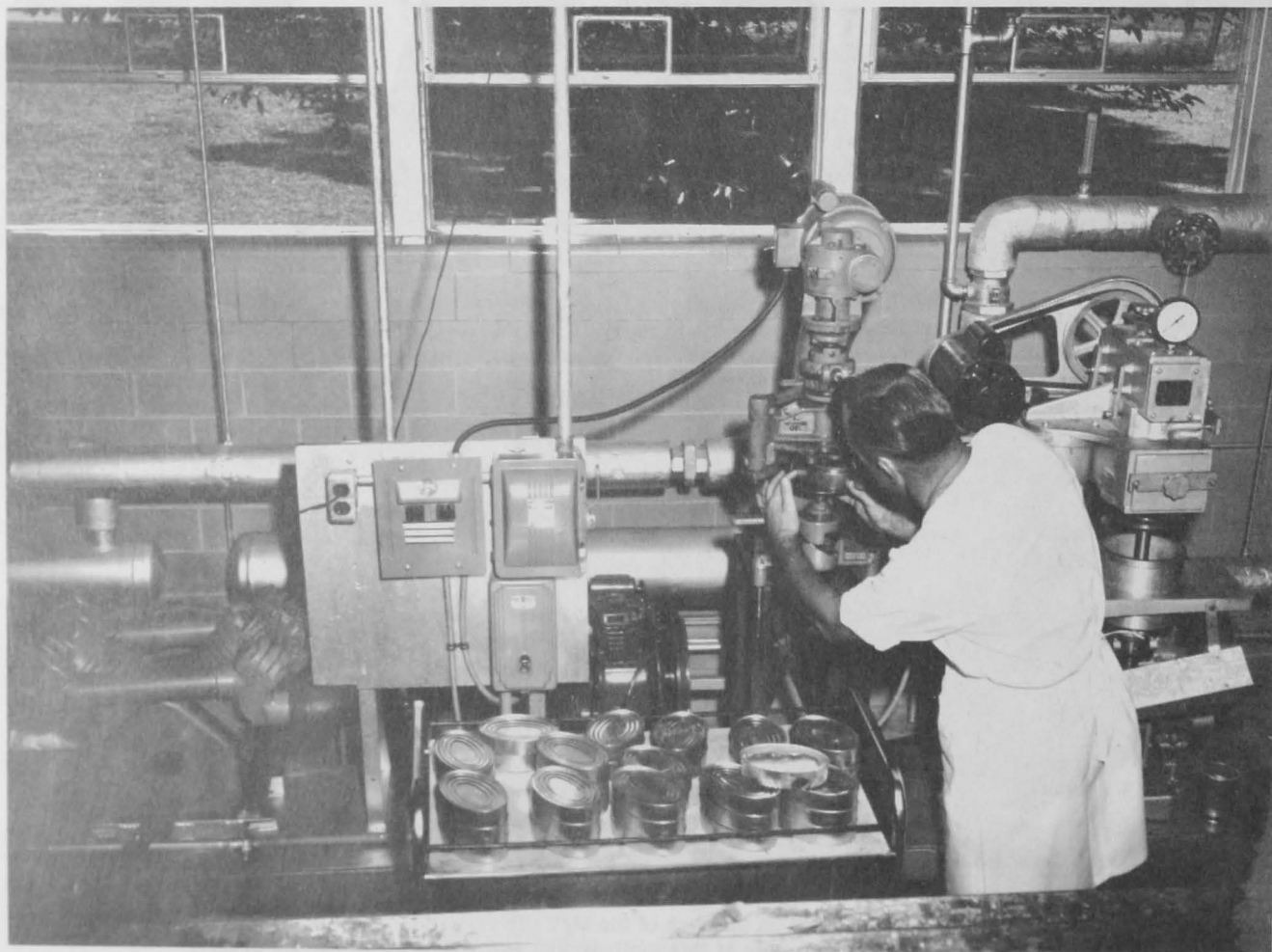
breaded fish fillets, and frozen breaded scallops. The most urgent needs will determine the sequence in which these standards will be developed. Work to determine the cause and prevention of excessive drip loss from scallops will be initiated.

The objectives of the program are to (1) provide background information for good sound workable standards, (2) develop standards suitable to industry that will result in a higher quality product to the consumer, and (3) supervise and train personnel to insure the proper use and uniform application of new standards.

### Preservation and Processing

Many edible species of fish and shellfish are available in the Gulf and South Atlantic, but lack of technological data has prevented their utilization. The purpose of this program is to develop methods, processes, handling techniques, storage, and other technological data on underutilized fish and shellfish.

Some funds were provided to begin a study on canned mullet, a phase of this program.



Closing cans of an experimental pack of anchovies at the Bureau's Technological Laboratory, Pascagoula, Miss.

Considerable effort has been made to produce an acceptable product. Boneless, skinless fillets have been canned without regard to cost and have been judged highly acceptable. Efforts are being made to reduce the cost of production without impairing quality or appearance. Methods and processes have been established by use of thermocouples and potentiometers, and processing data have been released to the industry.

The future plans of the program include product development studies encompassing all important underutilized fish and shellfish such as royal red shrimp, sardinelike fishes, mullet, and several species of tuna, and informing the industry of our progress, thus stimulating interest in utilizing research data.

The objectives of the program are to (1) develop methods for utilizing each available species, (2) determine consumer acceptance of new and modified products by taste panels, (3) calculate production yields and cost based on pilot plant operations, and (4) prepare and make available to the industry the data obtained from such research.

## Marketing

There is need, in this region and throughout the country, for more and better distribution of information on the purchasing, handling, and preparation of fishery products. Institutional, restaurant, and school lunch personnel who prepare food in large quantities, as well as many professional home economists and homemakers who prepare food in small quantities for demonstration purposes or for their own use, have very little information regarding fish and shellfish. As a result, they are unable to plan and prepare meals that make the best use of the wide variety of available fishery products. Seafood cookery demonstrations aimed specifically at reaching these various segments are vitally needed.

To stimulate the use of fish and shellfish by the homemaker, school lunch, and military and institutional personnel, it is necessary that methods of preparation and recipes suitable to their needs be developed, tested, and distributed widely. Such information is limited, and that which is available is of doubtful quality or origin and, in many instances, impractical. Such information is also needed for seafood cookery demonstrations and public service work utilizing the media of radio, newspapers, and television.

The eight States of the region (Florida, Georgia, South Carolina, North Carolina, Alabama, Mississippi, Louisiana, and Texas) are populated by more than 34 million people. To expand the consumption of fishery products among this large segment of the nation's population requires a vigorous educational program directed at all levels of production and consumption. There is a continuing

program to do this, staffed by fishery marketing specialists and home economists located in four marketing offices--St. Petersburg Beach, Atlanta, Pascagoula, and Dallas. Greatest emphasis is placed on consumer-oriented activities such as seafood cookery demonstrations, preparation and distribution of material for newspaper food editors, educational work with college and university home economics classes, and distribution of high-calibre literature, recipes, and audiovisuals to radio and television stations and other information media. Close liaison also is maintained with the producing segments of the fishing industry, and special emphasis is given to assist the marketing efforts of those industry segments in an unfavorable supply-demand situation. Future plans call for more work of this extension service type.

The objective of this program is to increase the per capita consumption of fishery products and thereby strengthen the market and improve the economic position of the domestic fishing industry.

## STUDIES OF SPECIFIC FISHERIES

### Shrimp

Life histories and population dynamics.--In 1961, the total catch of shrimp in the United States amounted to about 172 million pounds, having an ex-vessel value of \$54.4 million. South Atlantic and Gulf States accounted for more than 90 percent of the landings, most of which originated in the Gulf of Mexico. In 1961, the failure of all species of shrimp to appear in normal quantities in the fisheries of these States was a near disaster. It is apparent that management of a fishery of this magnitude and importance requires that we understand what and how natural as well as artificial factors influence significant fluctuations in shrimp supply.

The present expanded program, although based on work dating back to the 1930's, had its inception in 1958. Since that time, the operating budget has increased fourfold and virtually all phases of shrimp biology and dynamics are now under investigation. There has been a considerable advance in our knowledge of shrimp. Readily tangible evidences of accomplishments are the 21 publications that have resulted from various segments of this program since 1958. These range in content from the identification of shrimp larvae to the first paper on the dynamics of a penaeid shrimp population.

Future plans call for extending the offshore studies into the northeastern Gulf, giving more attention to oceanographic observations, placing more emphasis on shallow-water aspects of shrimp life history, intensively investigating promising methods of catch prediction,



Marking shrimp with an internal biological stain to trace time and routes of their movements. The different-colored stains may be injected by a fine hypodermic needle or ingested by feeding shrimp with treated food.

performing research on shrimp culture techniques with special reference to the commercial species of the Gulf of Mexico, making extensive mark and recapture experiments, and, as more pertinent data on such facets as growth and mortality become available, accelerating its study of population dynamics.

The objective is to provide the basis for a management program that will assure efficient utilization and maintenance of the resource at levels that will result in maximum yield.

Physiology and behavior.--At present, the environmental factors underlying natural mortality, growth and migration of commercial shrimp are poorly understood. The need for information in these areas is particularly acute in evaluating present and projected man-made changes in estuaries. Laboratory-controlled experiments can provide valuable information on the optimal and limiting levels of such factors as salinity, temperature, light, and food for commercially important shrimp. Physiological studies may also provide useful

means of identifying races and species which are not morphologically distinguishable.

The two currently active phases of this program measure the influence of these factors in terms of (1) tolerances and behavior and (2) growth and metabolism of selected shrimp. The two phases of the program have produced growth, survival, and behavior information that indicates young brown shrimp have a broad salinity range of tolerance. Survival and behavior studies suggest that temperature may have more influence on survival than salinity. Metabolic work has provided information on the oxygen uptake of white and brown shrimp.

When the constant-temperature rooms are completed and the laboratory renovated, attention will be directed to effects of temperature, food, and light on shrimp survival, growth, and behavior. Preliminary work on paper chromatography and pigment analysis will be extended, and electrophoresis will be used to determine what utility such methods have in identifying races and species of shrimp. In cooperation with the Panama City Gear Development Station

we will evaluate possibility of long-term effects of electric fishing gear on commercial shrimp.

The objective is to obtain information that will contribute to a clearer understanding of the effects of various environmental factors on commercially important species of shrimp. Eventually, these studies will be extended to include commercial species of fish, such as the Atlantic croaker.

## Oysters and Other Shellfish

Erratic production of shellfish causes serious and unpredictable economic distress in various segments of the Gulf of Mexico shellfish industry. Production fluctuations result to a varying extent from predation, disease, pollution, and natural as well as man-made changes in the environment. We need a better understanding of the changes which affect shellfish cultivation. Methods must be found for controlling disease and predation. New resources such as clams and scallops must be developed so that, by diversification, the shellfish industry can work on a year-round basis.

Studies have been completed on the population dynamics of the oyster and its major predator, the drill. Continuous records of hydrographic changes in the environment are being analyzed for their importance to estuarine productivity. Physical and biotic inventories of estuaries are underway for comparison with future environmental changes. Population dynamics of clams and scallops are being studied.

Future plans include (1) continuing the surveillance of environment, necessary to

determine effects of man-made changes, (2) developing improved methods for predator control, and (3) studying the mechanization of cultivation and harvesting to select methods that are not harmful to the resource.

The objective is to establish shellfish culture on a much more economically sound basis by improving cultivation techniques and developing superior, disease-resistant varieties of commercial species.

## Blue Crab

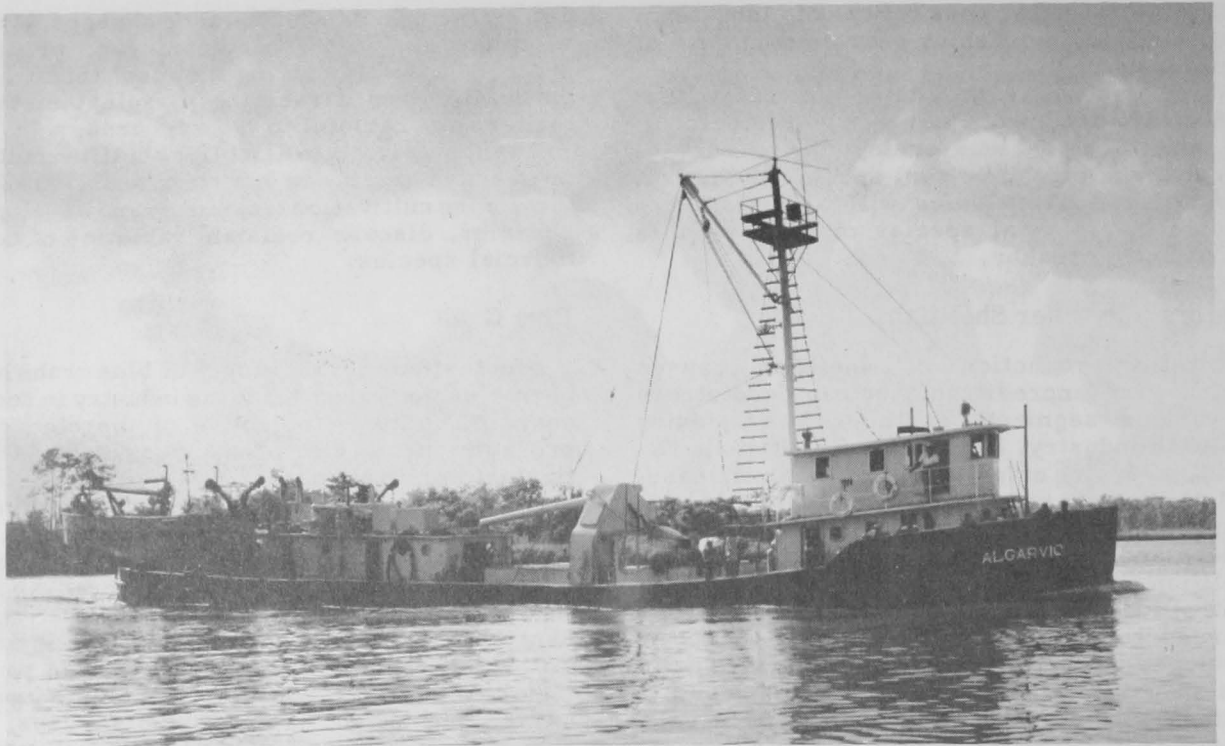
Fluctuations in the supply of blue crabs have been a serious problem to the industry in recent years. The basic objective of the blue crab program is to determine the causes of these fluctuations in abundance.

Current research concerns the studies of (1) the effects of environmental factors on the survival and development of blue crab larvae, (2) the life history of the blue crab and its fishery in the St. Johns River, Fla., and (3) the blue crab in the Newport River and adjacent waters in North Carolina. Information sought includes the effects of environmental changes on the abundance of marketable crabs; the abundance and distribution of blue crab larvae and juveniles; the species composition of the crab population; and the migratory movements of the adults.

As a result of these studies, migratory patterns of adult blue crabs between estuarine and ocean waters have been established; pertinent data have been collected on the distribution and abundance of larvae and juveniles in brackish and ocean waters; blue crab larvae



Blue crabs being tagged and measured on stern of research vessel in studies to determine extent of migration and size of population. The plastic tag measures 44 by 7 by 1 millimeters and is fastened to the crab's carapace with stainless steel wire.



The Algarvio, one of the top boats in production for the last 3 years, entering Pascagoula River from the Gulf of Mexico, with a full load of menhaden.

and larvae of closely related species have been successfully hatched and reared in the laboratory, yielding information on the effects of environmental factors on their survival and development, as well as aiding the positive identification of larvae collected in the field.

The present program emphasizes the biology of the blue crab, rather than the fishery. This is necessary if the research results are to be applicable to the resource as a whole, rather than just to stocks in the geographical localities under study. Future plans are for expanded basic research in the laboratory to answer some of the questions arising from field studies. Specifically, information is needed on the requirements for survival of the various life history stages, the behavior of the animals under controlled laboratory conditions, and the physiology of the blue crab.

The objective of the program is to provide detailed information on the biology and life history of the blue crab for scientific management of the species.

### Menhaden

Atlantic and Gulf menhaden support the largest fishery in the United States, with landings exceeding 2 billion pounds annually. During the past decade, the total catch has increased tremendously, but catches in different localities varied markedly, both within and between years. An investigation of the Atlantic menhaden was undertaken with the

objectives of determining the causes of such fluctuations and the extent to which these are predictable.

The present research program is concerned with (1) determining the seasonal and geographical distribution and interrelations of natural populations of menhaden, (2) measuring the amount and composition of the annual catch for determining the dynamics of the Atlantic fishery, (3) accumulating scientific information on biology, including spawning, early life history, and migrations, (4) estimating relative abundance of juveniles of each new year class in estuarine nurseries, and (5) making field studies and laboratory experiments to determine the effects of varying environmental factors on the survival of young.

Major accomplishments of the program include (1) published reports of biostatistics, early life history, distribution, and population structure, (2) annual evaluation of the condition of the Atlantic fishery and prediction of catch for the following year, (3) discovery of unexploited stocks of menhaden, and (4) establishment of the vital importance of the estuaries to the menhaden resource.

Future plans are to (1) improve the reliability of predictions and assessments of the condition of the Atlantic fishery by mathematical refinement of estimates of the various factors that govern populations, (2) expand studies on those aspects of biology which are necessary for understanding fluctuations in the fishery, (3) determine the environmental

factors which influence the distribution and abundance of the fish, (4) undertake studies of the Gulf menhaden resource, and (5) identify the underexploited and unexploited stocks of menhaden or menhadenlike fishes and establish their patterns of distribution and abundance.

The objective of the program is to provide the basic scientific information required to determine the maximum continuing production from, and the full utilization of, the menhaden resources.

### Anadromous Fishes

Research on the American shad was begun in 1949 to determine the causes of a decline in abundance and to provide information for improving the management of the fishery to arrest further decline.

The objectives of present shad research are to (1) assist State and Federal agencies in the solution of problems encountered in rehabilitation of runs above existing and proposed impoundments, and in areas of channel improvements, and (2) obtain estimates of population size, exploitation rates, and escapement for five major runs, and where possible, predict the size of runs 1 year in advance of exploitation. Published research accomplishments include (1) discoveries pertaining to the biology of the species, (2) determination of causes of population fluctuations, and (3) development of methods and procedures to arrest future declines in abundance and to increase the annual catch substantially.

Research on striped bass was initiated in 1955, in cooperation with research agencies of the Atlantic Coast States, to protect the commercial fisheries against unwarranted



Tagging "jumbo" striped bass on the coast of North Carolina to determine migrations. This fish weighed 47 pounds.



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exclusion of fishing rights and to obtain basic biological data to assist the States in their joint management of the species for optimum benefit of both the commercial and sport fisheries.

The current research is concerned with (1) developing methods, whereby sampling of young striped bass and the commercial catch will provide a basis for predicting the age composition of the catch and population size in advance of exploitation, (2) applying developed methods and procedures to Chesapeake Bay stocks, and (3) obtaining information on movement, origin, and identity of stocks occurring along the Atlantic coast. Research accomplishments include (1) estimation of population size and exploitation rate by age class in Albemarle Sound and the Roanoke and Potomac Rivers and (2) discovery of important facts on the biology of the species which are essential in management recommendations.

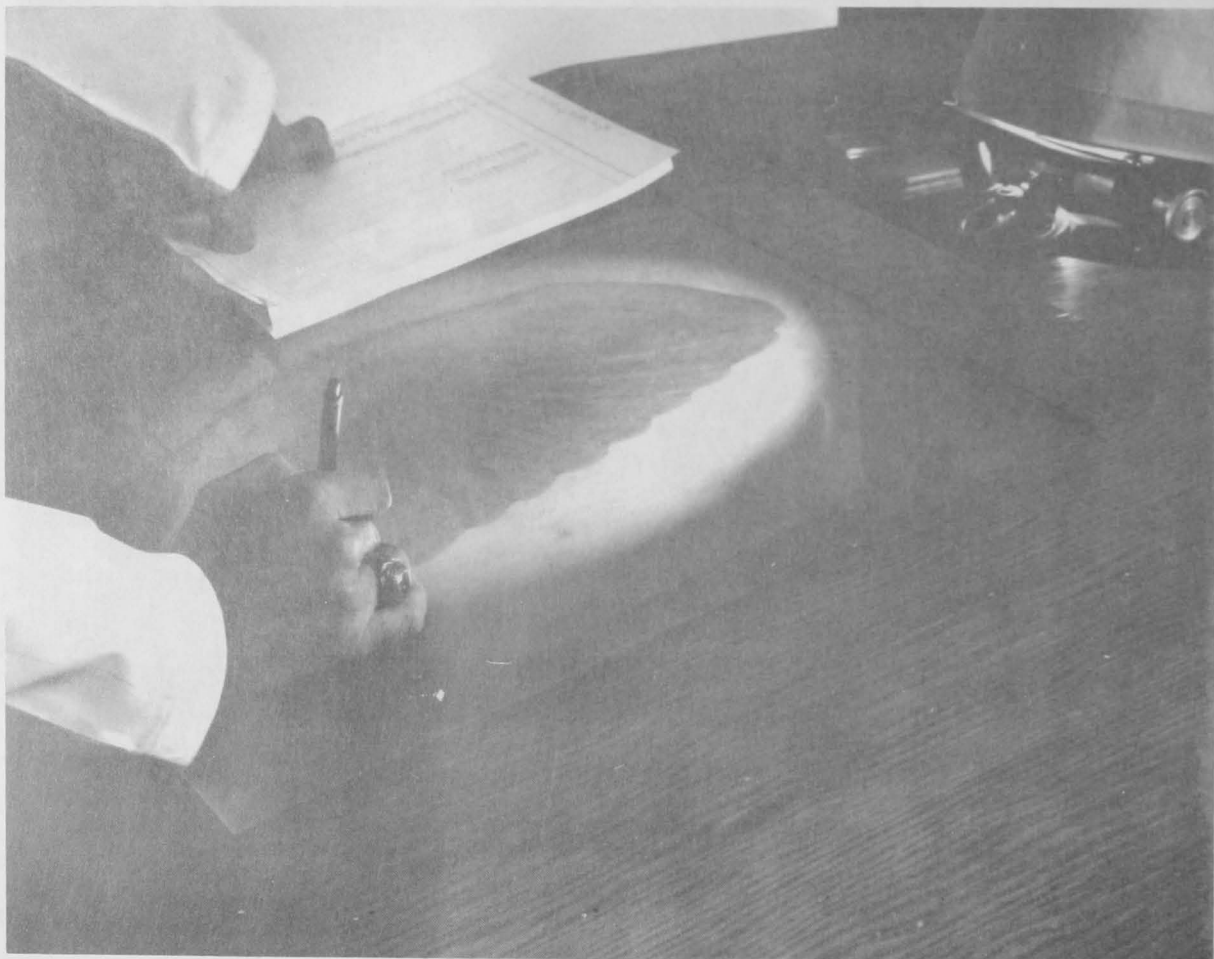
Future research plans include (1) continued studies of shad and striped bass population dynamics and prediction of the composition and size of catch in advance of exploitation in the major population centers, (2) tag and recovery,

anatomical, and serological studies to identify the movement and origin of striped bass stocks occurring along the Atlantic coast and subpopulations within areas, and (3) assistance to State and Federal agencies on problems encountered in rehabilitating runs of all anadromous species deprived of their spawning grounds by existing and proposed impoundments, and in areas of channel improvement.

The objective of the program is to provide scientific information to all agencies on the Atlantic seaboard concerned with anadromous fish problems, so that the fisheries may be more effectively managed on a sustained basis.

### Industrial Fishes

The Gulf of Mexico fishery for industrial-type fishes, other than menhaden, has developed rapidly in recent years and has not yet reached its full potential. Unlike the menhaden fishery which operates with purse seines and large capacity vessels in the nearshore shallows and has its catch reduced to oil and meal, the bottomfish fishery employs otter trawls and smaller vessels, ranges farther offshore and is



In an attempt to decipher the age, a scientist studies the enlarged image of a scale of the longspine porgy, a potential industrial fish abundant offshore.

supported by a variety of demersal fishes, mainly sciaenids, which are used in the manufacture of petfood. Of the 1961 U.S. catch of industrial fish, more than 40 percent was taken in the Gulf region. Practically all of this came from the 300-mile stretch of coastal waters off Mississippi and Louisiana.

The questions now being asked concern the feasibility of extending present bottom fisheries to the east and west of this area, and the conservation of currently exploited stocks. We anticipate that research under the industrial fishery program, directed by the Biological Laboratory at Galveston, will provide at least partial answers.

A project designed to survey the species and age composition of landings made by the "petfood" fleet at Pascagoula has functioned since 1958. The project's principal objectives are to observe changes that may occur in the fish populations as a result of exploitation and to obtain life history information for the dominant species. Results to date constitute a detailed inventory of species contributing to the fishery and a fair amount of life history data for the more important ones. Monthly trawl samples of fish obtained systematically on the Continental Shelf between the Mississippi Delta and the Rio Grande River, incidental to the shrimp research program, are providing additional information on patterns of seasonal and geographic distribution for the major

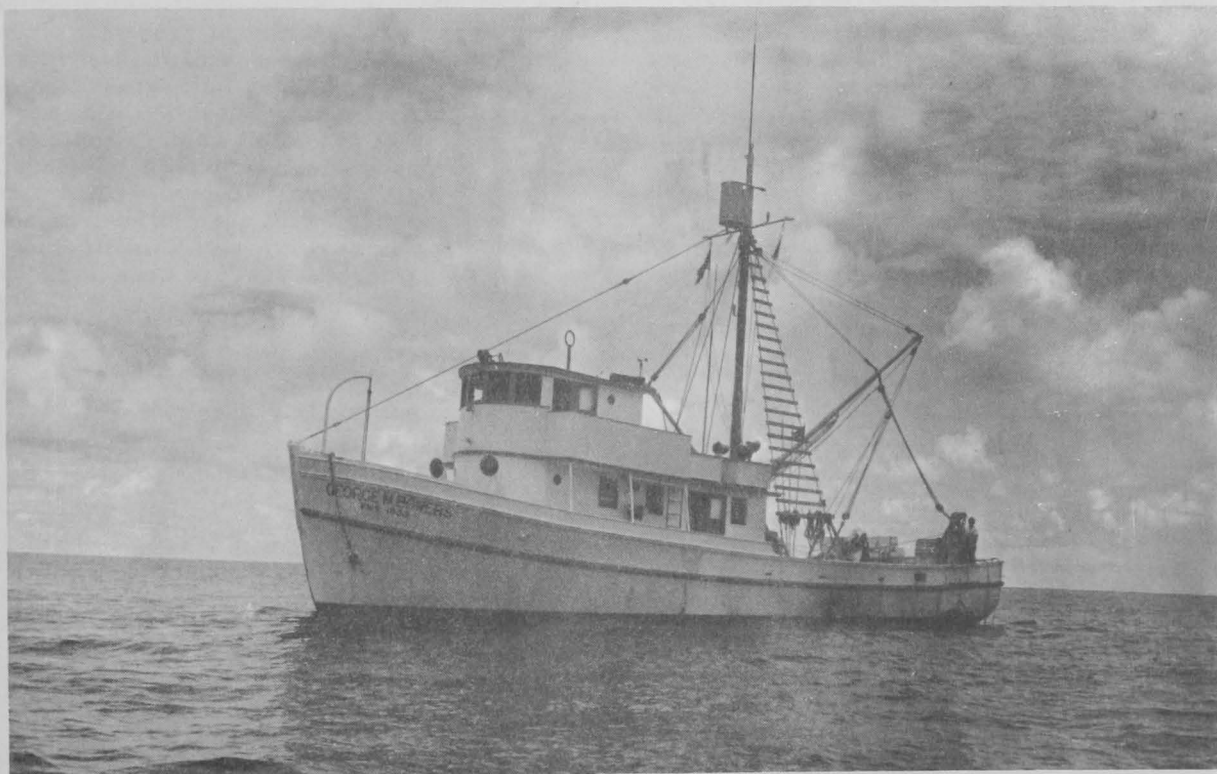
bottom species. Since a few sampling stations are in the area fished by the existing industrial (bottomfish) fishery, comparative analysis of commercial and research statistics will make possible a realistic appraisal of the potential that the western Gulf holds for this fishery's expansion.

The objectives are to (1) describe the life histories of species dominating existing or potential fisheries, (2) ascertain their geographical and seasonal distribution, (3) provide means for measuring and predicting their abundance, and (4) define the mechanisms whereby artificial and natural factors govern their populations.

## SPECIAL SERVICES

### Fisheries Loan Program

Commercial fishermen of the United States generally have been undercapitalized and traditionally have depended upon financing from private sources. When fishing was profitable, credit was usually available to vessel owners from banks, fish-processing firms, or supply houses. This sustained the fishermen until such factors as increased operating costs and decreased prices caused unprofitable operations. Sources of financial assistance became increasingly difficult to find, and maintenance of



The M/V George M. Bowers, based at Panama City, Fla., is a 73-foot wooden hull trawler outfitted for gear development and related studies.

fishing vessels and gear suffered. By 1950, certain segments of the industry had become so depressed that foreclosures of vessel mortgages were not uncommon. This was especially true of the New England groundfish and Pacific coast tuna fisheries. Even the Small Business Administration refused to make loans to vessel owners because there was no reasonable assurance of ability to repay the loans from earnings.

As conditions worsened, the industry appealed directly to Congress for relief. This effort resulted in a provision in the Fish and Wildlife Act of 1956 for making Federal funds available to assist commercial fishermen. The Fisheries Loan Fund of \$10 million was established for the financing or refinancing of operations, maintenance, replacement, repair, and equipment of fishing gear and vessels, and for research into basic fisheries problems. In 1960 an additional \$3 million was appropriated to increase the revolving loan fund. Unless the Fisheries Loan Program is renewed, it will expire June 30, 1965.

Since the inception of the program in 1956, 309 loan applications requesting \$7.9 million

have been processed in the Gulf and South Atlantic region. Of these, 121 were approved for \$2.8 million, 19 have been paid out, 7 foreclosed, 22 cancelled, and 76 are still active.

Fishery loans granted in the past have served in most instances to help commercial fishermen over financially difficult times and have tended to maintain and upgrade the fleet. This important assistance program is scheduled for continuation to meet the needs of qualified industry members.

### Fishing Vessel Mortgage and Loan Insurance

The Federal Fishing Vessel Mortgage and Loan Insurance Program, established in the Department of the Interior in 1958, by transfer from the Maritime Administration, is designed to assist the industry in financing construction and reconditioning of fishing vessels. Vessel owners arrange with qualified lenders for the money to be borrowed, and the mortgages or loans may be insured by the Secretary of the Interior in accordance with the Act and regulations.



A modern shrimp trawler and the first commercial fishing vessel financed in the United States under the Fishing Vessel Mortgage Insurance Program.

In Region 2, this relatively new program has been widely advertised throughout the industry, and applications requesting insurance for \$133,060 have been received and processed. Continued efforts are scheduled to keep the industry advised of the availability of this program, its benefits, and procedure for its use.

While mortgage and loan insurance activities have not been used extensively by the industry, the program is considered to be outstanding and one which has been and will be a stabilizing vehicle for fishing vessel financing.

### Fishing Vessel Construction Differential Subsidy

In June 1960, Congress enacted P.L. 86-516 (U.S.C. 1401-13), giving authority to the Secretary of the Interior to provide the fishing industry with financial assistance to correct inequities between foreign and domestic costs for fishing vessel construction. The Secretary may pay up to one-third of the cost of construction of a new fishing vessel, provided the owner of the proposed vessel and the fishery meet requirements outlined in the regulations. Since construction of fishing vessels in some foreign countries costs 40 to 50 percent less than in American shipyards and since by law fishermen are prohibited from purchasing foreign-built vessels for use in domestic fisheries, the subsidy is intended to equate the production cost of certain fishery products which have invaded the markets in this country. No fisheries in Region 2 were qualified for this subsidy, and the program, therefore, was inoperative. The law expired in June 1963.

Currently there is a movement by the industry to extend and broaden through congressional action the eligibility requirements for subsidies. Future regional activities are contingent upon passage of pending legislation which will qualify fisheries of the Gulf and South Atlantic.

### Statistics

Market news.-- There is a continuing need for current information concerning production, distribution, and market demand for all perishable products. Daily market news data are collected and distributed by the Market News Service to encourage the orderly marketing of fishery products; to aid in the determination of past, present, and future development of the fisheries; to assist firms or individuals in making intelligent and profitable decisions; to aid in determining the proper utilization of fishery products; to assist Government agencies in making regulations and decisions regarding fisheries; and to keep industry informed of trends and developments of fisheries in the United States and foreign countries.

Daily reports are issued on landings, receipts, imports, rail and truck movements, cold storage holdings, market conditions, and prices of fishery products and byproducts within principal production areas along the Gulf coast. These data are collected and reported by 16 statistical agents stationed at major Gulf ports. Also, a monthly and annual report is issued summarizing Gulf of Mexico landings, production, prices, and imports and shipments of fishery products. The present mailing list consists of 1,100 subscribers in the fishing and allied industries.

Future plans call for inclusion in the daily Fishery Products Report of (1) shrimp landings at major ports of the South Atlantic States, (2) receipts of fishery imports at Miami, Fla., and Houston, Tex., and (3) landings at other Gulf ports that become important.

The objective is to provide, on a current basis, fishery marketing data essential to efficient industry and governmental planning and operations.

Statistics.-- Statistical coverage of the commercial fisheries provides industry, and Governmental agencies concerned with the fisheries, information essential to efficient industry operations and basic actions needed to protect, conserve, and develop fishery resources. Statistical activities are closely coordinated with those of Market News.

Statistical surveys are made in both the South Atlantic and Gulf States to collect, analyze, and disseminate statistics on the volume and value of the catch of each species by type of gear and geographic area; employment of fishermen, fishing craft, and gear; volume and value of processed fishery products; and employment in shore plant facilities. In the Gulf States, a program to obtain continuous detailed catch information on the shrimp fishery was established in 1955. Information obtained consists of the volume and value, by species and count-size composition, of each trip landed by vessels; productive and nonproductive fishing effort; and area and depth from which individual catches are taken. Future plans will extend the collection of detailed catch information to the shrimp fishery of the South Atlantic States and the menhaden and crab fisheries of the Gulf States.

The objectives are to meet the needs of research activities and industry planning by providing current, continuous, and comprehensive fishery statistical information.

### Forecasting

The leaders of the U.S. fishing industry repeatedly have demonstrated their ability to meet and overcome adversity by their own aggressive and oftentimes ingenious actions. The most recent example is the purse seine conversion of tuna vessels in the Pacific fleet.

This conversion has reduced fishing costs and made the catch economically competitive with foreign production.

In view of this inherent resilience of the industry and its demonstrated ability to solve many of its own problems, perhaps one of the chief services it needs, and cannot readily provide, is advance information concerning changes in abundance of fish on the grounds and available market supplies. Forecasts of catastrophic changes, whether from biological causes in the resource or foreign competition in the market, would enable the industry to prepare for these eventualities. Instead of incurring heavy financial loss before recognizing and attempting to solve a problem, the industry would begin to seek a solution while it had full economic strength.

The full staff of the Bureau--biologists, economists, technologists, marketing specialists, statisticians, and others--in a sense serve as an intelligence unit providing a vast amount of information. If this information were evaluated and analyzed currently, and considered together with data from other sources, possibly through the use of electronic computers, it would form the basis for the forecasts needed to guide the industry in its operations. This would be one of the most important services the Federal Government could provide the U.S. fishing industry.

## PUBLIC RELATIONS IN RESEARCH

Regardless of merit or urgency, a research program to be fully effective must have public awareness and support. The recognized responsibility to publish findings in research journals cannot in itself keep the public well informed. A well-organized regional program must provide established lines of contact with the area's newspapers, TV and radio stations, and civic groups. It is the responsibility of the research worker to furnish understandable reports of not only spectacular findings but also interesting material which explains the need for new or continuing research to the public. An equally well-defined objective of such news releases is to avoid the conflicts of interest that arise through misunderstanding and lack of knowledge.

## SUMMARY

The preceding pages discuss in detail the status of the commercial fishery resources of the region, their utilization, and their needs. This section summarizes the programs that should be continued or undertaken within the region to strengthen the fishing industry and point the way to full utilization of the resources of the Gulf and South Atlantic waters. Many of these needs will be met by the industry without

assistance. Other needs will be met by cooperative industry-Government action; and still others, particularly in the field of biological research to provide the basis for resource management, must be met through Government efforts--both State and Federal. Coordination and integration of these separate activities are possible through the Gulf States Marine Fisheries Commission and the Atlantic States Marine Fisheries Commission, and their standing committees.

## Government Programs

1. Continue and expand the faunal survey in the region to obtain basic knowledge concerning the inhabitants of our waters and conditions of the environment in which they live. This will yield information to the fishing industry concerning distribution, abundance, and changes in abundance of fish and shellfish of potential importance. Specific means of communicating these findings in layman's style to the industry should be developed.

2. Continue and complete research on the life histories of commercially important species that range across State boundaries. Such research will provide the knowledge needed for resource management. Included in these studies are shrimp, Atlantic menhaden, blue crab, striped bass, oysters, and several species of industrial fish. Work on the Gulf menhaden should be undertaken at the earliest possible time.

3. Continue, expand, and expedite research in the estuaries to provide precise information on the immediate effects of engineering projects on estuarine conditions, and in turn, their effect on the aquatic life. Long-range effects also must be studied through systematic observations on physical, chemical, and biological phenomena on a long-term basis.

4. Continue research in the laboratory and in the field to determine the relative toxicities of all the important agricultural insecticides and pesticides to our valuable estuarine animals, including the oyster, crab, shrimp, menhaden, and other finfish, and the phytoplankton which forms the basis of their food web. The objective is to assist in the development of chemicals which will be specific in the eradication of unwanted forms but will not be harmful to commercially valuable fish and shellfish.

5. Continue research on the effect of radioactive materials, which could reach the marine environment either by accident or design, on fish and shellfish, and the suitability as human food of such contaminated animals.

6. Continue, in cooperation with the State conservation agencies, to collect accurate, detailed statistics of catch, including such information as quantity by species and size, place of capture, depth of water, and effort expended. These data, now being obtained for

the Gulf shrimp and Atlantic menhaden fisheries, should be gathered for other fisheries, and especially new fisheries as they come into being. Collection of statistics from the South Atlantic shrimp fishery, in the same form as in the Gulf, should be undertaken immediately.

7. Continue and expand research to improve the efficiency of existing forms of fishing gear and develop new, imaginative devices for harvesting our marine resources. The industry should share in this program.

8. Establish economic studies to determine the relationship of fishery management regulations to economic returns in the major fisheries of the region. Basic knowledge is needed to determine the effect of regulations resulting from accumulated biological data on the future economics of the fisheries.

9. Continue to use the fishery loan fund to assist qualified fishermen. Sustain efforts to insure mortgages given in the construction of new vessels for qualified applicants. Initiate or coordinate studies into practical subsidy grants for new and advanced vessel construction, particularly where such subsidies would tend to equate the unfair cost differential between American- and foreign-built fishing vessels.

10. Continue and expand the market development, market promotion, and home economics activities conducted by the regional marketing staff to increase the consumption of regionally produced species. Assist in encouraging new or expanded industry in the region to create new markets for underutilized species such as mullet and threadfin herring. These marketing activities should supplement, but not replace, those of industry.

11. Basic research is needed on the chemical composition and nutritive value of fish and shellfish, and the chemical and microbiological changes that occur during their handling, processing, and storage. Many industry problems will be solved only after fundamental knowledge derived from such research is available.

### Industry Programs

1. Diversify fishing operations to utilize equipment and personnel to the maximum extent possible. The fact that half the Gulf and South Atlantic shrimp fleet fishes less than one-third of the time emphasizes this need. This diversification will minimize the adverse effects of poor seasons caused by natural conditions, as well as unfavorable markets.

2. Modernize plants and processing methods to produce products of consistently high quality in a form attractive to the consumer.

3. Develop new products for both industrial and consumer use. Products that can be more conveniently handled by the housewife are needed if such Gulf species as mullet and snapper are to be competitive in today's market. Assistance to the industry will be provided by the Bureau's technological staff.

4. Expand the promotional effort on seafood products, using recent knowledge of health-giving qualities and other proven attributes to attract consumers. This effort now is infinitesimally small in contrast to that of other food industries such as the Florida citrus industry. The Bureau will assist the industry in this field of endeavor.

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