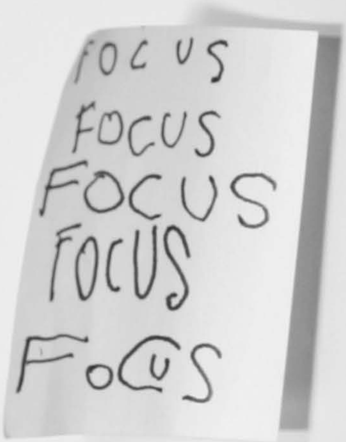
Annual Report
Bureau of Commercial Fisheries
Exploratory Fishing and Gear Research
Fiscal Year 1963

Circular 193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Annual Report
Exploratory Fishing and Gear Research
Bureau of Commercial Fisheries
Region 2

for

Fiscal Year 1963 ending June 30, 1963

Harvey R. Bullis, Jr., Base Director

Circular 193

Washington, D.C.
December 1964

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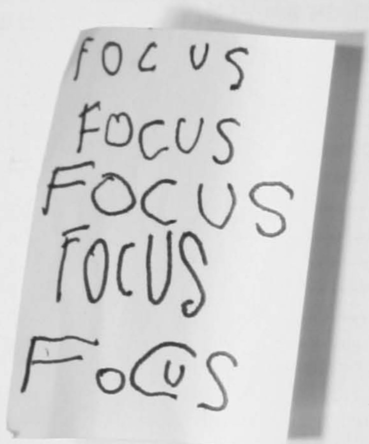
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Part One

An Historical Glance and Overall View of Exploratory Fishing and Gear Research in Region 2

by

Harvey R. Bullis, Jr., and J. R. Thompson

INTRODUCTION

This circular describes the exploratory fishing and gear research activities of the Bureau of Commercial Fisheries in Region 2 (Gulf and South Atlantic States) during fiscal year 1963. Included are descriptions and accomplishments of programs at the Exploratory Fishing and Gear Research Base, Pascagoula, Miss., and at the three field stations under the Base's direction: The Gear Research Station, Panama City, Fla.; the Exploratory Fishing and Gear Research Station, Brunswick, Ga.; and the Bureau of Commercial Fisheries--Agency for International Development--Spiny Lobster Exploratory Fishing Project, Republic of Panama.

Since this is the first published annual report of the activities of the foregoing installations, we are providing historical sketches and statements of aims, goals, and methods of exploratory fishing and gear research.

HISTORY

Exploratory Fishing and Gear Research Base, Pascagoula, Miss.

The Fish and Wildlife Service was named as primary research agency for the Gulf States Marine Fisheries Commission on May 19, 1949. Passage of Public Law 163, 81st Congress (1949), transferred the vessels Oregon and Alaska from the Reconstruction Finance Corporation to the Fish and Wildlife Service for fishery development and research in the Gulf of Mexico. A Commission resolution quickly followed, urging that the vessels be made "available for immediate use for the research and exploration work" intended by Public Law 163, and this Congress soon passed legislation providing funds for outfitting and operating the vessels. The 100-ft. Oregon was assigned to Pascagoula for use in exploratory fishing, and the 100-ft. Alaska was assigned to the biological research program in Galveston, Tex.

Recommendations formulated by the Gulf States Marine Fisheries Commission in January 1950, stipulated that tuna, shark, and snapper would receive the primary attention of exploratory evaluations, but that other species "such as mackerellike and flat fishes, menhaden, and shrimp," would also receive concurrent study. Six months later, the Commission requested that shrimp be substituted for shark as one of the primary targets of exploration. It was further suggested that "strenuous effort be made to locate offshore concentrations of shrimp. . . ."

On May 8, 1950, the Oregon sailed on cruise 1, and in the next 6 years extended its explorations over the Continental Shelf areas of the Gulf. An intensive effort was made to extend the known boundaries of commercially profitable beds of brown and pink shrimps and to discover new areas for possible commercial use (Springer and Bullis, 1952a, 1954a). Concurrently, explorations were extended beyond the Shelf Edge--into the pelagic realm for yellowfin tuna (Bullis, 1955d; Captiva, 1955; Wathne, 1959) and to bottom areas of the Continental Slope where sizeable stocks of royal red shrimp were found (Bullis, 1956a).

In 1955, at the suggestion of the Commission, the Oregon left the Gulf for a brief period to fish with longlines for yellowfin and bluefin tunas in the northern Caribbean. This work, undertaken in view of awakened interest in the Caribbean by members of the fishing industry of the Gulf and South Atlantic States, established the usefulness of the Oregon in both the Gulf and the Caribbean, although primary emphasis continued to be placed on Gulf resource investigations.

Organizational changes in accordance with the Fish and Wildlife Act of 1956 placed the Pascagoula facilities under the general supervision of the Gulf and South Atlantic Regional Office (Region 2), St. Petersburg Beach, Fla.

Figure 1.--Bureau of Commercial Fisheries Laboratory, housing the Exploratory Fishing and Gear Research Base offices and work areas, Pascagoula, Miss.

In 1957, operation of the exploratory program was greatly strengthened by the completion of a new, modern brick office and laboratory building, a net shed, machine shop, and fenced dock area. Program scope expanded and in May 1957, the Oregon was joined by the 96-ft. Silver Bay. The latter vessel was chartered by the Bureau to test the effectiveness of roller-rigged trawls for catching snapper and grouper in the Gulf waters and to evaluate the economical use of this gear (Rathjen, 1959; Captiva and Rivers, 1960). The Oregon then concentrated on the midwater and surface schoolfish resources of the Gulf (Thompson, 1959; Bullis, 1961b). In addition, the use of the Silver Bay in the Gulf enabled the Oregon to make four cruises to the Caribbean and the northeast coast of South America (Bullis and Thompson, 1959). As a result of these cruises, 200 U.S. shrimp vessels are now working successfully along the coasts of the Guianas.

From 1958 to 1962, the Oregon continued to explore both the Gulf and the tropical waters of the Caribbean and southern North Atlantic. In the Gulf, efforts were made to develop midwater trawling gear. A depth recorder transducer mounted on the headrope of a midwater trawl proved extremely useful in trawling operations. A trawl-mounted camera system (Kruse, in press[1]) was also developed to study the reactions of fish to the midwater trawl; analysis of the film footages obtained is not complete. Outside the Gulf, the Oregon cruised off the coasts of Puerto Rico and the Virgin Islands, off Trinidad, and along the Caribbean coast of Central America to expand knowledge of the distribution of commercial shrimping areas. From these studies we added considerable knowledge to the previously scanty store of faunal information on the areas surveyed. Appendix A summarizes Oregon cruises.

At the beginning of fiscal year 1963 (July 1, 1962) a pronounced shift in program emphasis was evident. Exploratory fishing practice was becoming more systematic and more precise than it had been previously, and there was greater attention to detailed analysis of the faunal assemblages making up the resource complexes in the Gulf, Caribbean, and tropical western Atlantic. Automatic data processing

[1]Paul J. Kruse. In press. A remote controlled underwater photographic surveillance system. U.S. Fish and Wildlife Service, Special Scientific Report--Fisheries.

(ADP) equipment had arrived, and we began transferring 12 years of field records to punchcards. At the same time the staff began assembling identification records from the more than one hundred cooperating taxonomists in universities, State agencies, and other organizations, who had worked with Oregon material.[2]

Exploratory Fishing and Gear Research Station, Brunswick, Ga.

The history of Bureau explorations on the southeastern coast of the United States in the past decade started in 1956, when funds were made available under the Saltonstall-Kennedy (S-K) Act for a survey of the shrimp potentialities. A small vessel, the 75-ft. Pelican, was immediately chartered and put into service, with docking facilities at Jacksonville, Fla. Shortly afterward, the Pelican proved to be slightly too small for full-scale explorations in the face of the strong Gulf Stream and offshore conditions and was replaced by a second charter vessel, the 97-ft. Combat. Together, the two vessels completed stations in depths of 2-600 fathoms between Cape Hatteras, N.C., and the Dry Tortugas. Investigations concentrated on the commercial potential of previously unknown royal red shrimp stocks off Florida's east coast, but the entire assigned range was routinely explored. Results of these explorations and of a cruise by the Silver Bay to the royal red shrimp grounds off Florida in 1958 are found in the paper by Bullis and Rathjen, 1959.

In 1959, at the request of the Atlantic States Marine Fisheries Commission and the Southeastern States, S-K funds were provided for a more comprehensive investigation of resources on the southeastern coast. The Silver Bay, having just completed a 2-year survey of the snapper grounds of the Gulf of Mexico, was rechartered and assigned to the east coast program. The city of Brunswick, Ga., provided docking facilities and office and storage space. The resources of the Continental Shelf off the Carolinas, Georgia, and Florida were explored first.

Among other results of this early period were the findings of commercially valuable stocks of hard clams off Beaufort Inlet, N.C., and a large bed of calico scallops off

[2] A listing of these records will be a continuation and updating of Fish and Wildlife Service SSR-F 196, "Collections by the Oregon in the Gulf of Mexico" by Springer and Bullis, 1956.

Figure 2.--Present shore facilities, Exploratory Fishing and Gear Research Station, Brunswick, Ga.

Figure 3.--Exploratory fishing vessel Silver Bay.

Cape Kennedy, Fla. (Bullis and Cummins, 1961). This scallop bed so stirred industry interest that in 1960 to 1961 the Bureau used the Silver Bay for further scallop investigations.

Preliminary explorations of rough-bottom areas with roller-rigged New England fish trawls indicated an extensive foodfish potential at several points in the areas worked (Cummins, Rivers, and Struhsaker, 1962). These explorations led, in part, to the work in fiscal 1963. A summary of Silver Bay cruises is given in Appendix A.

Gear Research Station, Panama City, Fla.

In 1955 funds were provided for the establishment of a station devoted to (1) the scientific study of commercial fishing gear and methods and (2) gear problems besetting Bureau exploratory fishing operations. The site chosen for the station was in Coral Gables, Fla., on the campus of the University of Miami. Somewhat later, the station was moved to more spacious quarters in Miami proper. The 74-ft. George M. Bowers was constructed to serve the station's needs.

Early projects included a study of the effects of auditory stimuli on shrimp behavior. This study was inconclusive primarily because equipment of the necessary precision was not then available for recording and observing. A second project was the development of a small midwater trawl for sampling schoolfish populations and an electronic telemetering device for controlling trawl depth.

In 1958 the Gear Research Station was placed under the supervision of the Exploratory Fishing and Gear Research Base in Pascagoula. For operational economy the station was moved to Pascagoula where it operated until fall 1962, when it was relocated in Panama City, Fla., where conditions were more favorable for shrimp behavior studies.

While in Pascagoula, the Gear Research staff completed an underwater study of shrimp trawls in action under a variety of conditions. SCUBA diver observers and camera operators produced a movie film, in color, with sound track, showing and describing the effects of varying vessel speeds and water conditions on trawl performance as well as the comparative performances of trawls of different designs The film has since been in demand by fishermen's groups throughout the country. A commercial studio recently added a Spanish sound track to the film for use in Latin American countries, and Brazilian officials are considering the production of a Portuguese version.

After the film was completed, attention turned to more basic studies, which are being pursued at the new installation in Panama City, Fla.

Figure 4.--Gear research vessel *George M. Bowers*.

Figure 5.--Exploratory fishing vessel *Pelican*.

BCF/AID Panama Spiny Lobster Exploratory Project

In 1961, the U.S. Agency for International Development (AID) requested the Bureau to survey the fisheries of Panama and to recommend programs in which technical assistance could materially contribute to the development of national fisheries. Among the recommendations of the resulting survey was a proposal to explore the spiny lobster resources of both the Caribbean and Pacific coasts of the Republic of Panama. Local interest in this proposal was high, owing to recent successes in lobster fishing in neighboring areas (Costa Rica, Honduras, El Salvador), as well as in some localized Panamanian areas where lobster fishing was tried. In 1962, AID approved a 1-year program to explore the coastal areas for spiny lobsters and gave the Bureau a contract to conduct the project.

NATURE AND FUNCTION OF EXPLORATORY FISHING AND GEAR RESEARCH IN REGION 2

The fundamental objective of exploratory fishing in Region 2 is to systematically assess the biological resources of the tropical and subtropical western Atlantic. Emphasis is placed primarily on surveying those resources or resource segments not now used or used very little by the commercial fishing industry and lying in, on, or above the Continental Shelf and Slope. The principal long-range goal is to compile a basic resource inventory for the region. Such an inventory will depict the spatial and seasonal distribution of all resource elements quantitatively. It will be based on catch rate figures from samplings made with a wide array of types of gear under a variety of conditions.

Exploratory Sampling Devices

Gear used for exploratory work in most instances is patterned closely after commercial fishing gear or serves as the prototype for new gear. Certain gear have proved more satisfactory than others as sampling devices and are considered as standards. These include:

a. 40- and 65-ft. shrimp trawls.
b. 6- and 8-ft. tumbler dredges.
c. 8-ft. Georges Bank scallop dredges.
d. 60/80-ft. New England fish trawls with rollers.
e. 40- and 100-ft.-square modified British Columbia midwater trawls.
f. 1,000-hook units (100 tubs) of Japanese longline tuna gear.

Owing to the high degree of selectivity of the gear used, any approach to providing a resource evaluation must consider the need for sampling with a wide variety of gear.

Sampling Patterns in Fishery Exploration

An important aspect of the work of exploratory fishing in the region today is a study of sampling methods and approaches that are more applicable to surveying marine populations than the conventional grid-intersect system. It is now apparent that any adequate sampling program must consider the relations between the animals and such environmental factors as temperature, substrate, bottom topography, and depth to mention a few of the more important.

Recognizing that uniform grid-intersect methods of sampling have their primary application to uniform areas (which are usually small), ecologists have pioneered sampling methods based on a preliminary familiarization with the specific area to be studied. Much the same types of procedure have been used traditionally in exploratory fishing, but with the insights received from a thorough study of tested and proved methods a well-defined scheme can be worked out.

Bases for Quantitative Estimates of Animal Abundance and Availability

Development of a truly quantitative estimate of the abundance of a species must include (a) an idea of the distribution and varying densities of that species in the area sampled, (b) area traversed by the gear, and (c) the effectiveness of the gear in capturing animals in its path. Heretofore results have generally been reported in terms of availability, with little or no realistic way to link availability with abundance. Recently, however, instrumentation and methodology developed or acquired by exploratory fishing and gear research installations in Region 2 have made possible the beginnings of an availability-abundance correlation.

Distance traveled by the vessel can be measured by distance between two Loran fixes or read from a pitometer log aboard the Oregon. This figure times the width of the opening of the collecting gear gives a reasonable figure for estimating area covered with such bottom collecting gear as shrimp trawls and dredges. An additional factor, height of the gear opening, must be added when estimating water volumes sampled by fish trawls and midwater trawls, as organisms captured occupy a three-dimentional medium, rather than the sea floor only. Little problem is presented in determining the width of such rigid gear as dredges, rakes, or beam trawls, but determining the width (and height) of the path of a nonrigid otter or shrimp trawl is more difficult. Two methods of measuring have been used: (a) directly by SCUBA divers and (b) indirectly by photometric means. Bullis and Cummins (1963) have discussed application of direct measurements to 40-ft. shrimp trawl bottom coverage estimates, and Kruse (in press[3]) has explained the

[3] See footnote 1, p. 2.

application of photometric methods to midwater trawl measurements.

The recent development of an underwater motion picture camera and light system and the coming acquisition of an underwater television system, both capable of use on the shelf and slope, will increase our ability to estimate the effectiveness of the gear and the pattern of animal distribution within the areas sampled. Preliminary camera footage indicates that both factors are resolvable with the use of the camera system. Thus, we hope to be able to estimate with increasing accuracy the area covered by the gear and the proportion of organisms in that area captured by the gear. With these estimations, staff members can calculate the relation between abundance and availability.

Exploratory Follow Through and Fishery Development

An important aspect of exploratory fishing that decisively separates it from other segments of marine zoological endeavor is the need to recognize potentially valuable resources that are sampled in a preliminary survey. Such recognition depends upon a combination of experience in commercial or exploratory fishing and zoological background with some awareness of current economic trends in the fishing industry. It may be based initially on subjective interpretation as well as on analysis of records. Most of the more important finds of the Exploratory Fishing and Gear Research organization in Region 2 have been recognized as worthy of further investigation before sufficient records had accumulated to show clearly the importance of the find. Included in this category have been the resources of royal red shrimp, yellowfin tuna, and calico scallop, and the South American shrimp grounds.

When resources of present or potential commercial value are located, the obligation of exploratory fishing extends past the preliminary survey and faunal listing stage. A large amount of follow-through is necessary before resources uncovered on surveys are used by the industry.

Once a resource is located, prospective users (and investors) must have the answers to a number of cogent questions before they will spend time, effort, or money on the resource. The major questions to be answered have been listed by Walford in his Living Resources of the Sea (Ronald Press, N.Y., 1958, p. 40-41). Potential users and investors will ask where the resource lies in relation to markets, transportation facilities, freezers, and sources of vessel maintenance and supply; how large the grounds are and specifically where the boundaries lie; how abundant (or available to conventional gear) the resource is; how the resource stocks are distributed over the grounds, seasonally and spatially; and what the relation of the stocks is to other stocks being fished in neighboring areas. Finally they will ask about the seasonal and yearly fluctuations of the catches, and how large a harvest is to be expected from grounds per unit of effort, seasonally and yearly.

Providing answers to these questions is within the province of exploratory fishing, as are the steps necessary to catalyze commercial fishing of previously unused or underutilized resources. Once the fishery has become established, the fishery problem becomes one of management, and exploratory fishing has completed its task.

How does exploratory fishing gain answers to the questions asked by the industry and how does it encourage industry to make use of resources uncovered? This can be answered best by an example--the development of the calico scallop fishery off the east coast of Florida, though several other examples would serve as well.

Preliminary survey.--In 1959-60, the Silver Bay made a preliminary survey of the Continental Shelf and Slope bottoms off the east coast of Florida with trawls and dredges. The object was to become familiar with the bottom types and topography, existence or absence of trawlable grounds, temperature structure of bottom waters, and knowledge of the principal faunal components present.

Delineation of promising resources.--As the general survey progressed, sample catches of calico scallops indicated a valuable resource. Followup cruises were, therefore, made to discover the areas in which scallops were in commercially important concentrations (placed at 5 or more bushels of scallops per hour with a 8-ft. dredge). This work showed that the scallops extended over an area of some 1,200 square miles and were especially concentrated in a narrower area included between 17 and 23 fathoms. In this latter area, commercial fishing looked promising. The industry was alerted through cruise reports[4] and talks to industry groups.

Simulated commercial fishing trials.--To pin down the catch rates to be expected from a commercial venture on the grounds, the Silver Bay made an extensive series of fishing trials in which the fishing operations were similar to those of regular scallop vessels.

[4] Reports of cruises of exploratory fishing vessels operating from Bases or Stations in Region 2 can be obtained by writing the Base Director, U.S. Fish and Wildlife Service, Bureau of Commercial Fisheries Exploratory Fishing and Gear Research Base, P. O. Box 1207, Pascagoula, Miss.

Again, cruise reports, newspaper publicity, and talks to fishermen's groups informed the industry.

Demonstration landings.--Scallop landings at ports along the Southeast coast where industry interest was beginning to grow, also stimulated investors and fishermen. In some instances, scallops were sold on bid to seafood houses; in other instances the scallops were distributed to the Bureau Technological Laboratory in Pascagoula, to Bureau biologists and marketing specialists, and to persons interested in developing mechanical shuckers.

Stimulating development of accessory equipment.--We felt that lack of suitable methods of economically shucking the scallops would reduce the commercial potential. Efforts were made, therefore, to stimulate the industry to develop a mechanical shucker; personnel at the Bureau's laboratory in Pascagoula also experimented with developing a shucker (Bullis and Love, 1961).

Demonstration cruises.--To allow the industry to judge the potential, a series of short demonstration cruises, open to industry and prospective investors was arranged. The cruises were well attended and received considerable favorable comment.

Direct aid to industry.--As interest developed among vessel owners, numerous requests were received by the Bureau for technical consultation on fishing gear and methods. Gear technicians of the Exploratory Fishing and Gear Research Station in Brunswick helped rig and equip some of the first vessels entering the fishery. Once the vessels were ready, the Silver Bay devoted sections of several cruises to fishing scallops with the fleet.

Publication of summary results.--By this time, sufficient data for publication had been assembled on the resource, seasonally and geographically. Reports were prepared and released by the Bureau (Bullis and Cummins, 1961; Cummins, Rivers and Struhsaker, 1962a) and by trade journals.

At this point, the existence of a going fishery should have been assured. Unfortunately, however, the mechanical shuckers proved inadequate for the task, and interest in the fishery diminished. The fleet turned to other fisheries, pending further development of mechanical processing equipment. We then decided that sufficient industry interest had been displayed to indicate a reopening of this fishery with the availability of efficient processing equipment, and it was decided to maintain a seasonal check on the condition and availability of stocks.

Periodic checks on the resource.--In addition to seasonal and geographic delimitations and assessments, year-to-year assessments of an unused resource are necessary to determine the long-range stability of a resource. Portions of the cruise schedule of the Silver Bay are, therefore, devoted to periodic checks of potentially important resources. Checks on the scallop resource have shown that its potentiality persists, but its location is highly mobile, changing from time to time.

At the end of fiscal year 1963, the industry was again showing signs of readiness to dredge the calico scallop grounds and the Exploratory Fishing staff received requests for added assistance.

EXPLORATORY COLLECTIONS AND COOPERATIVE WORK

The earliest exploratory reconnaissance revealed that scientific knowledge of the region's varied and complex fauna was quite incomplete. To familiarize the staff with the broad faunal scope of the region, therefore, we made extensive collections of specimens representative of the waters explored, and these were sent to the National Museum. As the collecting continued, specific requests from taxonomic specialists in other institutions were received in increasing numbers. The thoroughness of collecting was increased accordingly, as was the effort to distribute specimens to achieve the maximum benefit for marine biology in general and the knowledge of the region's fauna in particular. Gradually we established a complex system of cooperation and collaboration with numerous taxonomists in many institutions in this and other countries. Objectives of this system of specimen dispersal are to (1) receive verified identifications of the faunal components of the region from persons most highly qualified in each faunal specialty and (2) encourage and foster increased interest in the study of the fauna of the region by making available the collected material. At present, material from the Oregon and Silver Bay cruises has dominated the total study material for many major groups of fishes and invertebrates in the western North Atlantic. This identification system is now an integral part of the overall program.

The practice of sending basic and representative faunal collections to the U.S. National Museum has continued, and insistence on delivery of original specimens, to the Museum has been maintained with all collaborators.

Particularly close cooperation and coordination have been established with two Bureau laboratories in the Division of Biological Research that are concerned with the taxonomy

Figure 6.--Specimen laboratory, Pascagoula.

of fishes of our region: The Ichthyological Laboratory at the U.S. National Museum, Washington, D.C., and the Biological Laboratory, Brunswick, Ga. In addition to collections made directly for these laboratories by the exploratory fishing staff, specialists from both laboratories have accompanied the exploratory fishing vessels on many cruises, have made extensive collections from survey catches and afterwards have coordinated these collections with the data report system at Pascagoula.

To improve the scope of their study collections, duplicate biological material has been provided to many major research institutions in the United States. In addition, specimens have been made available to graduate students specializing in marine zoology. This material has provided the subject matter, in whole or part, of many theses and dissertations.

An estimated one million specimens were distributed in the years 1950-62. In August 1962, an invoice system was initiated to notify recipients of biological shipments and to serve as a distribution control and check at Pascagoula. Thirty-one uninvoiced shipments were made from July 1 to August 1962, and 171 invoiced shipments were made from August 1962 to June 30, 1963. A rough breakdown of the specimens itemized on the invoices follows:

	Specimens
Fishes	6,300
Sponges	50
Coelenterates	75
Mollusks	375
Annelids	450
Crustaceans	776
Echinoderms	180

Also shipped were uncounted chaetognaths, ascidians, pogonophores, bryozoans, foraminifers, pteropods, anemones, nematodes, salps, unsorted plankton samples, and algae. Approximately 8,000 specimens of fishes and invertebrates are currently on hand awaiting study or distribution. No accurate figure can be given for the number of specimens collected by cruise participants during the past year, but an estimate of 25,000 approaches the true level. Shipments of specimens were made to many individuals and institutions.

Exploratory cruises have also been accompanied by staff writers of many national magazines (National Geographic, Life, Field and Stream, and others). The resulting articles have included information on the work of the Oregon and Silver Bay.

The exploratory operation has cooperated closely, also, with other Bureau activities, such as those of biological research, technology, marketing, and statistics. Samples brought in for the Bureau Technological Laboratory, Pascagoula, have been useful in rounding out proximate analysis studies, canning experiments, and other research. Samples supplied the home economist at the fishery laboratory in Pascagoula and marketing specialists in the region, have been used in demonstrations and promotions of new and underutilized products.

ROLE OF EXPLORATORY FISHING AND GEAR RESEARCH IN EDUCATION

Since the inception of the exploratory fishing activities in 1950, we have had close contact with educational institutions in the United States and elsewhere. Each summer a limited number of students are hired as Fishery Aids or Fishery Technicians. These students are provided with an unparalleled opportunity to observe first hand the fauna of the region and to learn methods of collection and preservation in the field.

Since the number of ocean-going vessels used in faunal work is limited and the number of graduate students interested in marine biology is ever-increasing, the obligation of the exploratory fishing staff in the region in training biological oceanographers will increase apace.

Part Two

Exploratory Fishing and Gear Research Programs and Projects, FY 1963

OPERATIONAL AND ADMINISTRATIVE ORGANIZATION

In 1950, exploratory fishing in the Southeastern States was limited to one vessel working in the Gulf of Mexico. A staff of 3 technicians, 2 clerk-stenographers, and the 10-man vessel crew was responsible for resource evaluations, which were largely confined to waters of the Continental Shelf and to short-term projects of immediate benefit to the commercial fishing industry.

At the end of fiscal year 1963, activities had expanded geographically to embrace the entire western North Atlantic from Cape Hatteras to the Equator and the portion of the western South Atlantic to Fortaleza, Brazil, and included the Gulf of Mexico and the Caribbean Sea. A separate gear research unit was also incorporated. The staff (exclusive of established vacancies) totaled 20 fishery biologists and gear technicians, 9 administrative clerks, typists, and clerk stenographers, and a total vessel complement of 25 aboard four vessels, in addition to aids and technicians. The exploratory fishing evaluation of the resources had become more detailed and broader in scope, covering not only those of immediate practical use but also including assessment of

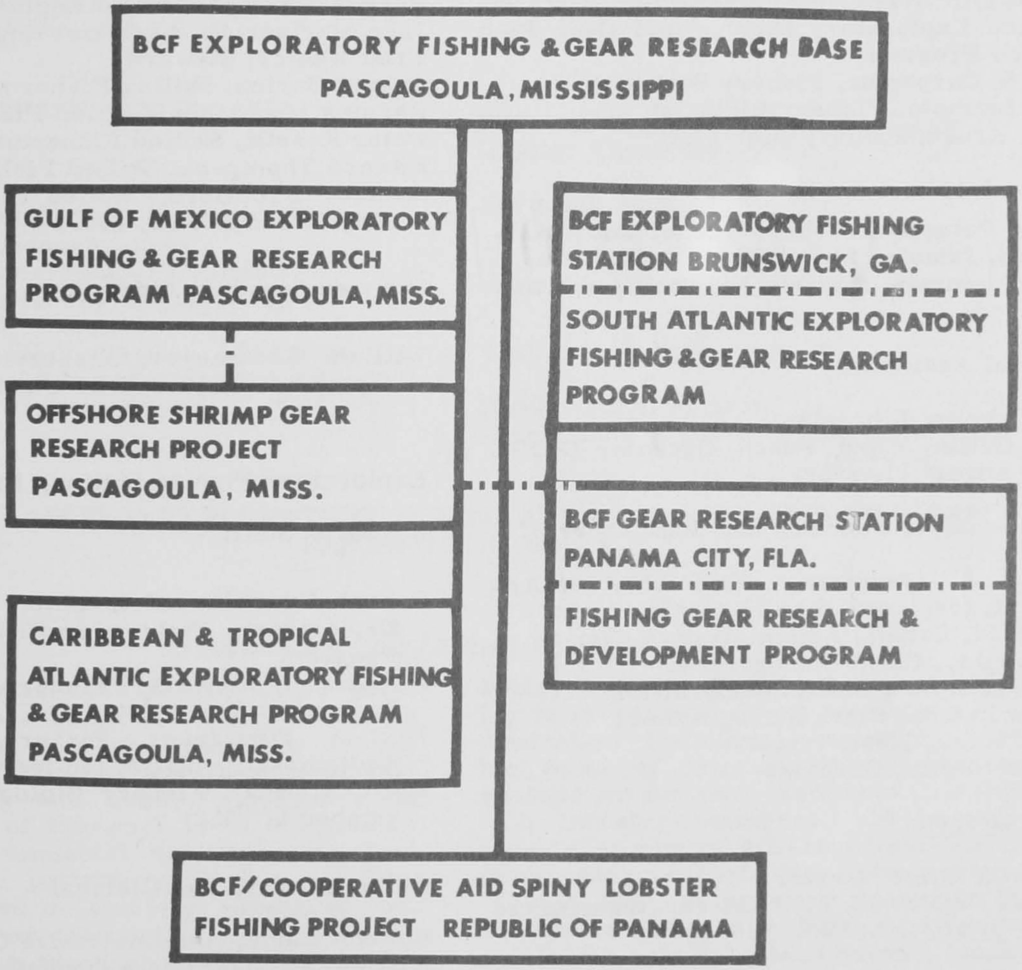

Figure 7.--Organizational chart. Exploratory Fishing and Gear Research, Region 2.

those of the future in waters of the Continental Shelf and Slope. Coordination of activities into a broad pattern of faunal survey had become a major point of emphasis.

The overall organization of program activity in exploratory fishing and gear research is shown in figure 7. Total program staff is listed on the following pages. A headquarters staff at the Base in Pascagoula coordinates the activities of five field programs, determines the emphasis of investigations, and reviews the progress and results of the various programs.

Program planning centers around individual vessels. With the exception of the gear research activities, where vessel usage is a less important element, attainment of a maximum number of sea days per year is important. Professional staff members must spend some portion of their time each year at sea. Sea-time among individuals varies from as much as 60 percent to as little as 15 percent. In this manner, close organizational contact is maintained with problems encountered in all aspects of the operation.

STAFF
GULF AND SOUTH ATLANTIC FISHERIES EXPLORATION AND GEAR RESEARCH

Harvey R. Bullis, Jr., Base Director
John R. Thompson, Assistant Base Director
Francis J. Captiva, Fleet Supervisor

Exploratory Fishing and Gear Research Base, Pascagoula

Research Staff

Richard A. Waller, Acting Chief, Gulf of Mexico Exploratory Fishing and Gear Research Program
James S. Carpenter, Fishery Biologist
Tomio Iwamoto, Fishery Biologist
Paul J. Kruse, Fishery Biologist

Technical Aids:

LaNelle Peterson, Fishery Technician (transferred, January 13, 1963)
Arden Sumerall, Fishery Aid (resigned, May 24, 1963)

Technical Assistants:

Alice Colmer, Librarian
Judith Gatlin, Card Punch Operator (ADP), EOD August 21, 1962)

Administrative, Clerical, and Maintenance:[2]

Virginia A. Terreson, Administrative Assistant, (resigned June 17, 1963)
Dorothy M. Latady, Administrative Clerk
Alice Cauley, Clerk Stenographer
Diane Davenport, Clerk Stenographer
Marilyn Nelson, Clerk Stenographer
Carol Taylor, Clerk Typist
Lorenza Nathan, Caretaker

Vessel Oregon:

Johnnie H. Tyler, Master
Frank J. Hightower, First Officer (transferred from Bowers, April 14, 1963)
Richard E. Adams, First Officer (July 31, 1962 - April 13, 1963; transferred to Bowers)
Sven Svensson, Supervisory Chief Engineer
Robert Roper, Assistant Engineer
Jake Marinovich, Assistant Engineer
Fred Weems, Steward
August Barich, Skilled Fisherman
Rasmus Mortensen, Skilled Fisherman
Peter Rosetti, Skilled Fisherman
Edward Thompson, Skilled Fisherman
Anthony Frontiero, Skilled Fisherman (January 28 - April 12, 1963)

Summer Seasonal Aids:

William Eschmeyer, Fishery Aid, (resigned September 6, 1962; EOD June 4, 1963)

Exploratory Fishing Station, Brunswick

Research Staff:

Robert Cummins, Jr., Chief, South Atlantic Exploratory Fishing andGear Research Program
Joaquim B. Rivers, Fishery Methods and Equipment Specialist
Paul J. Struhsaker, Fishery Methods and Equipment Specialist (on leave of absence)
Floyd A. Nudi, Fishery Biologist, (EOD November 5, 1962)

Administrative and Clerical

Harriet Lamb, Administrative Clerk
Martha N. Huff, Clerk-Typist (EOD July 30, 1962)

[2] Assigned to total building--combined facility.

Vessel Silver Bay:

Hilton M. Floyd, Master
Richard E. Adams, First Officer (transferred to Oregon, July 30, 1962)
James Barrett, First Officer
Robert Mattos, Chief Engineer
Harvey J. Ogden, First Assistant Engineer (EOD July 11, 1962, resigned September 7, 19620
Richard T. Wenstrom, First Assistant Engineer (EOD September 17, 1962, resigned April 23, 1963)
David Page Hudgins, Skilled Fisherman, (EOD September 17, 1962; transferred to First Assistant Engineer, April 1963)
James Carr, Cook
Robert Martin, Cook (temporary, January 18 - February 1, 1962; February 13 - March 11, 1963)
Harvey Bledsoe, Skilled Fisherman
George Wentzell, Skilled Fisherman
Ernest Williams, Skilled Fisherman
William Bentzel, Ordinary Fisherman (temporary, July 13-September 7, 1962)

Summer Seasonal Aids:

Lyle E. Brumfield, Fishery Aid (Resigned September 7, 1962)

Gear Research Station, Panama City

Research Staff:

Fred Wathne, Chief, Gear Reserch Station
Charles Fuss, Oceanographer
John Holt, Oceanographer (Biologist)
Larry Ogren, Fishery Biologist (EOD February 3, 1963)
David Wotherspoon, Fishery Methods and Equipment Specialist (EOD March 17, 1963)
Doyne Kessler, Fishery Biologist, (EOD April 28, 1963)

Technical Aids:

Gayle Sudduth, Fisheries Technician (Resigned June 30, 1963)

Administrative and Clerical:

Crystal Kelly, Clerk Stenographer (EOD December 9, 1962)
Joan Creel, Clerk Stenographer (EOD March 11, 1963)

Vessel George M. Bowers:

Frank J. Hightower, Master (transferred to Oregon, April 14, 1963)
Richard E. Adams, Master (transferred from Oregon, April 14, 1963)
Anthony Veara, Engineer (EOD July 1, 1962)
Arthur Hatcher, Cook-Fisherman
Laurence Vice, Skilled Fisherman

Summer Seasonal Aids:

Jon Von Farmer, Fishery Aid (resigned August 1962; EOD June 1963
Russel E. Schneider, Fishery Aid (resigned August 17, 1962)

BCF/AID Republic of Panama Spiny Lobster Explorations

Research Staff:

Johnnie A. Butler, Project Leader
Norman L. Pease, Fishery Biologist

Vessel Pelican:

Howard King, Master
(Remainder of crew hired by vessel contractor)

GULF OF MEXICO EXPLORATORY FISHING AND GEAR RESEARCH PROGRAM, PASCAGOULA, MISS.

by

Richard A. Waller, Acting Program Chief

The fundamental aims of the Gulf Program are to compile a basic inventory of fishery resources in the Gulf of Mexico and to make the information obtained available to the Gulf fishing industry and fishery biologists. An important part of the work is to accumulate sufficient environmental data to understand the distribution patterns of the fauna. Emphasis is placed on studying resources that are of present or potential commercial value or that influence the occurrence, abundance, or availability of commercial resources. An accompanying obligation to the fishing industry is to provide direct assistance in solving production problems. Assistance may take the form of demonstration fishing on new grounds or for new resources, consultations with industry members, aid in converting vessels to new or different fisheries, and aid in selecting or fabricating fishing gear.

Since 1950, exploratory fishing in the Gulf has been carried on in Shelf and Slope waters, and in the pelagic waters beyond. Much of the earlier work of the Program was designed to provide answers to specific industry questions in limited, specified areas, concerning specified species, or in narrowly bounded and specified depths.

Throughout the history of the program, however, attempts have been made to fit the short-term, immediate-solution investigations into a unified scheme of exploratory coverage and to spend some portion of every year in extending the study beyond the immediately desired ranges. In this way we began many of the more important, long-range investigations of the Gulf Program, including studies on the yellowfin tuna, royal-red shrimp, and snapper. We have uncovered many more possibilities for investigation and have begun new studies whenever vessel time and funds were available. Still to be investigated thoroughly are the resources of food fish in the north Gulf, clams and scallops in the east Gulf and west Gulf, and the thread herring and other clupeoid fishes in the east and north Gulf.

During fiscal year 1963, we obtained the first units of an automatic data processing (ADP) system. With this equipment we can soon compile listings of work accomplished on any specific resources. The compilation will allow us to analyze the status of the work as it pertains to commercial utilization. All future work in the Gulf will be programmed on the basis of such listings and analyses, with priorities assigned so that practical results of both immediate and long-range value will be provided.

The problems facing the Gulf Program are (1) completion of a basic resource inventory on the shelf and slope in the Gulf, (2) analysis of the status of the various resource investigations and pursuance of those investigations from their present status to the point of industry utilization, and (3) fitting together of individual resource investigations into a whole.

The program has four major projects: shellfish explorations, pelagic fish explorations, bottom fish explorations, and faunal survey. The last project includes the preparation of a fishing atlas. Faunal survey evaluation utilizing ADP will eventually be raised to program level to serve all exploratory fishing programs in Region 2.

Facilities

The 100-ft. exploratory fishing vessel Oregon (cover) is used primarily in the Gulf Program. The vessel has a diesel engine developing 600 hp. at 400 r.p.m. Accommodations provide for 10 crew members and 7 scientists, observers, or specialists. Winch capacity allows sampling to 2,000 fathoms with commercial gear. Electronic equipment includes depth recorders capable of reaching 6,000 fathoms, radar, loran, a pitometer log, and radio equipment. The Oregon was originally constructed for live bait tuna fishing, but to meet the needs of the Gulf Program it has been converted to a multi-purpose fishing vessel with primary emphasis centered on trawling and dredging capabilities.

The Gulf Program is housed in the Bureau's Fishery Laboratory in Pascagoula. Facilities include office space, a laboratory for examination of preserved specimens, and an ADP system. Library facilities serving all of the exploratory fishing units in the region are also housed at Pascagoula. A film collection, consisting mainly of films produced by the exploratory fishing and gear research staff, is maintained in the library. The dock, net shed, and machine shop were described in a previous section (fig. 8).

Shellfish Project

The shellfish project received major emphasis during the 1963 fiscal year. Explorations were carried out on the upper and middle Continental Slope for deep-water shrimp. Basic resource knowledge was extended to greater depths. The inner and middle shelf zones were dredged for information on clam and scallop stocks.

Deep-water Shrimp: Portions of four Oregon cruises were devoted to shrimp explorations on the upper Continental Slope of the Gulf of Mexico. Cruise 79, was devoted to the royal red shrimp resource of the northern Gulf. Transects through the normal royal red shrimp depth range, between the Mississippi River Delta and Pensacola, showed shrimp concentrated in largest numbers between 200 and 225 fathoms. Catches made with a single standard 40-ft. shrimp trawl in these depths, however, were only moderately successful. Fifty hours of fishing time resulted in an average of 23 pounds of whole shrimp per hour. One industry vessel from Texas investigated these royal red shrimp beds with the Oregon. This vessel made several promising catches until winch failure forced its withdrawal from the grounds.

The objectives of Oregon cruise 80 were concerned with the seasonal assessment of the north royal red shrimp grounds. This work was conducted in the late summer employing 100-ft. shrimp trawls. The fishing operation was designed to simulate round-the-clock commercial fishing methods. Optimum depths in maximum densities for royal red shrimp were determined on the basis of 51 trawling stations. The catches averaged approximately 40 pounds per hour reaching a maximum catch of 87 pounds per hour. Most shrimp were 31-35 count with heads on. Larger shrimp were found in deeper waters but in smaller numbers. Highest catch rates were obtained in 225 fathoms near the east end of the grounds and

Figure 8.--Dock area BCF Exploratory Fishing and gear Research Base, Pascagoula. Machine shop in foreground; net shed at right. The mast and boom of the Oregon are visible over the machine shop.

in 200 fathoms at the west end. A well-defined temperature gradient was observed throughout the fishing area and maximum concentrations were observed to center on the 50° F. isotherm. These observations are additional confirmation that royal red shrimp, being stenothermal, tend to congregate more densely in regions of rapidly changing temperature profiles.

Catches of the smaller pink speckled shrimp, Penaeopsis megalops, reported from this cruise stirred some interest in the shrimp canning industry. Catches of this commercially significant shrimp, which is suitable in size for canning, were taken in the 190- to 200- fm depth range. The highest catch landed amounted to 183 pounds of 52-count megalops in a 2-hr. tow.

Accordingly, on cruise 82 a 350-lb. sample of P. megalops was landed for canning tests by a Biloxi cannery. Concentrations of P. megalops were considerably lighter than those found during cruise 80. Oregon cruise 82 was conducted in October and early November on the north Gulf grounds. And again 100-ft. nets were employed to simulate commercial fishing practices. Heaviest concentrations of royal red shrimp were found between 195 and 200 fathoms. Catch rates averaged 81 pounds and ranged from 55 to 108 pounds per drag. Within the optimum depth range, catches from 16 successful drags ranged from 165 to 355 pounds of royal red shrimp.

The samples of P. megalops were canned at a Gulf coast cannery and were judged excellent in texture and flavor, but lacked the pink coloration that the canners believe necessary for top sales. No further attempts have been made to evaluate this species as a commercial product.

Commercial production trials were continued into November and December during Oregon cruise 83. Sampling both the north Gulf and Tortugas grounds provided a comparison between the two areas and filled gaps in seasonal production information. In addition, the area from the east end of the north Gulf grounds along the west coast of Florida to the Tortugas grounds was explored for suitable bottom for fishing royal red shrimp.

Catches on the north Gulf grounds were lower than those of the fall cruise (cruise 82) and about the same as those of the summer cruise (cruise 80), averaging about 44 pounds per hour with a 100-ft. trawl. The shrimp were distributed fairly uniformly over a depth interval of 200 to 225 fathoms during the cruise, with lower catch rates prevailing above or below this range.

Catches on the Tortugas grounds were somewhat higher than those on the north Gulf grounds, as was expected from previous experience (Bullis, 1956a), and averaged approximately 50 pounds of whole shrimp per drag. Optimum depths were from 190 to 210 fathoms--a narrower interval than that found in the northern Gulf. Catches between the north Gulf and Tortugas grounds were subcommercial, and little trawlable bottom was found in suitable depths.

In January 1963, all royal red shrimp data for the Gulf of Mexico since 1950 were placed on punchcards and tabulated. The tabulation showed clearly the gaps in seasonal and geographic coverage, and subsequent work on the red shrimp grounds has been programmed on the basis of this analysis.

Tangible results of Bureau work on the Gulf royal red shrimp grounds for the past 12 years are beginning to appear as industry interest is stimulated. A nucleus of a commercial royal red shrimp fleet of vessels equipped with winches capable of trawling in red shrimp depths is now present in the Gulf, and several vessels have made repeated trial cruises on the offshore grounds. Reports of results of these commercial trials are difficult to obtain. The few available show that the traditionally inshore fishermen are experiencing some difficulty adjusting to the necessities for precise navigation and for fishing in the narrow depth stratum where red shrimp live, but a steady rise in catch is also shown. Industry's upsurge in interest and actual attempts to fish the resource indicate that the royal red shrimp stocks will receive more attention in the future, especially when fishing is poor on the inshore shrimp beds.

Clams and Scallops. Explorations for clams were conducted during the year on the inner and middle portions of the Continental Shelf. On *Oregon* cruise 81, in September, 6- and 8-ft. tumbler dredges were used at 231 locations in the northwest Gulf (fig. 11). Small numbers of the Gulf clam, *Pitaria cordata*, and the papershell scallop, *Amusium papyraceus*, were taken throughout the area surveyed. Greatest densities of both occurred in 20 to 50 fathoms. Initial evaluations of meat quality and yield for both species indicate that they have a commercial promise, provided sufficient concentrations of either can be caught by commercial-type gear. No further work on the resource is planned until better dredging equipment is available. Funds for such gear have been requested.

A seasonal check on the shallow-water hard clam (*Mercenaria*) beds of western Florida was completed in December. Along the southwest coast of Florida 44 dredge

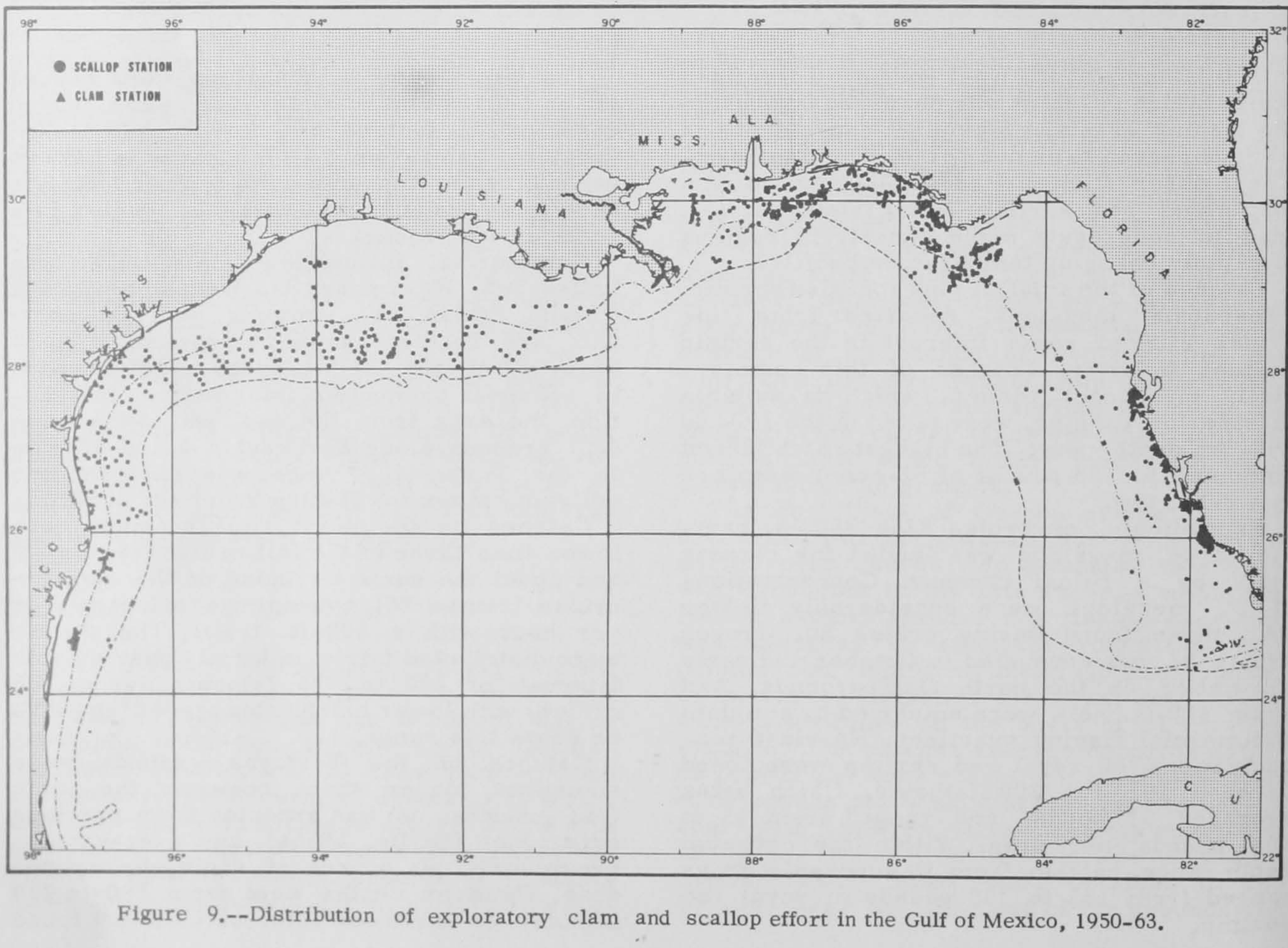

Figure 9.--Distribution of exploratory clam and scallop effort in the Gulf of Mexico, 1950-63.

hauls were made with a 22-tooth "Fall River" clam dredge in depths of 3 to 5 fathoms. Dragging time varied from 5 to 45 minutes, depending on the bottom. Best fishing was off St. Petersburg, where catches ranged from 20 to 185 clams per 30-min. drag. The clams varied from 3 to 5 inches in diameter. Northwest of Gasparilla Island in 4-5 fathoms a small area yielded as high as 154 clams in a 15-min. drag. Heavy beds of pen shells (Atrina rigida) hampered dredging efforts throughout the area, and sampling effectiveness was considered marginal for this reason as well as because of the deep draft of the Oregon. Definitive exploration and assessment of the shallow-water clam resources of the Gulf will await more adequate equipment and a shallow-draft vessel.

BOTTOMFISH PROJECT

by

James S. Carpenter, Project Leader

Bottomfish work in the Gulf has been de-emphasized because the Oregon is poorly suited for trawling with heavy roller-rigged fish trawls. With the anticipated delivery of Oregon II in fiscal year 1966, primary emphasis will be placed on fish trawling surveys.

Work achieved in this project has been accomplished as a by-product of shellfish investigations and has consisted primarily of accumulating data on the fishes taken in the shrimp trawls on the royal red shrimp grounds. Data collected on the fish include species identifications, estimated total catches and catches of individual species, and length frequency measurements of dominant species. Among the more promising fish resources are the hake (Urophycis) and whiting (Merluccius) in 100-400 fathoms. Combined catches of these two fishes not uncommonly run at the rate of 400-500 pounds an hour in shrimp trawls. Occurrence data accumulating in the ADP system will provide a comprehensive picture of the distribution and relative densities of these species throughout the region.

PELAGIC FISH PROJECT

by

Tomio Iwamoto, Project Leader

From 1957 through 1960 great emphasis was placed on assessment of pelagic school fish resources in the Gulf of Mexico. Primary gear used for sampling schools of clupeoid fishes and other small school fishes was a modified British Columbian midwater trawl. Field work with the midwater trawl was brought to the point where further midwater trawl explorations were suspended until a more adequate gear could be developed. Pelagic fish work has been sharply reduced since cessation of the midwater trawl operations and reassignment of personnel concerned to other work.

A report on the photoinstrumentation phase of the midwater trawl work has been completed, and reports on other phases will be developed as ADP tabulations are made available. A 12-year accumulation of surface-schoolfish data and temperature records was compiled and summarized. It is currently being put in report form for publication.

Patterns of distribution of commercially important tunas, as related to monthly sea surface temperatures, have been made clearer as a result of the data summaries made possible with ADP equipment. At the year end, multi- and monofilament tuna gill nets were prepared for "opportunity-basis" gill net fishing of surface tuna schools.

Surface school sightings, trolling captures, plankton hauls, and nightlight attraction stations are being made routinely with other program activities. Larval and juvenile stages of various fish species are collected routinely because of increasing requests from cooperators engaged in life-history studies. The collections are made, on an "opportunity basis," without disruption of assigned duties.

Figure 10.--Nightlight attraction stations are made on an opportunity basis as the Oregon lies to at night in the Gulf. An excellent opportunity is thus presented for obtaining life-history stages of many fishes and invertebrates.

FAUNAL SURVEY PROJECT

by

J. R. Thompson, Assistant Base Director

Most of the work of the faunal survey project has been covered earlier in this report. During the fiscal year, three of four basic units of an ADP system were acquired and put into operation. Punchcards and station sheets for data recording at sea were designed for use with the ADP system, and the 12-year backlog of filed information was placed on punchcards for future use. With the coming acquisition of a printer-tabulator, tabulations of data will be made available to the industry, to staff members as invaluable aids in programming, and to the scientific community for analysis.

The Faunal Survey Project is also responsible for the sorting and distribution of specimens collected during explorations and for transcribing into the record system the identifications received from over 100 cooperating taxonomists.

An important part of the project work in the future will be the production of faunal atlases, depicting distribution and availability of dominant species of fishes and shellfishes, geographically, seasonally, and with such ecological factors as differences in bottom types and temperatures. In addition to the atlases, detailed interpretive reports on the distribution, availability, and spread of faunal groups are planned.

CARIBBEAN AND TROPICAL ATLANTIC EXPLORATORY FISHING AND GEAR RESEARCH PROGRAM

by

J. R. Thompson, Assistant Base Director

The explorations in the Caribbean Sea and the tropical western Atlantic Ocean have, traditionally, been carried out with the Oregon and with the staff of the Gulf of Mexico Program. We have worked in this manner on the basis that the Caribbean and adjacent waters are of prime interest to the fishing industry of the Southeastern Atlantic and Gulf States and constitute the principal avenue of future fishery expansion.

Work during fiscal year 1963 has been confined to one cruise of the Oregon, in February and March. Objectives were (1) to extend preliminary coverage of the shelf and slope southward from the mouth of the Amazon to the latitude of Fortaleza, Brazil (about lat. 4^{o} S.), (2) to conduct preliminary fish trawling explorations of areas off the Guianas where earlier work with shrimp trawls had indicated possible concentrations of snappers, and (3) to continue investigations of shrimp resources off the Guianas where a fleet of 200 U.S. vessels is now working. In addition, the Oregon cooperated in the International EQUALANT I program as the Bureau representative.

During February the shrimp resource on the shelf off the Guianas was explored with 2-in. stretched-mesh trawls. We had made previous explorations in the area (cruises 47 and 53) in the fall. Areas of commercial pink and brown shrimp fishing potential were located off Devils Island, French Guiana, and off Cabo Orange on the French Guiana-Brazil border. Neither area had been fished by the growing fleet of U.S. shrimp vessels operating out of Guiana ports. We radioed to the fleet news of the catches, which ranged from 30 to 70 pounds of 15-count shrimp tails per hour drag.

Nine drags were made in 300-500 fathoms off French Guiana and Surinam where the Oregon had previously made small catches of the scarlet prawn Plesiopenaeus edwardsianus. Heavy seas prevented adequate fishing trials. Catches ranged from 15 to 20 pounds of the prawns per hour. The largest haul produced 80 pounds of 3-10 count (heads on) scarlet prawns in a 4-hr. drag with a 40-ft. flat trawl. These results indicate that by using high-opening trawls and fishing in this area intensively we may discover commercially valuable concentrations of scarlet prawns. This species is being fished commercially off Spain and marketed in the eastern United States. Of particular interest in trawling at these depths was the capture of from one to nine Atlantic king crabs (Lithodes sp.) per drag, ranging from juveniles to adults weighing 8-10 pounds each.

Bottomfish explorations with roller trawls on rough and broken bottom were made impossible because of the heavy seas created by the spring tradewinds and the exposed nature of the area. Smoother bottom, well suited to trawling, appears to prevail generally inside 60 fathoms, where we made 49 fish-trawl drags. From 5 to 20 pounds of small lane snapper (Lutjanus synagris) were taken per hour. Between 40 and 60 fathoms, small red and vermilion snapper (Lutjanus aya and Rhomboplites aureorubens) were also taken in small numbers. The broken bottom areas immediately adjacent to the 40- to 60-fathoms interval on the shelf edge hold promise for roller-trawl fishing in summer and fall when sea conditions are better. These areas have supported snapper handline fisheries in the past.

Largest fish catches between Georgetown, British Guiana, and Cayenne, French Guiana, were made in depths shallower than 20 fathoms. Drags with a 65-ft. high-opening, roller-rigged fish trawl, yielded from 800 to 1,500 pounds of fish per hour. Large sea trouts (Cynoscion sp.), croakers (Micropogon sp.), grunts (Haemulon sp.), and several species of catfishes made up the bulk of the catches. These catches yielded 150-300 pounds of seabobs (Xiphopeneus kroyeri) per hour. The seabobs were heavily concentrated out to depths of 35 fathoms between Cayenne and Cabo Orange.

During the second half of the cruise, Oregon explorations emphasized the shelf south of the Amazon River mouth. Between the Amazon and Fortaleza, Brazil, we made 35 shrimp trawl and 33 dredge hauls, generally in depths of 10-40 fathoms. Beyond the 40-fathoms curve a steep escarpment falls to 1,000 or more fathoms. Catches of shrimp were small, though both brown and white shrimp were present in half of the drags made inside 25 fathoms. East of Parnaiba, drags made on shell bottom caught from 1 to 4 spiny lobsters, and one drag yielded 49 lobsters.

On the EQUALANT I cruise, we obtained 40 plankton tows, 69 bathythermograph (BT) casts, 104 sea surface radiation temperature observations, 13 water samples (sediment transport) from the Amazon drainage. EQUALANT I participants from the University of Miami Marine Laboratory made selective faunal samplings on both sections of the cruise.

As time permits, the Oregon is being used in preliminary surveys of the Caribbean and tropical Atlantic areas. The largest areas remaining virtually unexplored now are the shelf and slope areas of the Caribbean off Venezuela, Colombia, and Panama. Cruises in these areas are scheduled for fiscal year 1964. The Lesser Antilles, although visited by occasional expedition parties, are also only poorly known, and work in that area is tentatively scheduled for fiscal year 1965.

OFFSHORE SHRIMP GEAR RESEARCH PHOTOINSTRUMENTATION

by

Paul Kruse, Project Leader

The photoinstrumentation studies at the Pascagoula Base are primarily concerned with underwater photography as a tool for understanding the behavior of fish and shelfish in connection with evasion of and escape from trawls and dredges. Motion picture studies on how these animals react to present types of gear can provide extremely valuable information on fishing efficiency, leading to definable and rational bases for gear improvement. In addition, these studies contribute greatly to our knowledge of the distribution and densities of species being evaluated in exploratory operations. They provide also some indication of abundance that can be compared with the availability data from trawl and dredge catches.

Earlier, we were concerned with developing a camera for observing how sardinelike fishes react to midwater trawls (Kruse, in press[5]). During the past year, we have emphasized modifying equipment to observe deep-water shrimp. Successful preliminary tests of this equipment in depths of 200-210 fathoms represent the only known successful application of deep-water motion picture photography to commercial fishing studies.

The present underwater photo system includes an electric, self-programmed, 16-mm. motion picture camera and floodlights, and a 35-mm. Edgerton CA-8 pulse camera with "Strobe" light sources (on loan from the National Geographic Society). The components of the motion picture system are designed so that two or more units may be coupled, physically and electrically, for synchronous

[5] See footnote 1, p. 2.

Figure 11.--Sea anemones photographed on the upper Continental Slope of the Gulf of Mexico at 200 fathoms.

Figure 12.--Housing of underwater motion picture camera attached to its frame in the mouth of a shrimp trawl.

operation. For present applications the motion picture camera system is set to operate at 32 frames/sec. With application of stronger light sources, the speed will eventually be increased to 200 frames/sec.

In preparation for use, the gear was tested and ballasted on three short trips. The camera and lights were oriented by SCUBA divers during shallow-water trial runs conducted by the Gear Research Unit at Panama City. Experimental application during two more short trips produced 1,400 feet of black and and white negative film and 2,000 still photographs of bottom conditions.

Successful deep-water motion picture photography of both trawl performance and shrimp reaction behavior was achieved during Oregon Cruise 85. This cruise was scheduled to conduct preliminary field trials and to calibrate the equipment. The work was carried out in the north central Gulf on the royal red shrimp grounds at 200-210 fathoms.

Individual trawl drags on the royal red shrimp grounds were limited to 30 minutes to minimize loss of equipment due to bottom fouling. The motion picture camera was positioned to shoot parallel to the mouth of a 40-ft. flat shrimp trawl. It thus covered an area immediately in front of and including the footrope. Moderately good detail could be observed within the area of illumination, which covered approximately 4-6 sq. ft. of bottom with a vertical column of some 2-1/2 to 3 feet (or 10 to 18 cu. ft.). Short 16-mm. film clips are developed on shipboard and were ready for projection within an hour, permitting on-site analysis of equipment operation.

Shrimp were more numerous than had been expected. One 400-ft. roll of film exposed at 210 fathoms shows 54 shrimp reacting to the trawl. These shrimp can be identified as royal red shrimp. Of this total, nine individuals can definitely be seen passing under the footrope, a reaction which indicates that one-sixth of the shrimp may escape the net. Two of the 54 appear to escape by swimming up in front of the headrope.

The photographs in 200 fathoms showed pink-speckled ("megalops") shrimp as the only shrimp present. All but one of these were swimming several inches above the bottom. At 200 fathoms, only this shrimp was taken in the trawl codend. At 210 fathoms, the shrimp catch was exclusively royal red shrimp. All photographed were resting on the bottom until touched by the trawl footrope. A detailed study of the film footage is in progress.

A series of observations is planned on each of the known royal red shrimp beds. Comparative evaluation of the resulting records will provide an entirely new perspective for developing more efficient trawling methods for these shrimp.

Studies of the behavior of fishes and other organisms associated with royal red shrimp are side benefits stemming from the work. In addition, we can observe animals which may have been able to evade trawls and, from the knowledge of behavior patterns gained, can design gear capable of capturing them.

The still photographs of the bottom at royal red shrimp depths in the northern Gulf show many areas "carpeted" with a thin layer of unidentifiable material, sufficiently fragile so that we have not been able to detect its presence in trawl catches. Dense patches of mud-dwelling anemones have been photographed (fig. 11). One still sequence shows a megalops shrimp rising from a resting position on the bottom and swimming well above the bottom.

The camera system will eventually be monitored with a closed circuit underwater TV chain. The equipment has been ordered, but has not been field tested in these studies as yet. When complete constant observations can be conducted on shipboard, remote camera controls will permit selective shooting with the motion picture camera.

SOUTH ATLANTIC EXPLORATORY FISHING AND GEAR RESEARCH PROGRAM

by

Robert Cummins, Jr., Program Chief

The South Atlantic Fisheries Exploration (SAFE) Program has four basic objectives: to understand the species composition of the area through exploratory fishing; to determine the relative abundance of the various species and species groups that are caught; to recognize those species that are potentially valuable for commercial use; and to determine the availability of such species on a seasonal and geographical basis.

These objectives require explorations into new areas as well as a continual appraisal of known or previously explored areas. To meet the specific needs of the Southeastern Atlantic States, the program is divided into three projects: Shellfish Explorations, Bottomfish Explorations, and Pelagic Fish Explorations. In keeping with the objectives of the program, our first efforts were to use trawls and dredges to make a basic inventory of the resources in the offshore waters. Later we emphasized the collecting of information on the abundance and the availability of these resources.

Not only are catch samples provided to industry representatives for use in testing and evaluating new products, but also extensive collections are made for Bureau researchers in technology, biology, and marketing, for additional specialized assistance. Frequently, tests are made at sea aboard the exploratory fishing vessel. These tests further help industry to evaluate the commercial potential of the product. Examples of this assistance are survival tests, quality controls, counts, weights and measurements, and results associated with freezing. Vessel space is occasionally provided for testing newly developed and pilot processing equipment.

Facilities

The exploratory fishing vessel Silver Bay is a 96.4-ft. medium North Atlantic beam trawler of steel construction with a draft of 12 feet on bareboat charter to the Bureau since 1957 (fig. 4). Accommodations are available for 17 persons including nine crew members. The Silver Bay has a cruising range of 3,200 miles and an original hold capacity of 200,000 pounds of iced fish. Electronics include three depth recorders (one of which records to 2,200 fathoms), two loran navigation sets, radio-telephone, radar, and automatic pilot. The vessel is driven by a diesel engine developing 562 hp. at 350 r.p.m. There are two 10-kw. auxiliary generators, a 2-drum trawl winch with a capacity of 650 fathoms of 11/16-in. wire cable on each drum, and an electric hydrographic winch.

Office, storage, and dock space are currently being leased from the Port Authority in Brunswick, Ga., and all facilities are at a single location (fig. 2).

The former St. Simon Island Light Attendant Station has been acquired for the Bureau as Excess Property and remodeled as an

Figure 13.--St. Simon Island Light Attendant Station renovated for office facility.

office facility. In addition, a long-term lease has been acquired for a site on the Intercoastal Waterway, where the construction of a temporary dock and storage facility is planned.

Shellfish Project

During three cruises dredging was conducted over the Cape Kennedy scallop bed, at 428 fishing stations. We maintained close cooperation with industry members and Bureau biologists and technologists who were collecting data on quality, yield, and life history. During September and October the bed was found to extend northward into Georgia waters. At this time low catch rates occurred south of Cape Kennedy and commercial concentrations were located at various stations north of the Cape to the St. John's River. The scallops ranged from 2-3 inches in width and yielded 61 to 91 meats/pint. Dead scallop shells comprised more than 90 percent of some of the catches, but small (1 inch) live scallops were abundant. The largest catches of commercial size scallops were in 14-20 fathoms.

During April most live scallops were located in depths of 19-25 fathoms north of the Cape, but nowhere did catches exceed 3-1/2 bushels per drag. Live scallops averaged 2-1/4 inches in width, and all examined were in spawning condition. The meats were fair to poor in quality and averaged about 155/pint. Data from previous explorations have indicated that meat yields are generally lowest at this season.

At the present time there is very limited commercial production of calico scallops because certain processing difficulties must be solved. Numerous experiments have been conducted by various segments of the fishing industry to develop automatic shucking machinery. We are aware of five different processing methods that have been attempted to date on a pilot scale. While each of these has done a satisfactory job of opening the shells and separating the viscera from the saleable meats, none of the equipment has been able to withstand the rigorous wear and tear of processing large volumes of catch.

Tumbler dredges, built with 2-in. angle iron, were shown by comparative tests to be the most effective gear for taking calico scallops because of the straight, rigid scraping bar (Bullis and Cummins, 1961). Numerous modifications to Georges Bank dredges, with their sweep chains, have shown them to be very effective in capturing sea scallops. Preliminary tests, however, show that the best catches of calico scallops are obtained when the angle of the dredge shoes permits the entire length of sweep chain to touch the bottom. A scallop trawl, fabricated and utilized for comparative trials (Rivers, 1962), proved less effective than the tumbler dredge on the Cape Kennedy bed. The scallop trawl, however, is a valuable biological sampling tool since it often captures a greater variety of fauna than tumbler dredges.

Portions of Silver Bay cruises 41 and 42 were devoted to the royal red shrimp grounds off the east coast of Florida. A total of 59 successful drags produced catches ranging from 250 to 400 pounds of whole shrimp per 3-hr. drag. The shrimp averaged 36-40 count of whole shrimp per 3-hr. drag. At industry request, the two cruises followed-up earlier exploratory fishing results and assisted the local fleet in its first year of deep-water shrimp fishing.

Commercial production has continued intermittently, and 19 vessels have been modified for deep-water shrimp fishing. Rough weather and the strong Gulf Stream current continue to plague the fishermen, but the market price has remained good all year. It appears that the royal red shrimp fishery will be utilized only on an interim basis,

Figure 14.--A catch of about 16 bushels of live calico scallops on deck.

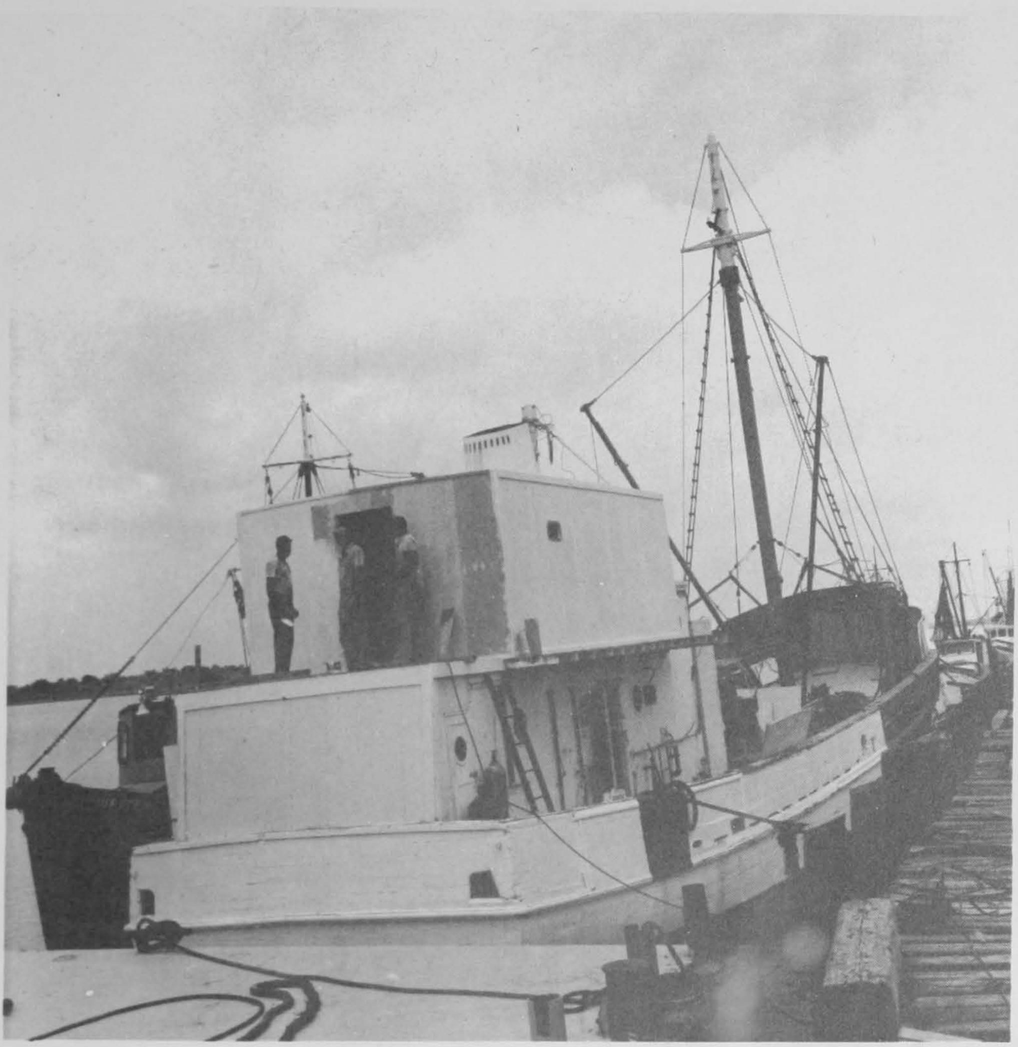

Figure 15.--Banner. Former Georges Bank scalloper being completely overhauled and modified for dredging and processing calico scallops - home port, Brunswick.

although six vessels are currently fishing the grounds with average and above average results.

Flat trawls and 2- and 4-seam balloon trawls, varying in size from 40 to 80 feet and fished with 6-, 8-, and 10-ft. chain and bracket doors, have been used on the royal red shrimp grounds. The results indicate that smaller nets can be more easily fished, but under similar conditions larger nets appear to produce larger catches. Likewise, single-rig trawling against the current, together with accurate control of bottom speed and depth, has consistently produced the best results. Swivels at the point of attachment between bridle and towing warp tend to reduce fouling and thus increase fishing time.

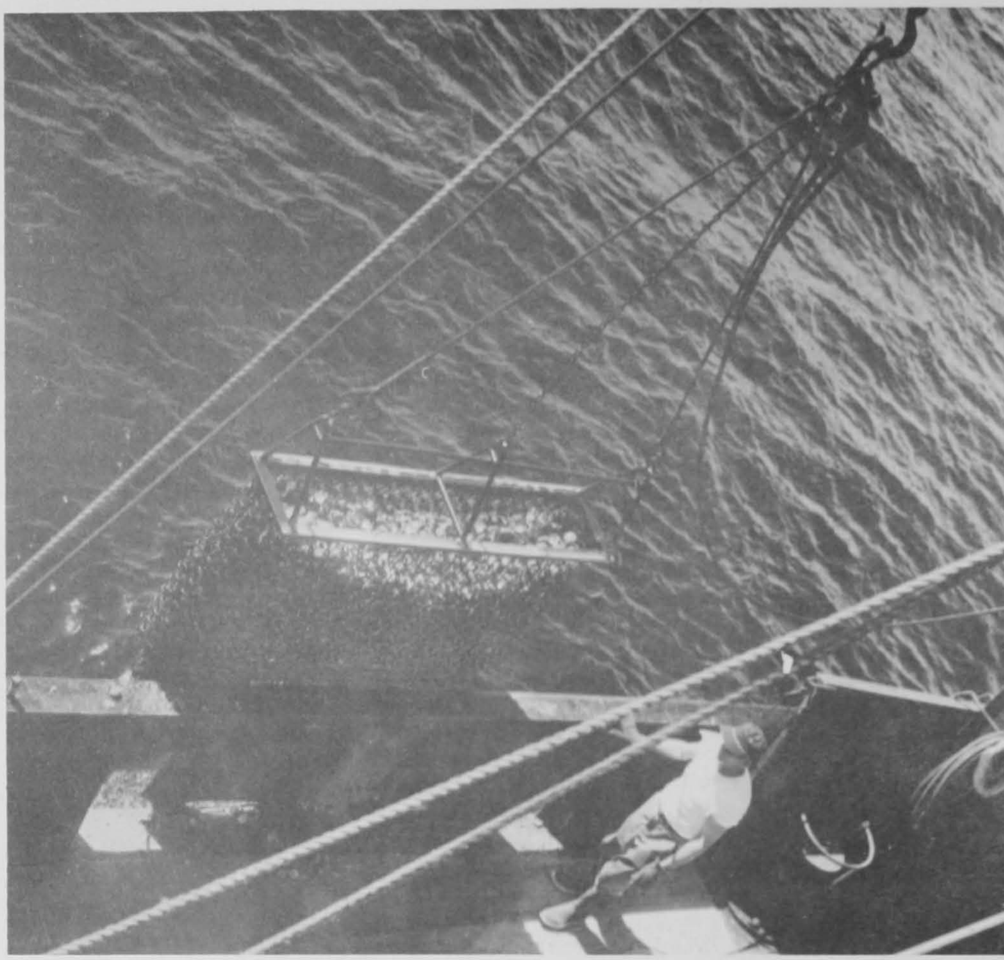

Figure 16.--Six-foot tumbler dredge coming aboard the Silver Bay with approximately 20 bushels of calico scallops.

Figure 17.--Combination shucker and eviscerator. A pilot scallop shucking and eviscerating machine being tested at sea aboard the Silver Bay.

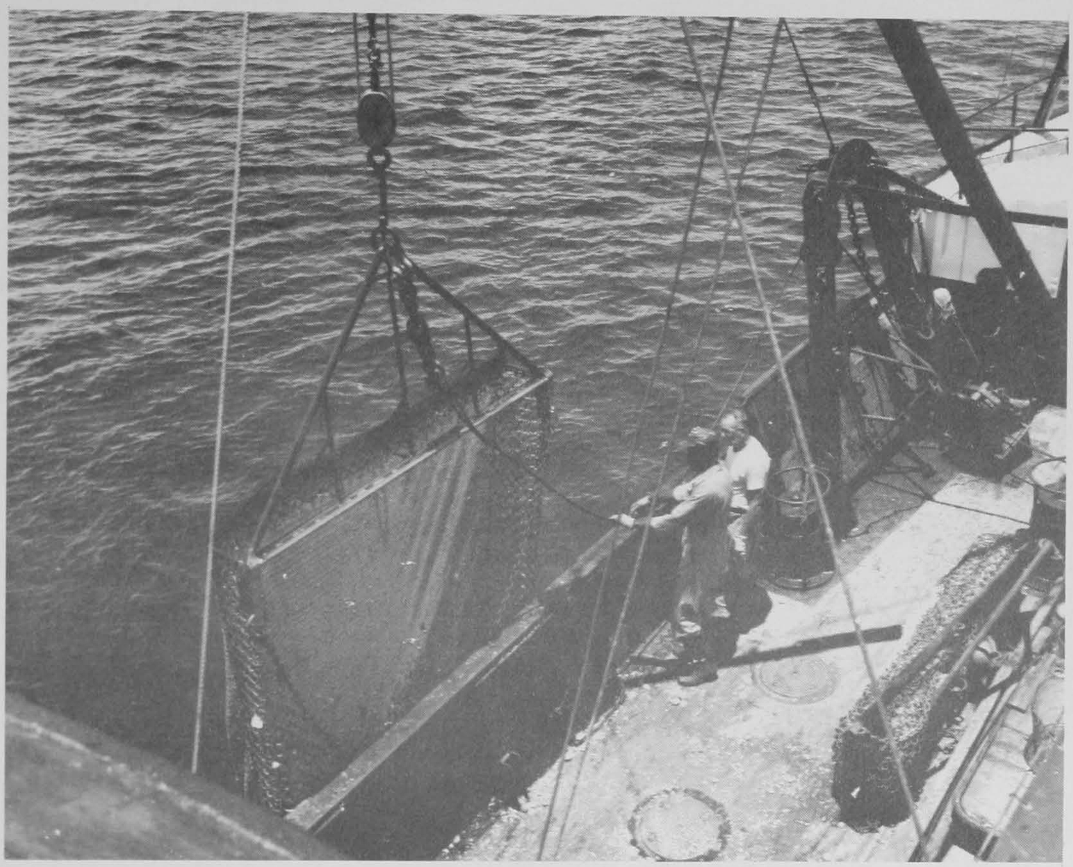

Figure 18.--A Georges Bank scallop dredge coming aboard the Silver Bay.

Figure 19.--Sorting the royal red shrimp catch on deck.

Bottomfish Project

Three cruises were devoted to bottom trawling. Each cruise covered a preselected area and fish trawls were towed at 99 locations. On the North Carolina coast during July, in Onslow Bay, where fish trawling has seldom been attempted, extensive areas of slab rock caused some gear damage. Here total catches were variable, ranging from 25 to 2,300 pounds per 90-min. drag. Scup (Stenotomus chrysops), averaging three per pound dominated most catches. Spottail pinfish (Diplodus holbrooki), up to 250 pounds per drag and averaging 1 pound each, were taken throughout the area fished and in nearly every drag. The largest catch, vermilion snapper (Rhomboplites aurorubens), was 600 pounds, and some were caught in most of the drags. Small amounts of red snapper (Lutjanus blackfordi) and grouper (Mycteroperca sp.) were taken in trawls, traps, and by handlines. The results of the cruise indicate that Onslow Bay is a potential commercial fishing area.

In January off Southport, S.C., scup, averaging three per pound, again dominated the catches. During the same period off Cape Romain, S.C., the best catches of saleable fish occurred in 20-24 fathoms, and total catches ranged from 525 to 3,057 pounds per 90-min. drag. In this area, nine consecutive drags yielded 15,396 pounds of marketable fish.

Off Florida and Georgia in May, fish trawling was demonstrated for industry members who had expressed interest and were rigging their vessels for fish trawling. During this cruise, we used modified gear of a type that could be readily adapted to shrimp vessels.

Snappers, groupers, and other ecologically associated food species represent a widespread and significant potential resource along the shelf from Cape Hatteras south. Some commercial landings have been made, but production attempts have occurred only intermittently. Particular interest in this potential fishery continues among fishermen from both the Carolinas and Florida. Recent test landings have shown that the landed value of these fishes ranged from about 10 to 25 cents per pound. We have developed procedures and modifications for adapting standard fish trawling gear to existing vessels in the area. These procedures include the delineation of bottom areas suitable for trawling, techniques for search and capture with the aid of electronic fish detection, and the use of smaller nets and lighter gear adaptable to shrimp vessels. The results have shown that nets the size of 50/70 foot fish trawls and equipped with 6- or 8-ft. bracket doors could be used by most good shrimp vessels.

Pelagic Fish Project

Preliminary efforts and gear trials during two cruises were devoted to this project, which is the newest project of the program.

In January, fishing results with midwater and off-bottom trawls between Cape Fear, N.C., and Brunswick, Ga., were generally poor. Northeast of Myrtle Beach, S.C., however, 3,500 pounds of anchovies (Anchoa sp.) averaging 38 per pound were taken in a 1-3/4-hr. tow with a wing trawl. On the same cruise east of Cape Romain 2,500 pounds of round herring (Etrumeus sp.) were taken in a 1-1/2-hr. tow with a British Columbia trawl.

East of the Bahamas and during two cruises in the Gulf Stream, numerous deep-water specimens were collected and preserved for study. During all cruises various larval and surface sampling gear were used and specimens were preserved. The samples contained hundreds of larval and juvenile sailfish and swordfish.

Small numbers of yellowfin tuna (Thunnus albacare), albacore (Thunnus alalunga), blue marlin (Makaira albida), and sharks, mostly white tip (Carcharhinus longimanus), were taken on longline gear in the oceanic region east of the Bahamas during March.

Surface gill net sets, made at five locations during January, February, and March, produced only three bluefish (Pomatomus saltatrix), three menhaden (Brevoortia sp.), and one pilotfish (Naucrates ductor).

Extensive tracings of apparently large concentrations of midwater and near-bottom fishes were recorded throughout Onslow Bay. These were probably scad (Decapterus sp.) since as much as 900 pounds of this fish were catches caught per tow in large-mesh fish trawls. At the same time, large numbers of bluefish were observed feeding at the surface around the vessel.

During daylight hours as the operation permits, trolling lines are fished. Species most frequently taken in this manner are dolphin (Coryphaena hippurus), king mackerel (Scomberomorus cavalla), barracuda, (Sphyraena barracuda), wahoo (Acanthocybium solanderi), and little tuna (Euthunnus alleteratus). North of Great Abaco Island in the Bahamas during February, yellowfin and blackfin tuna were caught simultaneously on trolling lines.

Three types of trawls have been used in off-bottom fishing. A 25-ft. square Pascagoula experimental high-speed midwater trawl and a 40-ft. square British Columbia midwater trawl were fished with 30-fathoms leglines of 3/8-in. diameter wire rope (the top leg with a 3-ft. extension) and spread with 6-ft. aluminum hydrofoil doors. The doors rode on

Figure 20.--A catch of mixed bottom food fish being hoisted aboard.

Figure 21.--A sorted catch consisting of 800 pounds of vermilion snappers and several red snappers and groupers.

Figure 22.--A typical catch of mixed fish on deck.

Figure 23.--A 2,500-lb. of round herring and anchovies being hoisted aboard from a tow with a mid-water trawl.

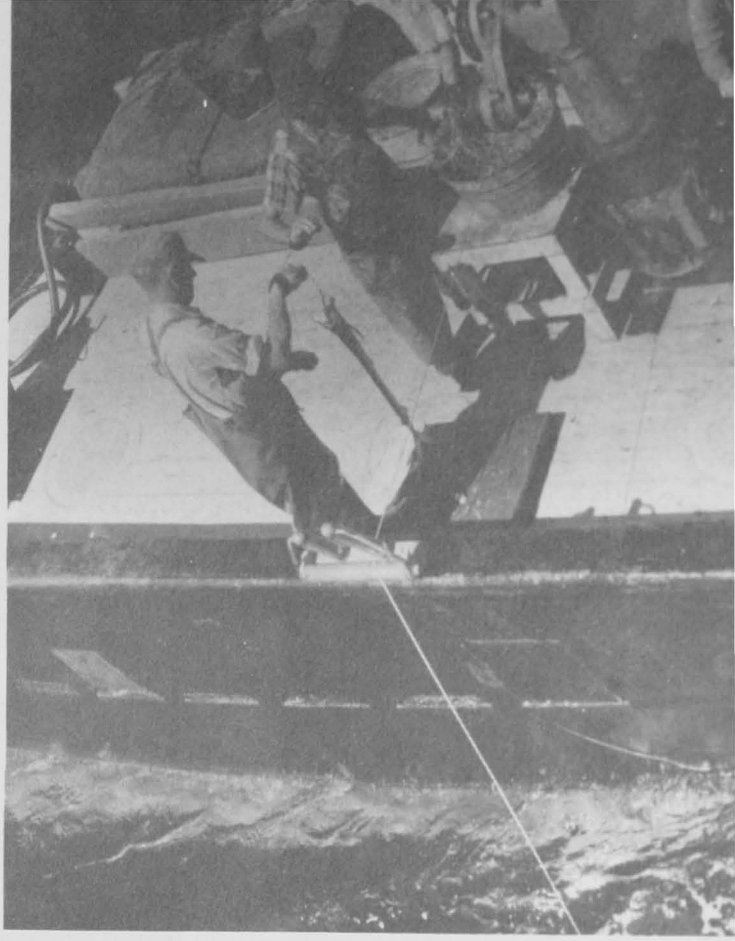

Figure 24.--Unhooking a lancetfish from the tuna longline as it is pulled aboard the Silver Bay.

Figure 25.--A 3,500-lb. catch of anchovies on deck.

Figure 26.--One of the commercial fleet working on the royal red shrimp resource with the Silver Bay, with a catch of royal red shrimp on deck.

gure 27.--Shipyard haulout and maintenance are integral parts of the safety program.

the bottom, and the trawls had a float arrangement along the corkline and loop chain weights along the leadline that permitted them to operate off the bottom. An 80-ft. wing trawl with swallow-tailed wings was also used. This net, of 4-1/2-in. stretched mesh frame, 2-1/2-in. mesh bellies, 1-1/2-in. mesh extension, and 3/4-in. mesh codend, caught 3,500 pounds of anchovies in 90 minutes. The net fished approximately 18 inches off the bottom when spread with 8-ft. bracket doors, 30-fathoms leglines, and standard V/D rig.

GEAR RESEARCH AND DEVELOPMENT PROGRAM

by

Fred Wathne, Chief, Gear Research Unit

The basic aim of the Gear Research and Development Program is to produce more efficient harvesting methods for marine animal resources. This includes development of improved gear for currently exploited species as well as for known but unutilized resources. The Program is based on the premise that significant improvement in harvesting methods depends upon acquisition of quantitative information regarding gear performance, animal behavior, and their interrelation. Research activities are currently directed entirely toward the development of improved methods of harvesting shrimp.

The program has three projects: (1) gear development, (2) animal behavior with respect to fishing gear, and (3) instrumentation development. The gear development project has two phases: gear mechanics and gear construction. Gear mechanics involves the measurement of pertinent gear parameters under various operational conditions. The purpose of this work is to determine quantitatively how the gear performs so that we can compare performance and give direction to construction work. The aim of the gear construction phase is to develop more effective gear after we have acquired information in mechanics and behavior studies.

The behavior project also has two phases; natural behavior and response to artificial stimuli. We have studied natural shrimp behavior by observing their burrowing and vertical migration patterns. The response to artificial stimuli is now concerned with electricity only. The objectives of this work are to determine how shrimp behave and how this behavior may be effectively influenced.

The instrumentation project is a support activity of the gear development and behavior projects. It includes design and development of necessary apparatus as well as adaptation of existing equipment.

During the year we have emphasized the development of an electrical shrimp trawl, design and development of instrumentation for trawl mechanics studies, and acquisition of facilities and personnel for expansion of all program projects.

Results of research projects were presented at industry meetings and in publications of interest to both the commercial and scientific communities. Also, we have extensively used color motion pictures to describe our results. We produced a 30-min. film with sound track describing the operation of Gulf of Mexico shrimp trawls. Ten copies with English narration and three with Spanish narration are in circulation in Europe and the Western Hemisphere. This year a 12-min. film describing the pink shrimp's burrowing behavior and response to electrical stimuli has been prepared and shown at a number of industry meetings. This film will be expanded and a sound track added soon.

In addition to the research projects, cooperative work with fishing gear was performed for other Government agencies, private research organizations, and private industry. Such activities during the past fiscal year included chartering the R/V George M. Bowers to the Bureau's Biological Laboratory at Galveston for shrimp staining experiments, training and qualifying Regional Bureau personnel for SCUBA diving, designing and constructing a canal sampling trawl for the University of Miami Marine Laboratory, and quantitatively evaluating experimental shrimp trawl gear for private industry. This last activity is restricted to testing full-scale gear in advance stages of development. We do not undertake the evaluation of model equipment or development of gear in the idea or theoretical stage for interests outside the Bureau.

Facilities

The Gear Research Station was relocated in Panama City, Fla., this fiscal year to take advantage of that area's natural hydrographic and faunal characteristics which are essential for effectively carrying on the present shrimp gear research program. These include naturally occurring pink shrimp 5 minutes from the dock; water clarity at dockside adequate for shrimp observation

Figure 28.--R/V Observer.

and photography; and water of exceptional clarity, suitable for gear observation and photography, 30 minutes from the dock.

The following facilities are also available to the Gear Research Station: George M. Bowers is a 74-ft. modified shrimp trawler with a 170-hp. diesel engine and a controllable pitch propellor. The vessel has a beam of 20 feet, a draft of 8 feet, and a cruising speed of 8 knots. A 1,800-gal. potable water supply and 2,400-gal. fuel oil capacity provides a cruising range of about 2,000 miles. Accommodations for nine people are available. Auxiliary facilities include regulated a.c. and d.c. power, complete electronic navigation and fishing equipment, a pitometer log for water speed measurement, inflatable liferafts, and a large-volume air compressor for supplying SCUBA diving tanks. Fishing gear includes a combination-type winch adaptable to trawling, purse-seining, and longlining.

The R/V Observer is a 30-ft. converted Navy motor launch with a 25-hp. diesel engine. It is used for behavior studies, specimen collecting, and model trawl studies. It has overnight accommodations for a crew of two. Electrical power is supplied by a 24-volt generator operated off the main engine. Cruising speed is approximately 6 knots. Control is from aft to permit one-man operation of vessel and fishing gear.

A semiportable all metal building measuring 15 ft. long, 6 ft. wide, and 8 ft. high is used for behavior studies and storage of diving equipment (fig. 29). The building is located on a leased "T" dock in the Panama City Marina adjacent to the shrimp observation area. It is equipped with a regulated power supply for instrument operation and air conditioning for humidity control.

A 250-sq. ft. laboratory (fig. 30) is utilized for testing, construction, maintenance, and storage of precision electronic and mechanical equipment. A multipurpose machine tool is available for fabrication of mechanical components of instrumentation.

A battery-powered two-man submersible (fig. 31) is available for gear observations and behavior studies when the use of towed sea sled is impractical or unsafe. Construction is of fiberglass, reinforced with peraluminum. The hull is completely open and requires three waterproof inserts for operation. These consist of a spherical buoyancy tank, a battery, and a container for the motor and gear box. Batteries are 12-volt lead-acid type and power a 1.8-hp. electric motor for 2 hours at a submerged speed up to 4 knots.

Figure 29.--Behavior laboratory and diving locker.

Figure 30.--Electronics laboratory.

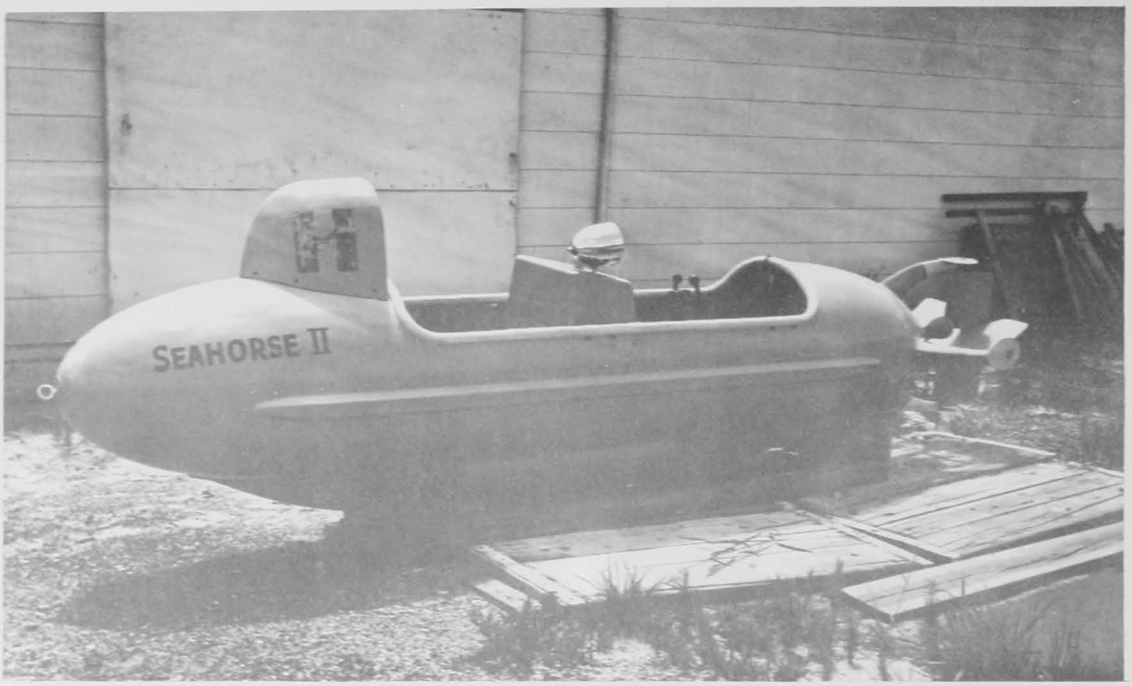

Figure 31.--Self-propelled wet submarine.

Figure 32.--Underwater observation chamber for use in shrimp behavior studies.

For continuous, all-weather, shallow-water observations of shrimp habits, we are constructing an underwater chamber (fig. 32). The chamber is a 3-ft. diameter steel pipe, 15 feet long, and equipped with two 22-in. viewing ports near the bottom. Access to the bottom is provided by ladder rungs welded to the interior. The chamber will be securely anchored in a permanent position next to the "T"-dock. Frequently, continuous observations or closed circuit television prove impractical due to weather or certain water conditions, then the underwater observation chamber provides for at least limited observations year round.

In addition to the submarine, two sea sleds are available for routine observation and photography of towed fishing gear. A two-way voice communication system is used between sled and towing vessel. We have available eight complete SCUBA units, including both mouthpiece-type and full-face-mask-type regulators. Also, for shallow-water work for extended periods we have a unit utilizing low pressure surface supplied air (Hookah).

Photographic equipment used in subsurface work includes three 16-mm. movie cameras, and two 35-mm. and one 120-size reflex cameras with underwater housings. Light-meters and an electronic flash, also with underwater housings, are used to measure and supplement underwater lighting. A 4 x 5 camera provides large-size negatives for illustrating program activities. A 16-mm. movie camera operating at 200 frames/second is used for obtaining slow motion records of pertinent activities. Two 35-mm. lapse cameras are available for obtaining sequential records of behavior patterns.

GEAR DEVELOPMENT PROJECT

by

Fred Wathne, Chief, Gear Research Unit

This project was established to investigate the mechanical aspects of gear research. Effort on this project has been in two areas: shrimp trawl mechanics and development of an electrical shrimp trawl. The mechanics work is covered in some detail in another section of this report.

The development of an electrical shrimp trawl began in 1960 when we experimented with shrimp behavior in aquaria. These tests showed that electrical stimuli of low power, suitably applied, caused burrowed shrimp to move rapidly up into the water into a position that made them available to conventional trawling gear. With this information, we incorporated electrodes into a 20-ft. flat trawl and constructed a sequential pulser, which supplied pulses of a.c. power to the electrodes. We made comparative fishing trials in Mississippi Sound. The experimental trawl was towed simultaneously with a conventional trawl of the same size. The results of these tests were reported in George M. Bowers cruise reports.[6]

Briefly, the results were extremely variable due to unknown reasons. During the first day the experimental trawl produced shrimp at rates slightly under night catches. The standard trawl, during the same tows, produced no shrimp or very few. After dark the same day, the standard trawl produced two to four times the catch of the experimental trawl, indicating that the electrical field was moving the shrimp out of the trawl path. On subsequent trials during this cruise and on the following cruise, comparative catches were inconclusive. At times the experimental trawl was considerably superior, and other times the standard trawl was more effective. It was apparent at this time that before further comparative fishing tests would be of any value, considerable quantitative basic type work was required. This work fell into three general categories: shrimp burrowing behavior, shrimp response to electrical stimuli, and development of an effective electrode-equipped trawl. We felt that to develop a functional electrical shrimp trawl (one capable of performing consistently as an electrical trawl rather than on a "sometimes" basis), much additional information was needed. For example, in order to evaluate the effectiveness of the electrical gear, it is necessary to know when the shrimp are burrowed and what environmental factors affect burrowing. Details of progress and current activities on this work are described in other sections of this report.

[6] See footnote 4, p. 7.

SHRIMP TRAWL MECHANICS PROJECT

by

Fred Wathne, Chief, Gear Research Unit, and
John K. Holt, Fishery Biolgist

Although shrimp trawls have been used for many years to harvest the most valuable fishery resource in the United States, little is known concerning the dynamics of their operation. To understand the mechanical performance of a shrimp trawl, we must evaluate the quantitative data obtained under operating conditions. The results of such an evaluation will also provide standards against which performance of experimental trawls may be compared for a valid evaluation, data on the relationships among load levels in various parts of the trawl, distance between selected points, and the angles involved in the geometry of the trawling assembly. These factors must further be related to both water speed on the hydrodynamic surfaces and ground speed and forces on those components which contact the bottom. The aim of this section is to report progress in achieving these objectives.

The mechanics phase of the program began with an evaluation of the gross performance of commercial shrimp trawls. SCUBA divers made direct observations and movies of the gear in operation. The purposes of the work were to establish generally how the gear performed under various operating conditions and to determine whether potential improvements in performance would become obvious by observation. This aspect of the mechanics phase ended in early 1962, and we released a movie describing the three basic Gulf of

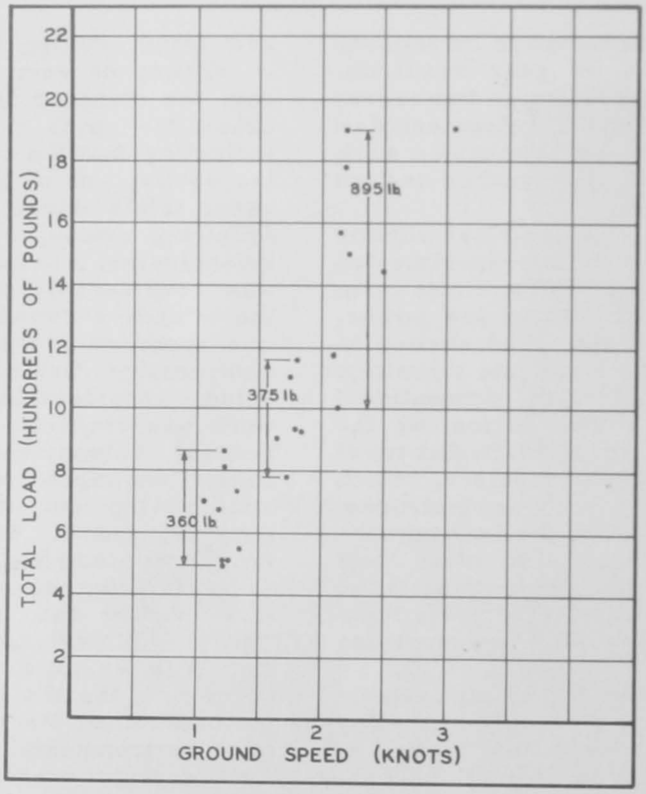

Figure 33.--Total towing load of trawl as related to bottom speed of trawl.

Mexico shrimp trawl designs and their performance under various operational conditions.

Work on the mechanics phase is now directed toward acquiring quantitative data on how trawls perform mechanically. The instrumentation used is described later. Basic to this type of investigation is the establishment of a reference standard. Originally we intended to use as this standard, the water speed measured at the vessel. Results from early tests showed, however, that water speed and gear performance could not be consistently related. A bottom-speed indicator was constructed and towing speed over the bottom was used as the standard. Results were much better but still lacked consistency when measurements of the same gear were made several days apart. Within-day consistency, however, was very good. Surface and subsurface currents in the test area affect the gear significantly.

Figure 33 illustrates the nonconsistency of total towing load (measured aboard the vessel) related to bottom speed. Each figure is the average of measurements made in opposite towing directions. At each of the three bottom speeds the total load varied 72, 48, and 85 percent. It is apparent that a valid mechanical evaluation of shrimp trawls will have to incorporate accurate knowledge of current vectors within the test area or tests will have to be made in motionless waters.

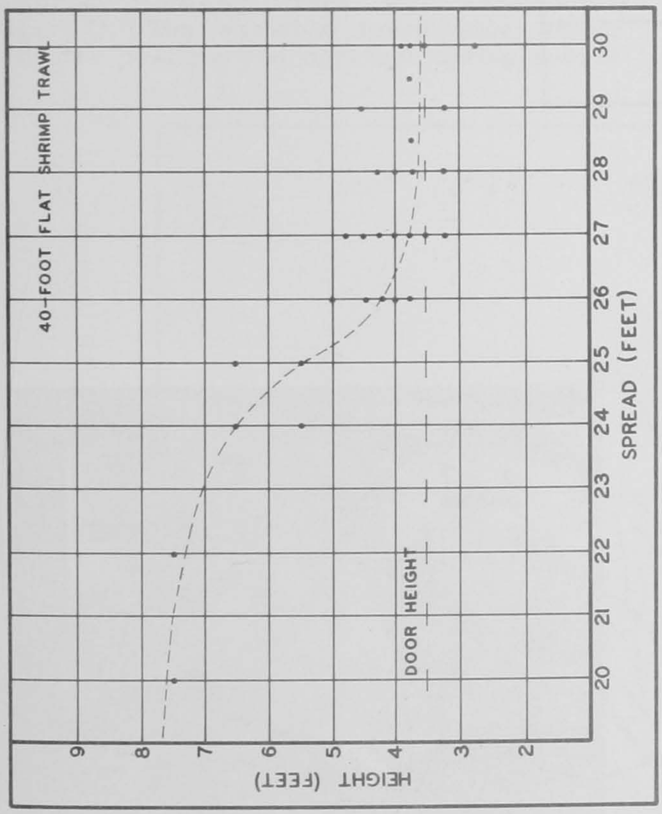

Figure 34.--Horizontal spread as related to vertical height of a 40-ft. flat trawl.

40-ft. Flat Trawl.--Initial experiments have been conducted with the 40-ft. flat trawl operated with 6-ft. by 38-in. doors. The trawl is constructed of 2-in., No. 15 untarred nylon webbing. The doors are of typical construction with a chain towing bridle. They weigh 150 pounds in air and 20 pounds in water. Standard towing procedure was to use a single wrap (7/16 inch) and a 20-fathom bridle. Experiments were conducted at a depth of 5 fathoms.

The rate of change of vertical height is greatest at the smaller horizontal spreads, for there is an inverse relationship between these two variables (fig. 34). The "normal" configuration of this trawl with 6-ft. doors is approximately a 27- to 28-ft. spread and a 4-ft. vertical opening. The data at lesser spreads and greater vertical opening were caused by abnormally low bottom speeds resulting from water currents. The water speed measured at the vessel was normal. Both spread and height readings oscillated slowly about 1 foot with a period of from 10 seconds to over a minute. The minimum distances were taken in all cases, and this causes some height figures to appear below the height of the top of the door.

Door Angle of Attack.--The door angle of attack decreased with increased towing speed and was greater with a 15:1 scope ratio than 10:1 in this water depth (fig. 35). An exception to this occurred when a scope ratio of 5:1 was employed. In this situation the door tended bottom very lightly and the angle of attack increased with faster speed--as the door approached an off-bottom condition.

Experimental Shrimp Trawl Doors.--We made preliminary experiments with a pair of shrimp trawl doors of a dihedral or V design (fig. 36). This design has been reported recently in several industry journals. Claims for the design include (1) greater spreading-drag force ratio, (2) greater stability in setting and towing, and (3) smaller scope ratio requirements.

The aims of the initial tests were to determine an optimum tow point and flotation-ballast balance. The experimental towing yoke permits individual adjustments in three planes, 'or example, the tow point can be moved up or down, back or forward, or in and out. By numerous towing tests, we determined an optimum tow point position, as well as a flotation-ballast relationship. A production model incorporating the information acquired will be tested and compared with standard gear later.

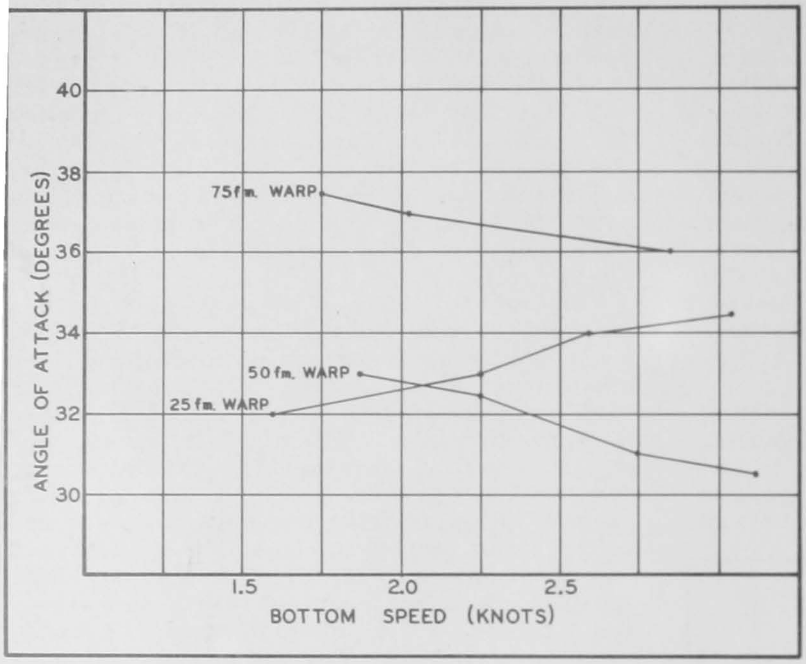

Figure 35.--Trawl door angle of attack and trawl door-leg angle as related to towing speed and scope ratio of trawl.

Figure 36.--Experimental shrimp trawl doors with adjustable towing point yoke.

GEAR CONSTRUCTION PROJECT PHASE

by

John K. Holt, Fishery Biologist, and
David G. Wotherspoon, Fishery Methods and Equipment Specialist

The gear construction project phase was initiated for the purpose of applying information acquired in mechanics and behavior studies to the development of more effective fishing gear. The development of an electrical shrimp trawl based on results obtained in the behavior project is in progress. Briefly, the behavior work revealed that (1) approximately three electrical pulses were required to cause a burrowed shrimp to come out of the bottom, (2) to be effective, pulses should be at a maximum rate of four per second, and (3) voltage drop across the shrimp should be at least 40 millivolts.

Mobile Electrode Experiments.--The initial behavior work was with static electrodes; however, we decided to use mobile electrodes to verify results because the latter would be used in trawling. To accomplish this a 30-ft. electrode towing track was constructed (fig. 37). The variable speed winch drive provides positive and constant towing speeds over the range of 1 to 3 knots. The pulse generator provides variable power levels and pulse rates.

Calculations show that 4-ft. electrodes and a pulse rate of 3.75/second will provide 3 pulses/second/4 feet of travel at a towing speed of 3 knots. The electrode length, however, chosen for these experiments was 2 feet, and this permitted a one-half reduction (2.5 ft./second) in towing speed with retention of the desired electrical stimulus. This substantially facilitated quantitative observations. Results of these tests showed that shrimp respond to mobile electrodes essentially the same as they do to static electrodes.

A similar but larger towing track is being constructed. This one, however, will be 125 ft. long and 15 ft. wide in order to accommodate the experimental trawl described below. The objective of experiments with this equipment is to determine what percentage of shrimp encountered by an electrical trawl escapes capture and the manner of escape.

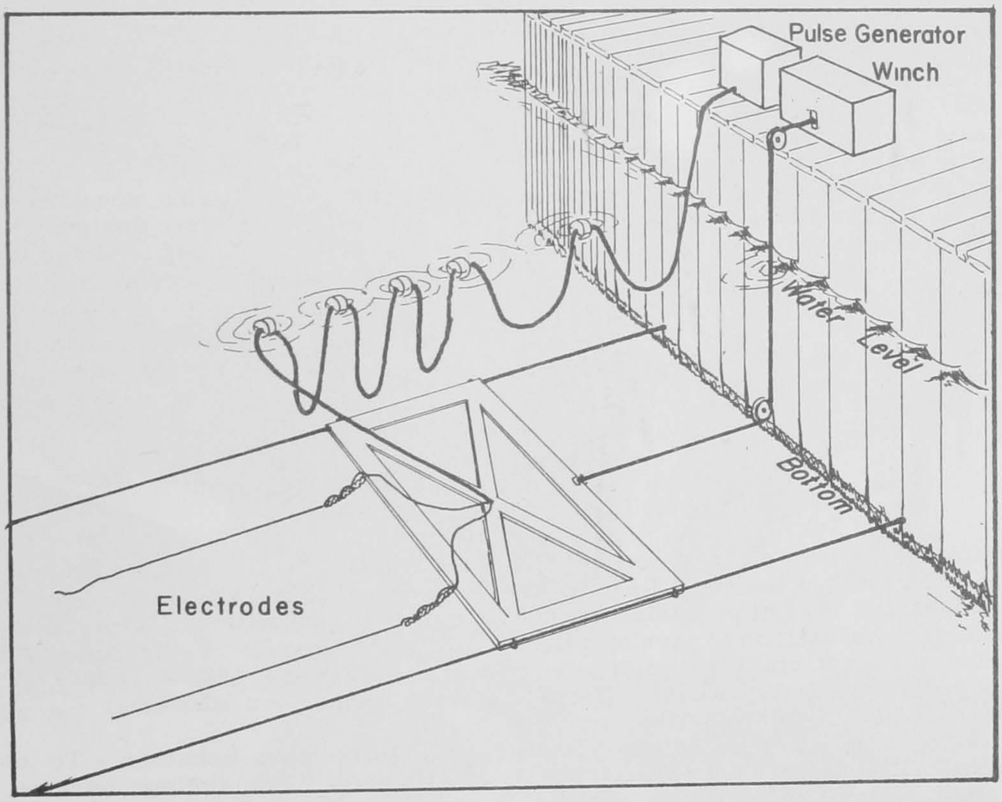

Figure 37.--Diagram of mobile electrode towing track.

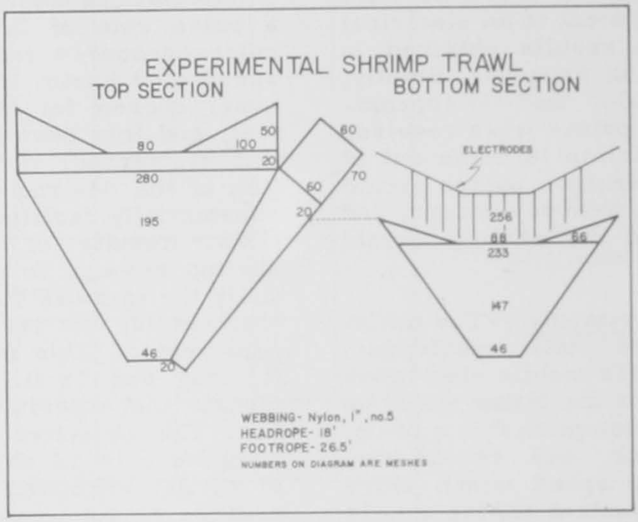

Figure 38.--Experimental electrode equipped shrimp trawl.

Electrode Trawl Design.--Observations of one-half scale model shrimp trawls equipped with electrodes indicated that some modifications in design were necessary to provide effective electrical coverage of the horizontal area sampled, as well as overhead cover to prevent vertical escapement. A 20-ft. model semiballoon trawl was modified (fig. 38). This design performed well while being towed; however, because of a higher than normal percentage of webbing in the top section, it had a greater tendency to leave the bottom. This was compensated for by increasing the footrope weight. The model towed well at speeds to 2 knots, which is approximately equivalent to a towing speed of 3 knots for a 40-ft. net of the same design. This trawl will be used in electrical experiments in the towing frame described above.

SHRIMP BEHAVIOR PROJECT

by

Charles M. Fuss, Jr., Project Leader, and
L. H. Ogren, Fishery Biologist

Marine animal behavior studies conducted by the Behavior Project of the Gear Research Station are orientated toward providing basic information for the evaluation and development of fishing gear. Present studies are limited to learning more of the natural behavior and responses to stimuli of pink shrimp, which provides a significant portion of the total Gulf of Mexico shrimp catch.

When possible, animal behavior is studied in situ utilizing diving equipment, underwater observation chambers, and closed circuit television. Underwater motion picture photography has provided a valuable tool in preliminary phases of these investigations and is used extensively. Purposes of the current study include the following:

1. Burrowing behavior - To obtain information on how shrimp burrow, when they burrow, and to what depths of bottom they penetrate. These data will be correlated with

Figure 39.--T-dock used for shrimp behavior experiments.

various environmental factors including temperature, salinity, dissolved oxygen, light levels, and current direction and velocity.

2. Reactions to electrical stimulation - To observe and measure how shrimp react to various electrical fields of both a.c. and d.c. pulsed currents. Parameters to be investigated include pulse rate, pulse strength, pulse duration, and concurrent field strength.

3. Reactions to mechanical stimulation - To observe and measure how shrimp react to probes, chain, water jets, and air jets.

4. Reactions to light - To observe and measure how shrimp react to various colors of the visible spectrum.

5. Vertical diurnal migrations - To obtain data on the daily vertical movements of shrimp within given water columns - and to attempt to correlate such movements, if they exist, with environmental factors.

6. Trawl escapement - To determine how shrimp escape from the paths of standard and experimental shrimp trawls.

7. Reactions to sonic stimulation - To observe and measure how shrimp react to various levels of sound.

During fiscal year 1963, the work accomplishments of the Behavior Section consisted of obtaining information on the burrowing habits and responses to electrical stimuli of the pink shrimp (Penaeus duorarum).

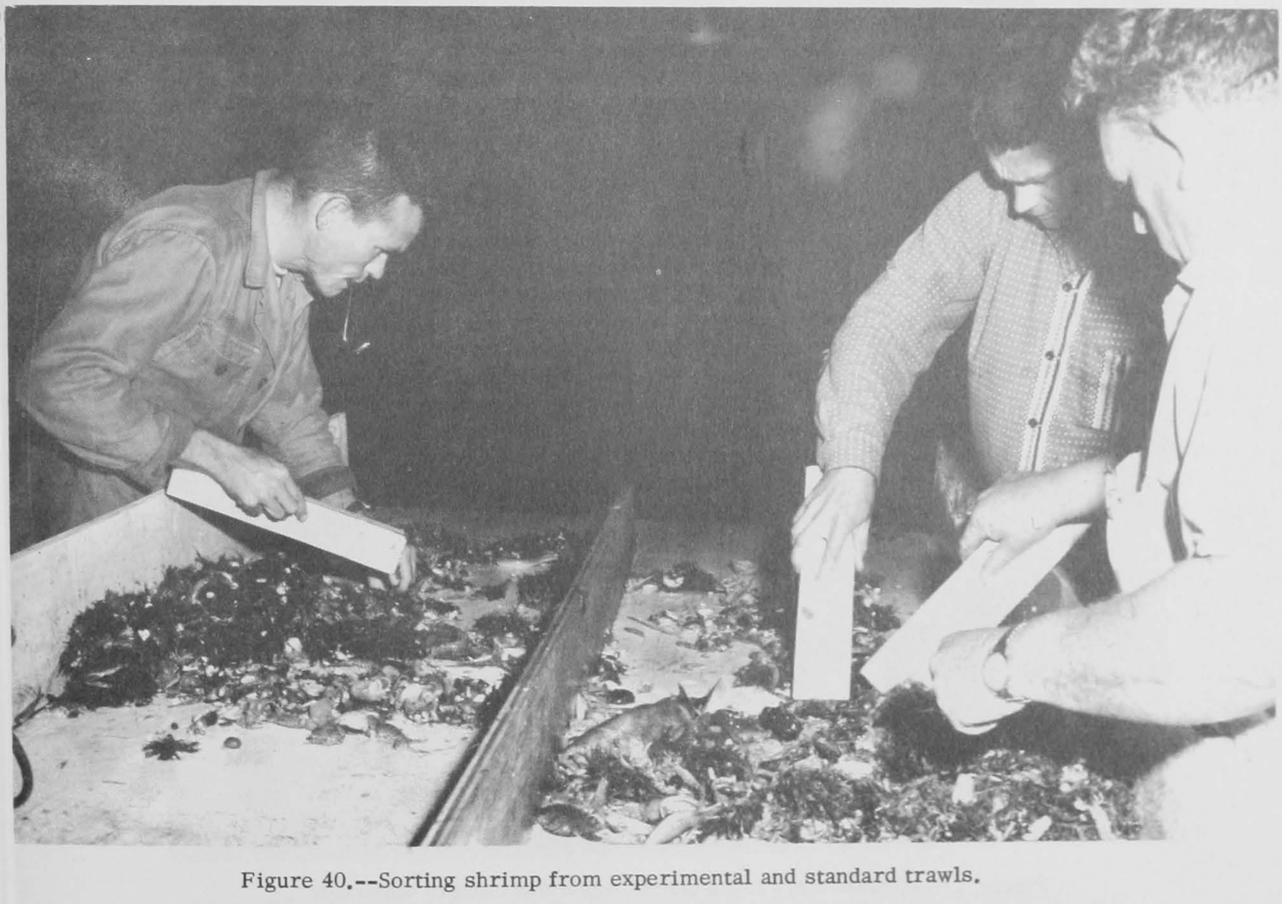

Figure 40.--Sorting shrimp from experimental and standard trawls.

Natural Behavior Phase.--The objectives of the shrimp burrowing phase of the behavior project are to improve the efficiency of shrimp trawling gear and methods and to develop more effective gear on the basis of a better understanding of the habits and responses of the species sought. Information on how deep the shrimp burrow into the bottom and how long they burrow will provide information needed to modify and develop tickler devices for standard and experimental shrimp trawls. Burrowing information is also extremely important in the application of electrical devices to experimental trawls.

A 12-min., 16 mm. color film was prepared showing various aspects of burrowing behavior. It was shown to interested groups to illustrate the importance of natural behavior studies to gear research. The film includes scenes showing the methods of burrowing, degree of bottom penetration, methods of observing times of burrowing, mechanisms of water circulation for respiration, and responses of burrowed shrimp to mechanical and electrical stimulation. Filming was accomplished in St. Andrew Bay and immediately offshore of Panama City Beach, Fla.

Studies on the general aspects of burrowing were conducted intermittently, using SCUBA diving equipment and closed circuit television. We released shrimp on the bottom or placed them in bottomless cages and watched their activity over 24-hr. periods. All shrimp studied burrowed during daylight hours and showed varying degrees of nocturnal activity. There appeared to be a correlation between burrowing

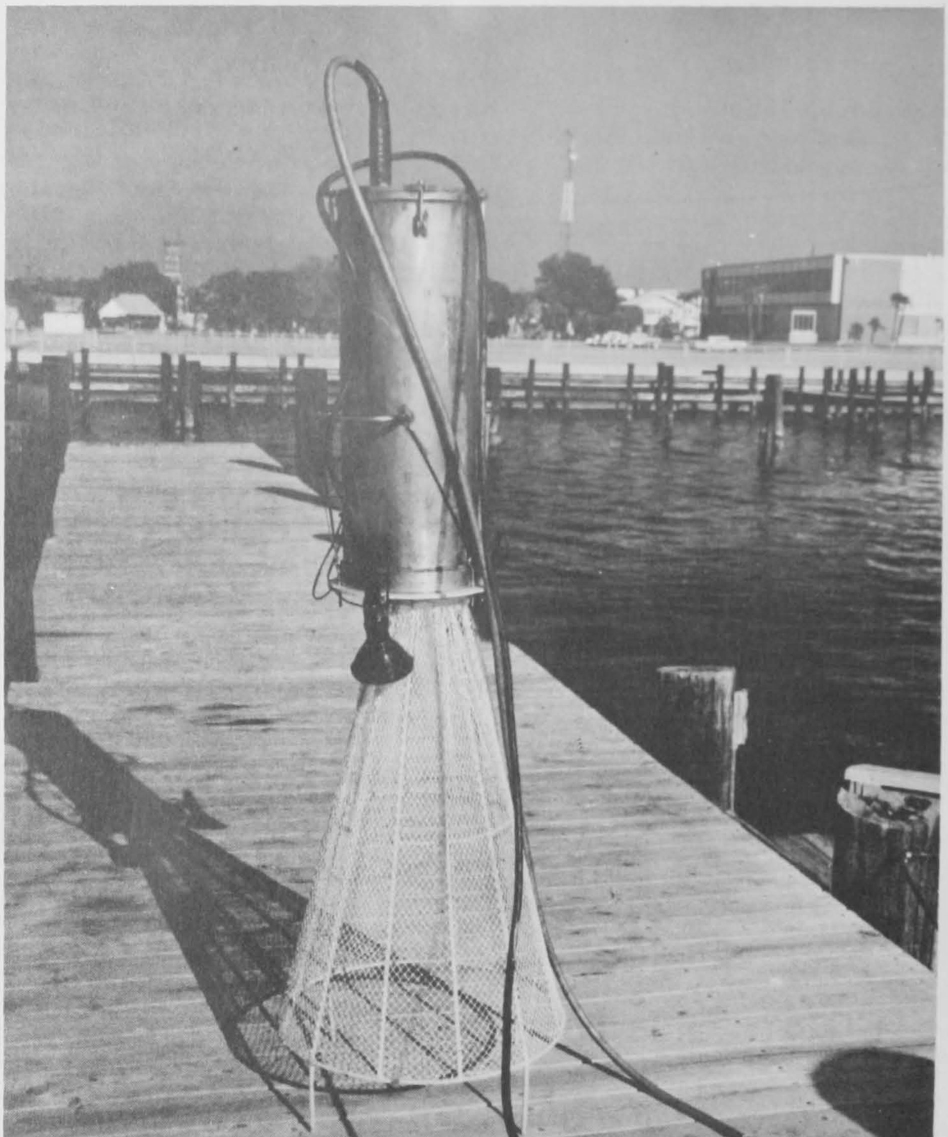

Figure 41.--Underwater closed circuit television camera apparatus.

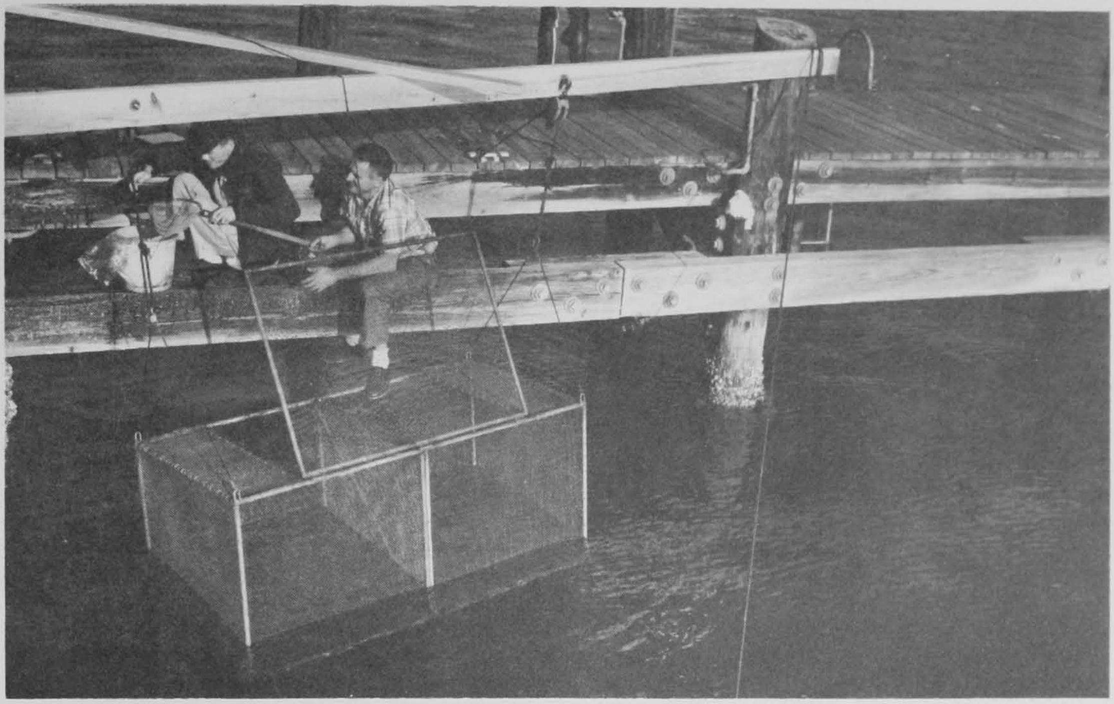

Figure 42.--Shrimp holding cage.

Figure 43.--Experimenting with the response of shrimp to electricity in an aquarium.

behavior and moon phases or light level. Two reports summarizing the work completed in this phase of the project were submitted for publication.

Response to Artificial Stimuli Phase.--We are continuing our investigation of shrimp response to electrical stimuli in order to expand and reinforce earlier data (Wathne, 1963). A 6-ft. by 15-ft. dockside laboratory was erected on St. Andrew Bay to afford space for experiments and housing the necessary test gear. A salt-water pump furnishes bay water for the aquarium. The laboratory has regulated voltage for the test gear, as well as a nonregulated electrical source for miscellaneous motors, lights, etc. An air conditioner was installed to eliminate any excessive heating of the exposed laboratory.

A d.c. electrical pulsing apparatus was manufactured especially for this project. To test shrimp response over a wide range of electrical stimuli, the pulser was designed to deliver a variable output, viz., voltage, pulse width, and pulse rate. The shocker used in experiments last summer had a transformer to supply a variable a.c. voltage. The output was interrupted (pulsed) by employing a motor-driven rotary switch. The pulse rate could be varied by this means, but not the pulse width and shape. The d.c. apparatus uses capacitor discharges to supply the pulsed output. A number of different sized capacitors can be selected in order to vary the pulse shape and width.

Preliminary response experiments were carried out in a 50-gal. aquarium and in the bay adjacent to the dock. The experiments in the bay were conducted by a diver who positioned the shrimp between the electrodes on the bottom and operated an underwater switch, which triggered the pulser. A second person on the dock recorded the observations and made the necessary adjustments to the pulser, for example, varied the pulse strength and the pulse width.

Results again demonstrate that the response threshold varies inversely with the size of the shrimp. Additional information was found concerning pulse width . . . the wider the pulse, the stronger the field strength. This means that pulse width, as well as input voltage, is a factor in determining minimum response thresholds. We are therefore studying pulse shape characteristics of the stimulus in terms of power requirements so that we

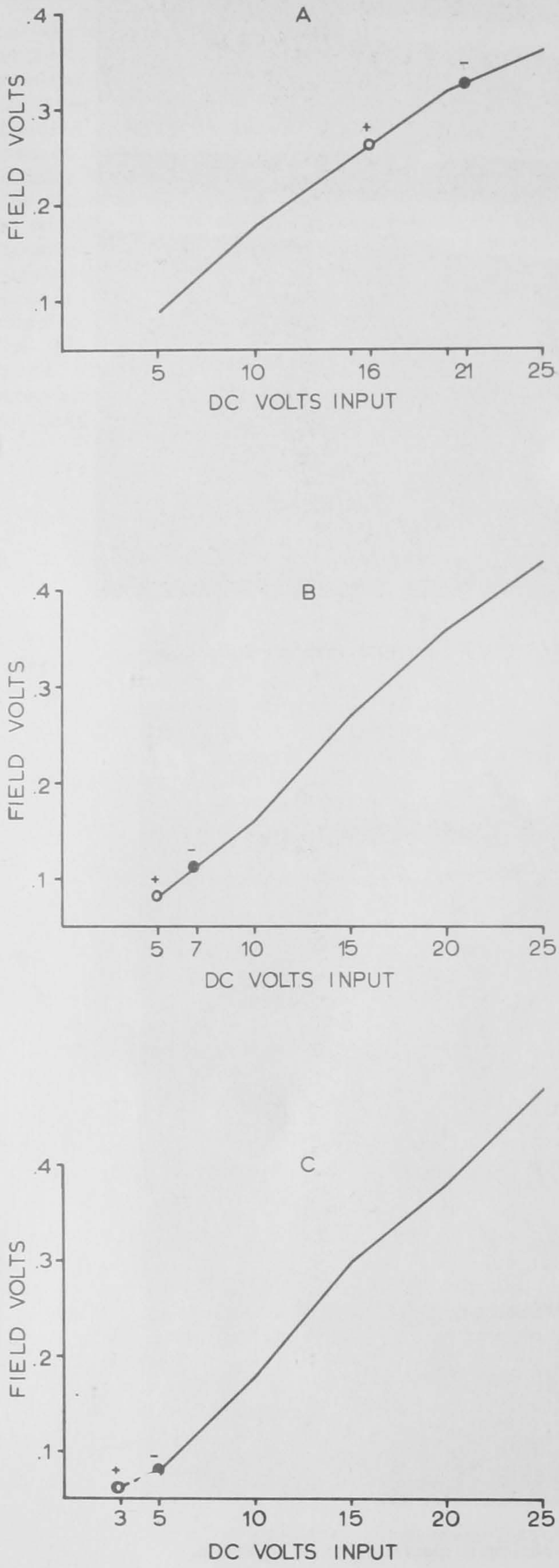

Figure 44.--Minimum blocking response thresholds of a 5-inch long pink shrimp.

(a) pulse width 0.4 milliseconds (msec.), (b) pulse width 4.0 msec., (c) pulse width 40.0 msec. (, shrimp oriented toward positive electrode; -, shrimp oriented toward negative electrode).

may determine the most efficient means to block a shrimp.

The optimum pulse repetition rate to allow for a maximum contraction-extension movement on the part of the shrimp was found to be 1-3 pulses/second. This agrees with work done previously (Wathne, 1963). In the aquarium experiments, field strength (recorded as the voltage drop between 1/2-inch probes 2 inches apart) of approximately 0.07 volts delivered at a pulse width of about 3.0 milliseconds were sufficient to cause blocking in a 6-in. long shrimp. It was demonstrated again, that the orientation of the shrimp in the field determined the strength of the stimuli necessary to give a blocking response. In addition to response differences due to the angle a shrimp subtends in the field, a definite polarity sensitivity exists in the animal when using a d.c. stimulus. If the shrimp is positioned normal to the field, with its anterior end directed toward the positive electrode, a tail flip response can be elicited by a lower voltage than if the reverse is true (see fig. 44).

INSTRUMENTATION DEVELOPMENT PROJECT

by

John K. Holt, Project Leader

Instrumentation objectives of this project include development of systems for trawl mechanics studies as well as development of apparatus to solve specific problems of gear performance and telemetry. Within the latter classification two phases are current. One is the development of an on-bottom indicator utilizing a sonic telemetering link between the gear and towing vessel. The transmitter design is such that in addition to transmitting "on-bottom" information, it will allow other data such as bottom speed to be coded into the signal. Initially this system is intended primarily for use by exploratory fishing vessels working in deeper depths (150-300 fm.). The primary aim is to provide pertinent information on a trawl performance feature that is fundamental to evaluating an exploratory trawling catch. The need for this information, particularly in deep water, has been evidenced by the frequent "water hauls" and by the extremely variable catch rates within relatively restricted areas. The water hauls show the gear did not reach bottom during an entire tow. The variable catch rates suggest that the gear may have been off bottom for various lengths of time during tows. An on-bottom indicator will afford a positive means of assuring bottom contact or permit catch evaluations based on time on bottom.

The other unit under development is a ball-bearing swivel for multiconductor electrical towing cable. Experience with this cable on trawling gear has been largely unsatisfactory for a number of possible reasons:

1. Excessive load.

2. Differential torsional resistance in the two layers of steel strands.

3. "Rolling mill" action on the outer strands during passage through trawl blocks.

It is felt, however, that conductor breakage and "bird-caging" are primarily due to continual twisting and untwisting of the cable under the inherent torsional forces of a cable under stress. The slip-ring equipped ball-bearing swivel will permit the cable to twist freely and afford a means of transferring the electrical signals through the swivel.

The development and use of instrumentation for the study of trawl mechanics have been reported by numerous workers. These instruments are all on-site recording, for example, the sensing elements and readouts are located on the gear. This has the significant advantage of not requiring either electrical conductors between the gear and vessel or complicated electronic telemetry. The method chosen for the shrimp trawl work involves a continuous readout aboard the vessel. This method has the advantage of simultaneous readings of variables without time-consuming reconciliation of numerous graphs. Also, more precise readout equipment can be employed because space and power requirements are not a major consideration, questionable indications can be repeated immediately, ground speed can be adjusted precisely, and there is no time limitation imposed on experiments by length of recording material.

Bottom Speed Indicator.--Since bottom speed was selected as the fundamental parameter for quantitative analysis of shrimp trawl performance we needed to develop a method of obtaining this information accurately and reliably. The basic technique selected is described by Bullis (1956a). The apparatus consists of a pair of wheels secured to the door in a manner which permits them to track in the towing direction irrespective of door tilt (fig. 45). The wheels are 24 inches in circumference. One wheel has two small magnets mounted opposite one another. The rotating

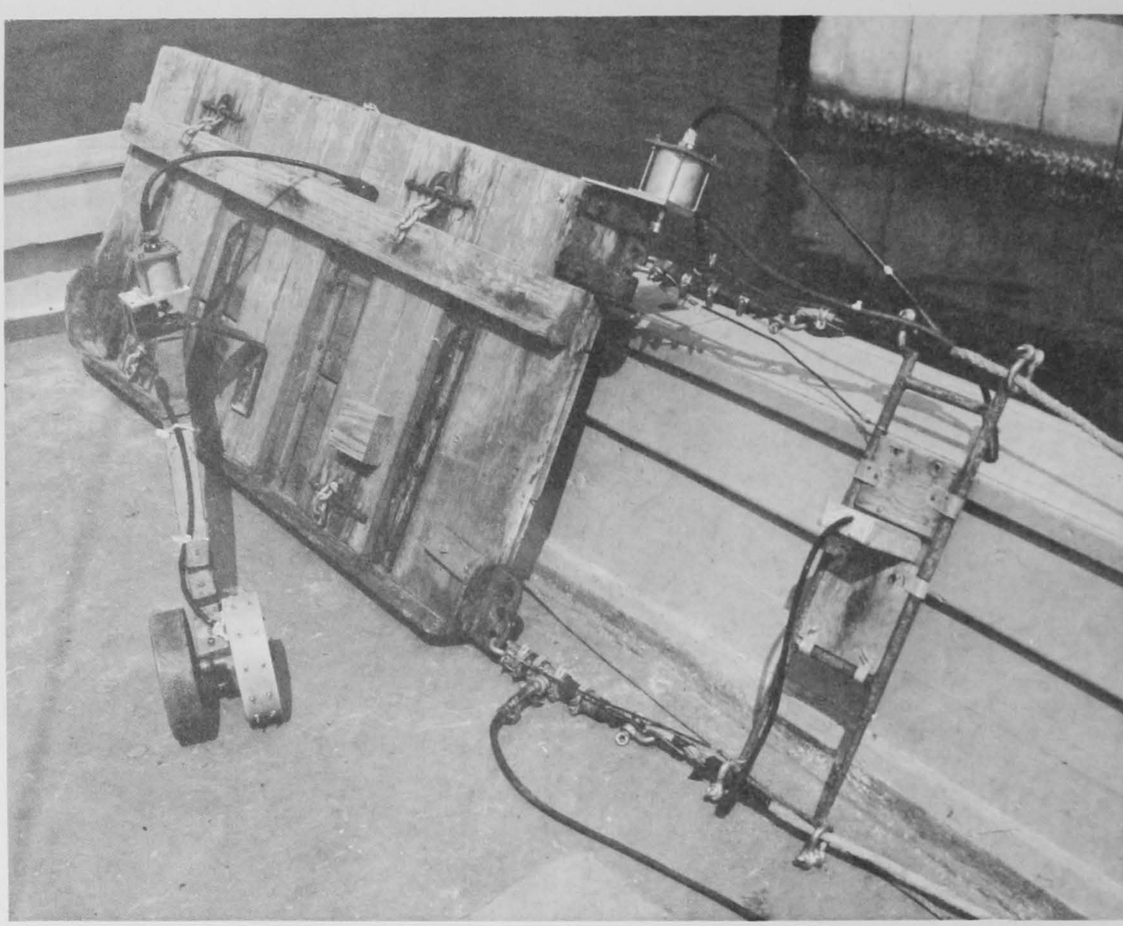

Figure 45.--Instrument-equipped trawl door (A). At left is bottom speed sensor. Mounted at forward end of the trailing arm (B) is the angle of attack sensor (C). The door-leg sensor is mounted on the top aft end of door. Load cells are located immediately behind each door and one of the distance measuring transducers mounted in the frame.

magnets activate a magnetically operated switch mounted adjacent to the wheel. The frequency of impulses produced is a direct function of bottom speed. The impulses are recorded aboard the vessel (fig. 46). A meter readout is being constructed that will eliminate the need to count pulse recordings.

Distance Measurement.--Distances between trawl components are other variables of trawl mechanics requiring measurement. The method selected for measuring required distances was acoustic signals, with readout aboard the vessel. We felt this would be the most reliable and operationally desirable.

We use a high-power depth recorder unit for signal generation and transmission, and an oscilloscope for measuring time difference between transmitted and received signals. The sonic gear was selected because it provided the power necessary for transmission over a relatively long wire, and because the design was such that the shape of the signal cone (40° by 60°) was great enough to minimize transducer alignment problems. The oscilloscope was chosen for signal display because it has a much greater resolution capability than the relatively slow-speed stylus of the commercial recorder.

A pair of sonic transducers is used in making all measurements. We obtain horizontal distance by using a direct signal between the points being measured. The transmitting transducer is mounted behind one of the doors of a trawl (fig. 45). The receiving transducer is located in a similar position behind the other door. For vertical measurements, utilizing an echo off the bottom rather than a direct signal, we mount the transducers adjacent to each other on the headrope. This system has proved to be extremely accurate and reliable.

Load Cell System.--Knowledge of the magnitude of forces between various components of the trawl assembly is essential for

Figure 46.--Instrumentation readout. From left to right oscilloscope, angle indicator (top), power supply for bottom speed sensor (top), strip chart recorder and load cell power supply and readout.

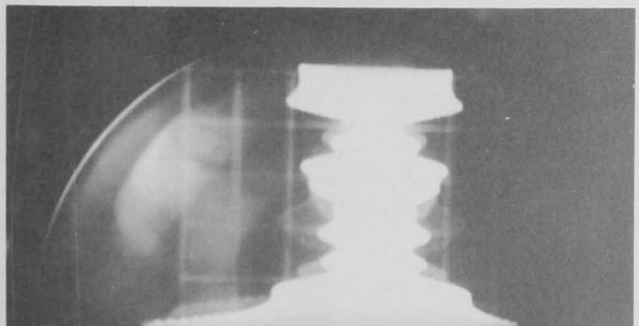

Figure 47.--Photo from oscilloscope. Spread at this time was 18 feet.

quantitative evaluation of shrimp trawl mechanics. To measure these forces, we are developing a remote indicating electrical load cell system. The system is composed of transformer-type transducers, an indicating milliampmeter, and a hydraulic calibration jig for setting and adjusting transducers. The load sensing member of the transducer assembly is a bar made from a number of transformer laminations. The laminations are secured together, four holes are drilled in the center for the coil windings, and the bar is annealed. Two coils are wound at right angles to each other with magnet wire. In this configuration, a small a.c. current is produced by the secondary winding when an a.c. current is supplied to the primary winding. When a tensile force is applied to the load member, the output current from the secondary winding increases and is indicated on the meter. The load capacity of the transducer is governed by the number of laminations used. A transducer can be used for a variety of full-scale load ranges, within its designed capacity, if it is recalibrated before each use. Ball-bearing swivels are used between the transducer and cable to prevent cable torque from affecting transducer performance.

The system is now in the developmental stage, and some problems have been encountered. The most formidable of these is a tendency of the transducers to shift calibration with changes in surrounding temperature. We intend to overcome this deficiency by changing the transducer design.

Angle Measuring.--In addition to measuring the magnitude of load between gear components, we also need to know the operating angle between them to compute resultant forces of lift and drag. Three angle measurements are considered essential to the analysis: door angle of attack, the angle between the door and legs of the trawl, and the angle between door and towing wire. The first two angles are sensed by a variable resistor mounted in a watertight housing (fig. 45). The door-towing wire angle is computed from measurements of door angle of attack, door spread, and bridle length. The door angle of attack sensing element is actuated by the bottom speed indicator arm, which trails in the towing direction. The sensing element for the door-leg angle is actuated by the trawl leg. The angle measurements are indicated separately on voltmeters aboard the vessel (fig. 46) or recorded on a strip chart (fig. 49).

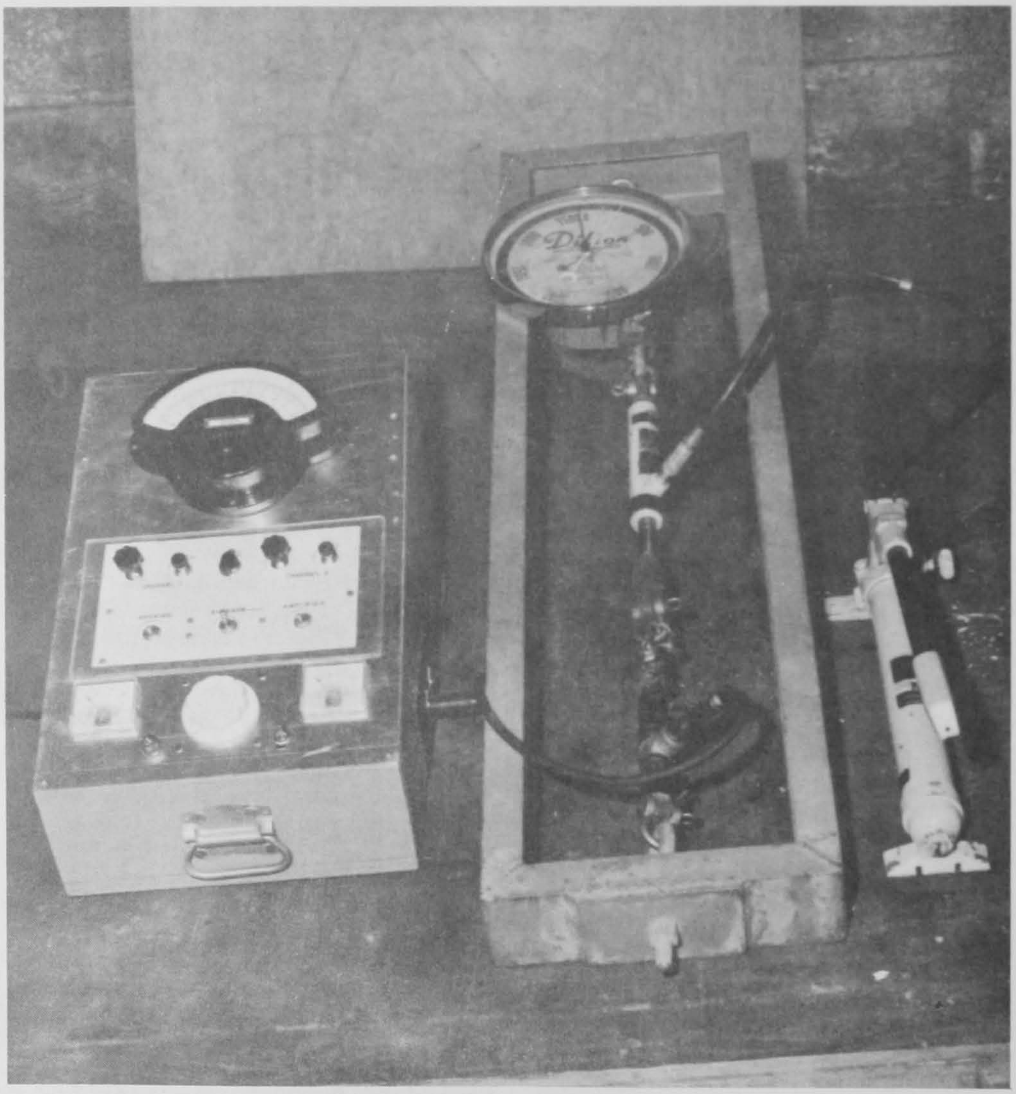

Figure 48.--Load cell calibration jig.

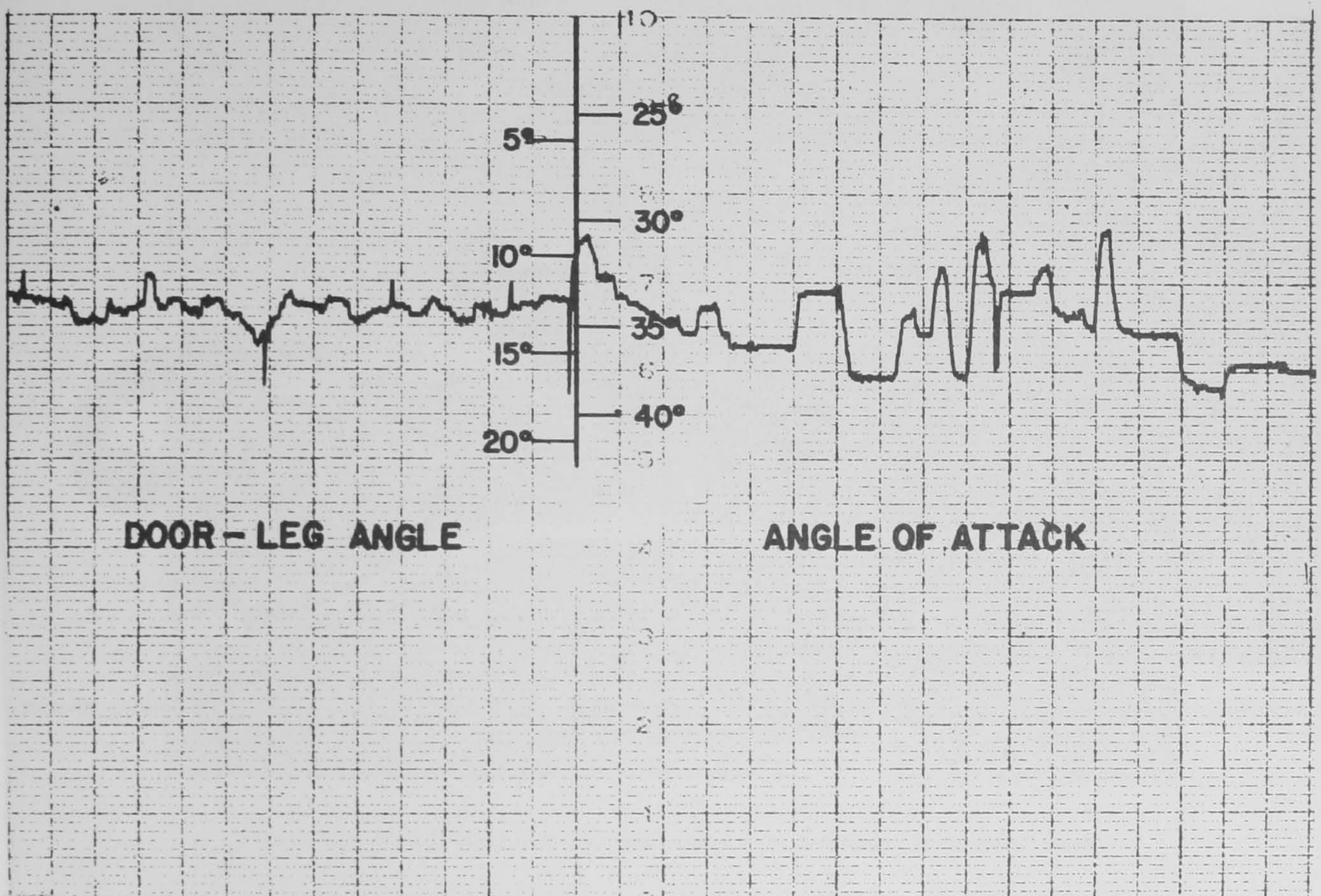

Figure 49.--Typical recordings of angle measurements of trawl doors.

A SEA-SLED TO TOWING-VESSEL VOICE COMMUNICATION SYSTEM

by

John K. Holt, Fishery Biologist

For several years, SCUBA divers have been an integral part of the gear research activities of the Bureau of Commercial Fisheries. Rather than swimming free, divers have found it advantageous to ride specially constructed underwater sleds towed by a surface vessel (Holt, 1960). Sleds enable the divers to cover more ground, cover it more thoroughly and systematically, and provide platforms from which mobile underwater objects can be readily observed and effectively photographed.

These observation sleds are towed and controlled from the vessel, but a degree of latitudinal control can be exercised by the divers. For operational effectiveness and safety some means of communicating with the surface is needed. Originally a buzzer device was used between sled and surface vessel (Holt, 1961), but coding and decoding difficulties limited the communication to simple messages. This section describes a system that allows the divers on the sled and the persons on the vessel to speak to each other directly.

Design.--The principal components of the voice communications system (fig. 50) are a 16-ohm underwater speaker mounted on the sled, 1,000 feet of coaxial cable between the sled and the towing vessel, and a 20-watt amplifier and 16-ohm speaker mounted on the vessel's bridge. Incorporated into the circuit and mounted with the amplifier is a 4-pole double-throw relay powered by a 6-volt battery and operated by a push button switch mounted in the bridge speaker housing. The relay affords a means of using the speakers as microphones.

In the block diagram of the system, the relay is shown in the normal position, for example,

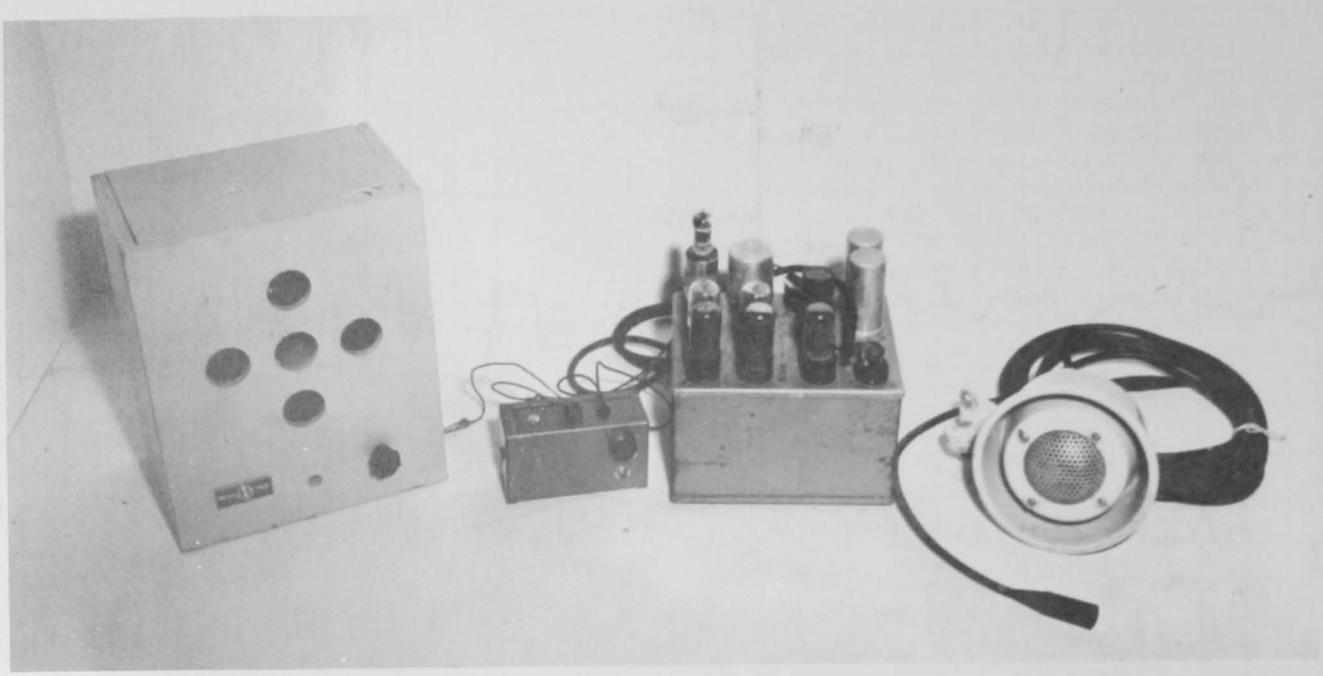

Figure 50.--Communication system components. Left to right--bridge speaker enclosure, relay chassis, 20-watt amplifier, underwater speaker.

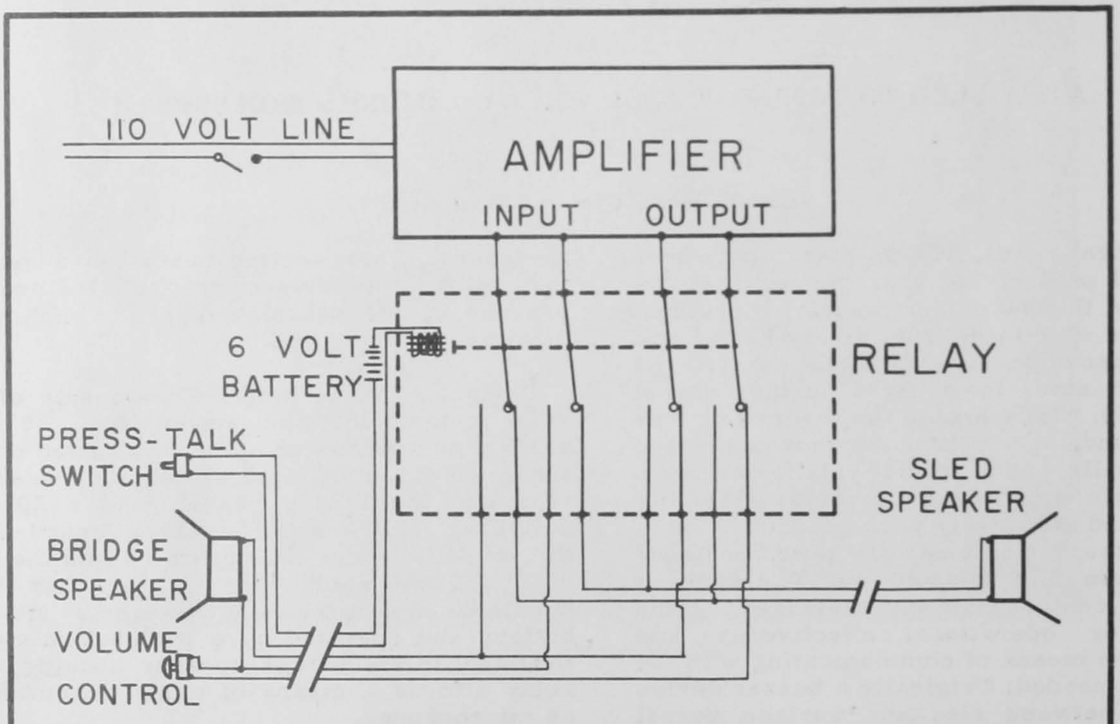

Figure 51.--Block diagram of communication system.

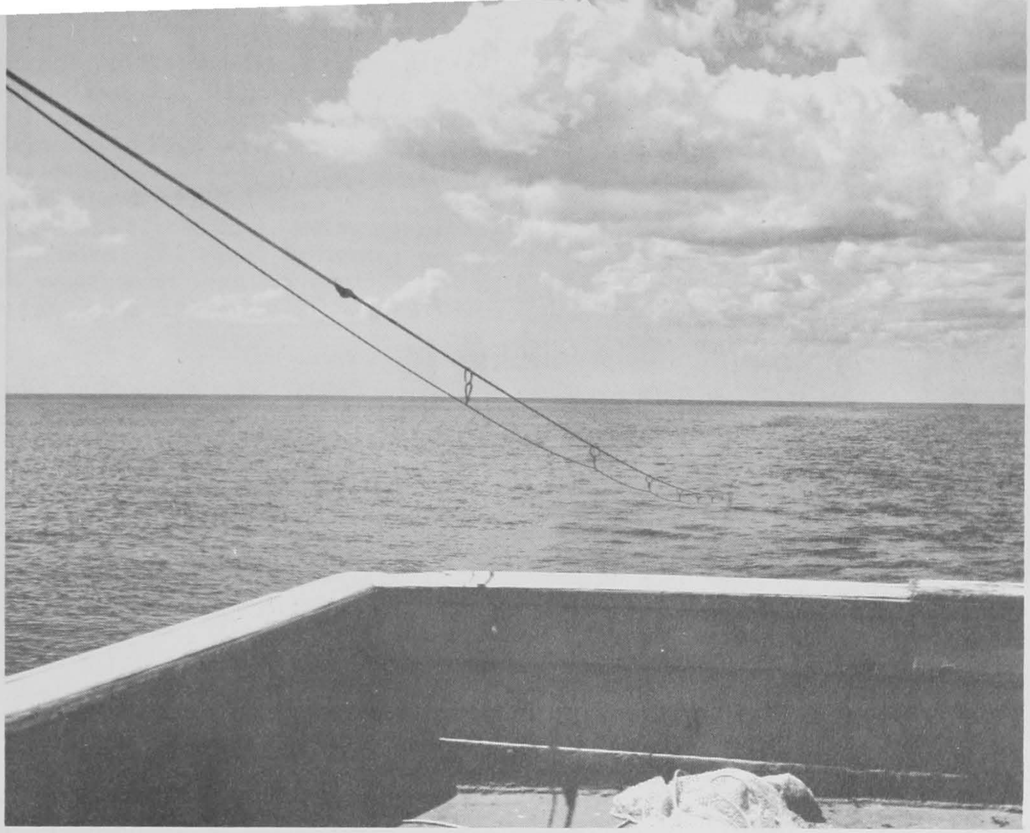

Figure 52.--Sled towline with communication wire suspended from metal rings.

the bridge unit is connected to the output side of the amplifier as a loudspeaker, and the sea-sled unit is connected to the input side as a microphone (fig. 51). To reverse the input-output relationship, the press-to-talk switch is closed, energizing the solenoid, which accomplishes the necessary switching. The sound level on the bridge is controlled at the speaker; that on the sled is preset at the amplifier.

The coaxial cable is suspended from the sled towline by means of metal rings (fig. 52). A watertight connector is used at the end of the cable to permit separation of the sled when necessary.

Operation.--To use the voice system, divers must have full face mask SCUBA gear. Mouthpiece gear cannot be used for transmitting. To operate the speaker as a microphone, the diver places his face mask against the speaker and talks in a loud voice. The sled speaker can be heard clearly without any action on the diver's part, from any position on the sled. The system is limited to an operational depth of approximately 30 feet due to the design of the underwater speaker.

Advantages.--The advantages of verbal communication between the sea-sled and towing vessel are many. Positioning of the sled is accomplished faster and more accurately, lost time is reduced, and the quality of observations and photographs is greatly improved. Changes in such conditions as speed, towing wire length, and towing direction can be ordered without resorting to the complicated signals required with buzzer systems. Also, the safety of the diving operation is significantly increased. In the event of trouble under water, specific instructions and information can be transmitted to the surface, and appropriate action taken. Also, the divers can be warned of bottom obstructions or other hazards that are observed on the vessel's depth recorder or on the surface.

Speaker-Microphone Trouble.--Initially, a small crystal hydrophone was used as the microphone-speaker on the sled. Operation was critical, owing to the high impedance and low output of the hydrophone. It was necessary to include a stage of pre-amplification in the input circuit and an impedance-matching transformer in the output circuit. The divers found it necessary to hold the hydrophone to the throat to talk and to the ear to listen. The highly amplified system frequently picked up extraneous noise, including nearby radio transmissions. The present system has eliminated all of these difficulties.

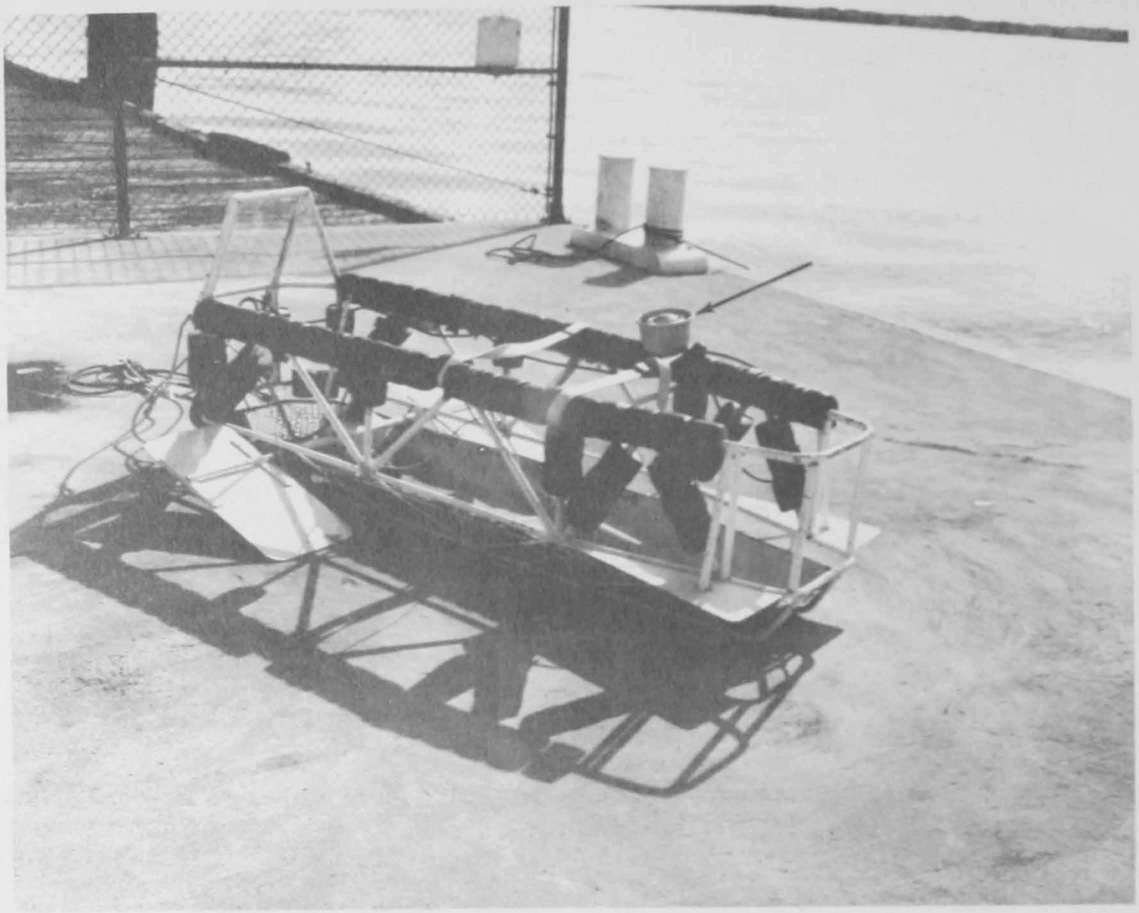

Figure 53.--Underwater sled equipped with speaker.

DESIGN OF A BIOLOGICAL SAMPLING TRAWL FOR A SPECIFIC APPLICATION

by

Fred Wathne, Chief, Gear Research Unit

The Gear Research Station received a request from biologists of the University of Miami Laboratory for assistance in designing a stationary trawl-type net or stop net to be used for biological sampling of a Florida canal. Following is a description of the significant considerations and the resulting design of this net which is now being made.

Problem.--Construct a sampling trawl capable of retaining all marine life (larger than what can pass through 3/4-inch stretched mesh) which migrate through a canal between Florida Bay and Whitewater Bay. A profile of the canal is shown in figure 54.

General Considerations.--(1) Trawl must sample from surface to bottom and bank to bank; (2) trawl will be anchored to bridge pilings on the canal banks; (3) trawl will be used for sampling on both flood and ebb tides, for example, it will be turned around at the change of tide; (4) water velocities to something greater than 3 knots will be encountered; (5) due to tidal action, water level varies 1.3 feet; and (6) means must be provided for permitting occasional passage of small vessels through the canal.

Design Considerations.--(1) Twine size as small as possible to reduce drag due to water flow; (2) anchor points on banks are 11-1/2 feet off horizontal (see fig. 54); (3) anchor points are 61 feet apart; (4) headrope anchor point is 1-1/2 feet above high water level; (5) footrope anchor point is 2 feet above canal bottom; (6) headrope and footrope anchor points are 7-1/2 feet apart and in a line perpendicular to the ground; (7) canal bottom slope is greater on west bank than on east (fig. 54); and (8) mesh size is to be 3/4-in. stretch measure.

Techniques.--The basic technique for design is that described in the report of cruise 32 of the George M. Bowers. The trawl was designed as a framework of supporting lines (fig. 55), and the webbing dimensions were calculated to fit the frame. This design is in contrast to the standard method in which the trawl is hung to the headrope, footrope, and breastlines and permitted to assume its position longitudinally. Advantages of this technique include (1) the support lines, rather than the webbing, absorb the towing strain and (2) less webbing is required to cover a given area. This reduces towing strain as well as webbing and labor costs.

In calculating webbing dimensions of component panels, we used a mesh configuration of a square (hung in 70.7 percent of stretched measure both longitudinally and laterally). The square shape was chosen because it is the most efficient for covering a given area and because calculations are facilitated since hang-in is the same in both directions.

Framework.--Since the anchor points were 11-1/2 feet off, we needed a horizontal modification to provide a symmetrical configuration between points A and B, and wing extensions were added as shown to compensate for the relative location of the anchor points. The top and bottom sections are identical, even though there is a slight difference in this application. The difference, however, is negligible.

The headrope-footrope curve was computed between points A, B, and C from the general equation of a parabola $X^2 = 2py$ where $p = 20.8$. Because tapering the webbing to fit this curve precisely would be extremely time consuming, a compromise was selected utilizing the two tapers.

As short a net as practicable was desired, consequently a 1-mesh, 2-bar taper was chosen for the body cut. This produced a trawl 52 feet long. The bag is 11.2 feet long, giving a total length of 63.3 feet. This was within the length specified by the biologists.

The design of the two wings is also shown in figure 55. The bottom of the forward edge of both wings is shaped to follow the bottom contour and consequently permit the footrope to follow it. The top edge is shaped to fall from the headrope anchor point to water level (at high water). The bottom edge of the after section slopes up so that water flow through the trawl will force it down thereby assisting in maintaining footrope-bottom contact. This feature is considered necessary because the footrope anchor point is 2 feet above the canal bottom.

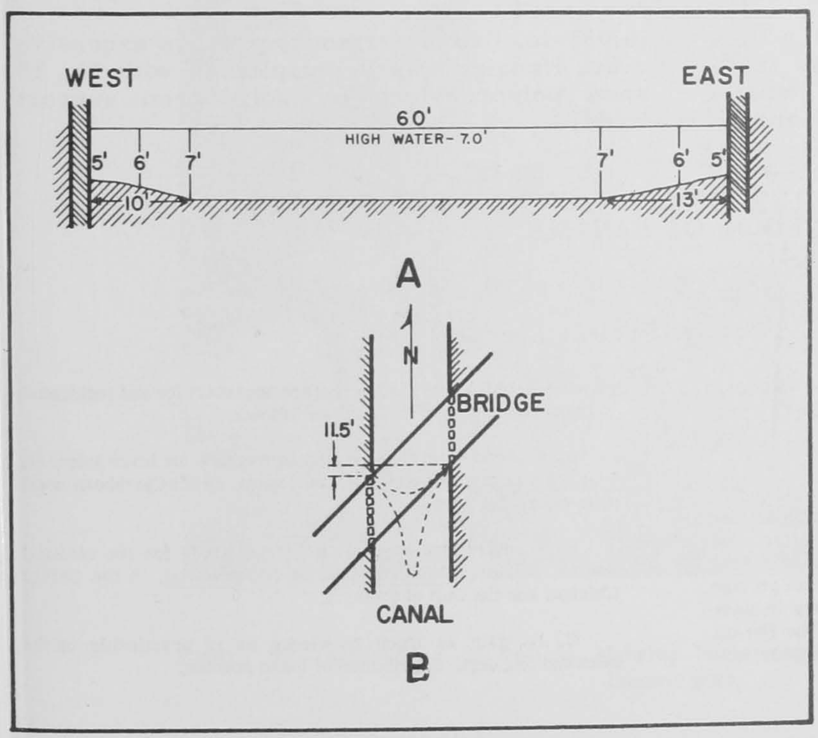

Figure 54.--A. Profile of Florida canal at high water.
B. Relation of trawl anchor points to canal.

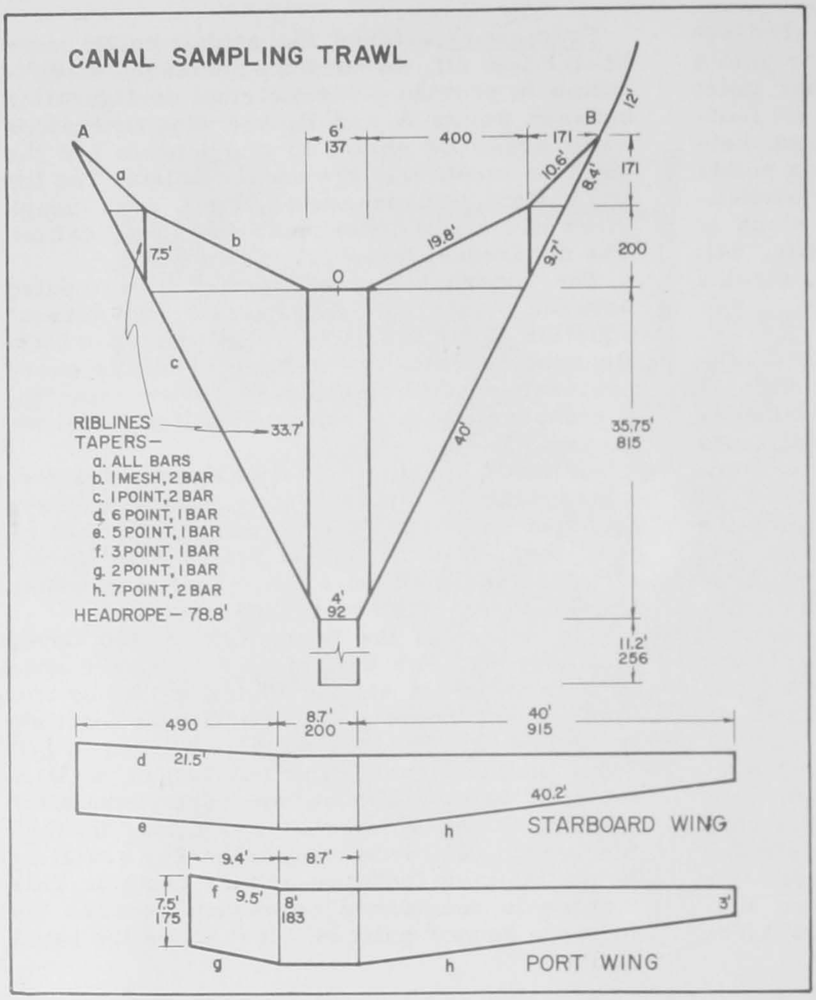

Figure 55.--A. Trawl framework.
B. Panel dimensions by mesh count.

Webbing.--No. 6 nylon webbing with a light bond treatment was selected for this trawl because it provided adequate strength (tensile strength of 50 pounds) yet was small enough (0.031-in. diameter) not to produce excessive drag. Hanging was accomplished with No. 15 spun polypropylene on polydacron support lines.

BCF/AID SPINY LOBSTER EXPLORATORY FISHING PROJECT REPUBLIC OF PANAMA

by

Johnny A. Butler, Project Leader

Objectives of the spiny lobster project, as stated in the contractual agreement with the Agency for International Development, are as follows:

> The purpose of this project is to undertake exploratory lobster fishing . . . to determine the best methods of fishing for the several species of lobsters, their seasonal and depth distribution, as well as the general areas of best fishing in order to provide sufficient information for developing a strong industry in spiny lobster and for training spiny lobster fishermen. The Bureau shall use its best efforts to supply the necessary supervisory personnel, which in its judgement are necessary for and incidential to the performance of the work as follows:
>
> A. To determine the best fishing methods for black lobsters, Panulirus argus, and pinky, P. laevicauda, on the Caribbean coast near Bocas del Toro.
>
> B. To determine the best fishing methods for the common Pacific lobster, Panulirus inflatus (P. gracilis), in the Gulf of Chiriqui and the Gulf of Panama.
>
> C. To gain as much knowledge as is practicable on the seasonal and depth distribution of these species.

D. To run fishing transects across the Continental Shelf along both coasts in an attempt to determine the east-west extent of fishable concentrations of each species.

E. To assess as thoroughly as practicable in the time available the commercial potential of the lobster resources by (1) undertaking comparative fishing in areas of known good fishing to test and evaluate different gear (2) undertaking short periods of production fishing, i.e., simulated full-scale commercial fishing to test the potential.

F. To adequately determine the number of lobster species present as a possible clue to their relative abundance.

The first exploratory cruise of the Pelican was commenced on August 30, 1962. Through June 1963, 11 cruises had been completed, totaling 161 days at sea.

Panama Caribbean Explorations

The results of cruises 4, 5, 12, and 13[7] in the coastal waters of the Caribbean during September, April, and May revealed the following: P. argus is present in the areas fished and can be caught in commercial-type lobster traps. The catch rate per night of fishing effort for wood slat traps averaged 30 percent (for example, 30 lobsters in 100 traps) and for wire traps averaged 19 percent; best catch rates were obtained in the Bocas del Toro and Bocas del Drago areas; traps set on or immediately adjacent to the reefs were not as productive as traps set in the forage area near the reefs; reef areas close to or in the open sea yielded higher catch rates than reef areas in lagoons and bays; no migration of lobster was observed during the months fished; various reef fishes, principally snapper, were caught in lobster traps, but the catches were not of commercial significance; no marked preference was noted for any particular bait, but sharks caught by hooks set from the anchored boat and by multiplehook longline gear were the most reliable bait source. During these cruises, bottom trawling for bait was only marginally productive due to the limited amount of trawlable bottom and the scarcity of bottomfish in the trawlable area; shrimp, present in a majority of the bottom trawl drags were not present in commercial quantities. Species

[7] Cruises 1, 2, and 3 of the Pelican were off the east coast of Florida in 1956-57.

Figure 56.--After deck of Pelican showing boom and hydraulic block for hauling spiny lobster pots.

taken were: Penaeus brasiliensis, P. schmitti, P. duorarum, and Xiphopeneus kroyeri. Rough seas during the dry season, usually from January through April, limit fishing operations in open sea areas.

Panama Pacific Explorations

Cruises 6, 7, 8, 9, 10, 11, and 14 were conducted in the coastal waters and island areas of the Pacific from October through March and in June. The spiny lobster, Panulirus gracilis, and rock lobsters, Scyllarides sp., are present, and can be caught by lobster traps and bottom trawls. Trawls were more effective than traps for rock lobsters. Spiny lobsters were present in varying quantities in almost all areas fished, but best catch rates were obtained in the Gulfs of Panama and Chiriqui. Sea and weather conditions appear to allow year-round fishing. The current velocities in certain areas precluded successful trap fishing, owing to excessive loss of gear and scarcity of lobsters in such areas. Where current velocity permitted the use of traps, wood slat traps were markedly more effective in catching P. gracilis than wire or reed traps. In some instances the ratio was better than 3 to 1. Moreover, reed traps are less durable than those of wood or wire, having an operational life expectancy of approximately 6 months.

The studies also indicated that there was no distinct preference for particular bait, and that bait (shark and bottomfish) is available in sufficient quantity for commercial operations. Catch rates from baited traps were better than from nonbaited traps. Traps set on and immediately adjacent to reefs had lower catch rates than those set away from the reefs in the foraging areas; furthermore, catch rates for traps were higher during periods of a dark sky, indicating that fear of predation affects the foraging habits of lobsters during bright moonlight nights. There also appears to be a seasonal influence on catch rates in some areas. During periods in which cold water invades the Gulf of Panama, lobster

Figure. 57.--Small outboard boat used for setting and hauling spiny lobster pots in shoal water.

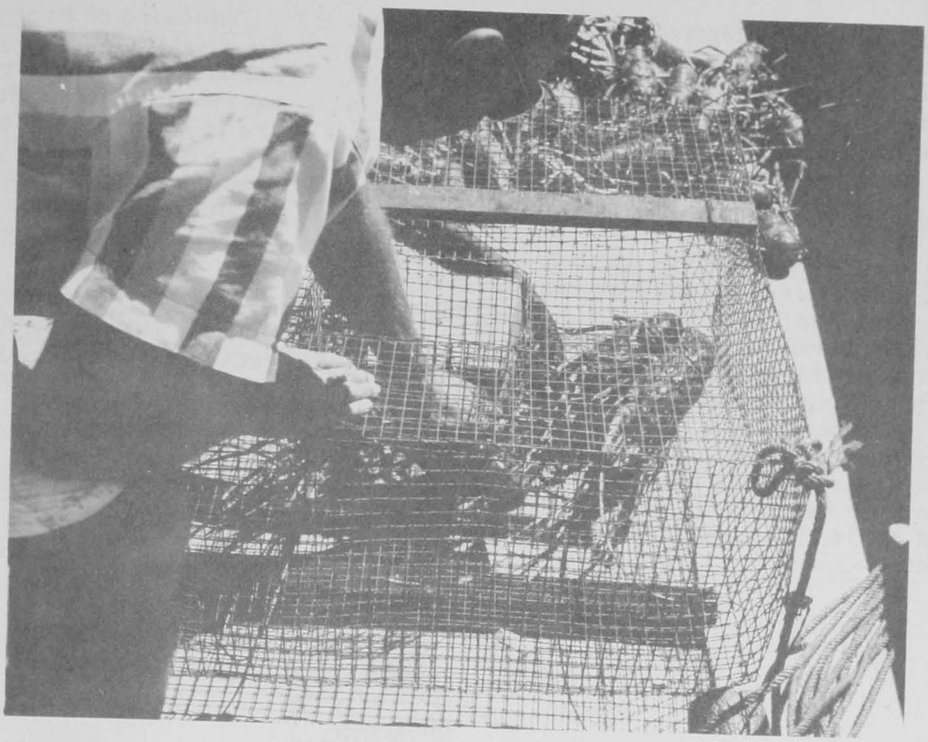

Figure 58.--Removing spiny lobsters from wire pot.

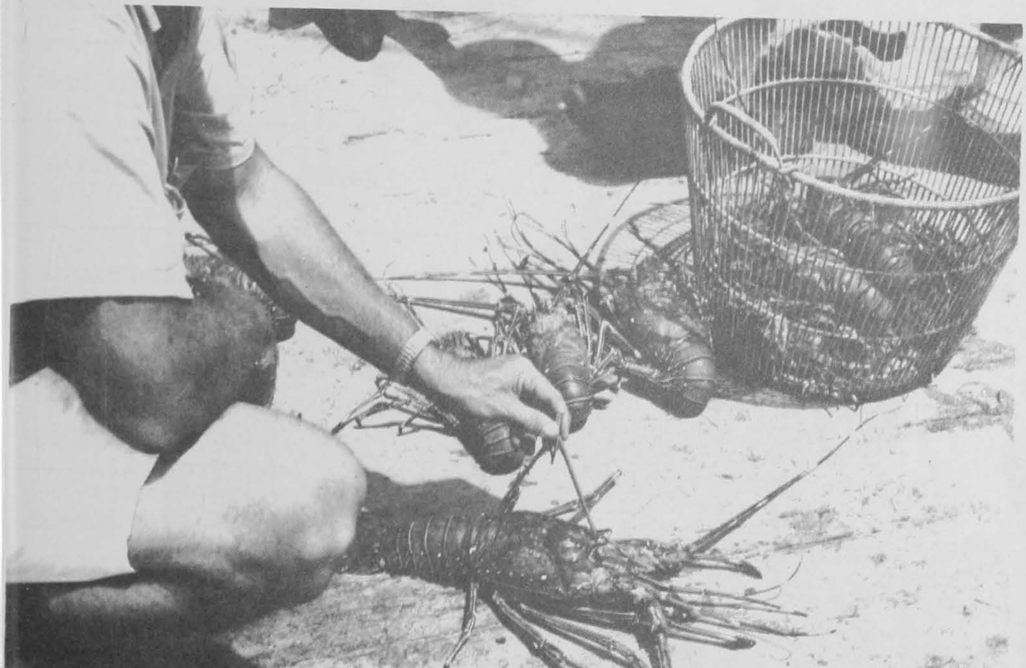

Figure 59.--Measuring carapace of spiny lobster.

traps are not effective even though observations made by divers confirm the presence of lobsters hidden in the cavities of the reefs. The average size range of the P. gracilis was found to be smaller than that of P. argus.

Miscellaneous Activities

Panamanian Participation.-- Technicians and biologists from the Panamanian Industrial Development Center and the Department of Fishes participated in most of the cruises and were trained in the techniques of exploratory fishing. Several industry representatives also participated in the cruises and were given a first-hand opportunity to observe the operation and results of the project. A movie was made of the various aspects of the operation and is available in Panama to interested industry groups.

Extension of Project.--Interest displayed in the explorations by private industry members encouraged AID to request that the project be extended for an additional year. The objectives are to continue exploratory spiny lobster fishing with emphasis on seasonal coverage in areas of commercial potential and to render technical assistance and training to participating private industry and commercial fishermen.

Publicity and Public Relations.--The project received widespread publicity within the country, being the object of one 15-min. television program, televised news programs, and numerous newspaper and magazine articles. Interest in the project was displayed by private industry and governments of other Central and South American countries, including some of the AID Missions in these countries.

Figure 60.--Panamanian cooperator assists Bureau biologist in weighing spiny lobster.

APPENDIX A1

INDEX BY TYPE CRUISE - R/V OREGON

TYPE CRUISE	CRUISE NUMBERS
Royal red shrimp	22, 23, 29, 32, 34, 36, 38, 39, 46, 47, 53 (S.A.), 62 (Puerto Rico), 66 (S.A.), 78, 79, 80, 82, 83, 84 (S.A.), 86.
Longline tuna	23, 24, 25, 26, 27, 27A, 28, 30, 31, 33 (comm. scale), 35, 37, 40, 41, 46 (Cent. Amer.), 47 (S.A.), 66 (S.A.).
Gillnet tuna	86
Red snapper	44, 84 (S.A.).
Scallop	43, 44, 67, 68, 70, 81.
Hard clam	81, 83
Midwater trawl	42, 48, 49, 50, 52, 56, 57, 58, 59, 63, 65, 67, 69, 73
Bottomfish and industrial fish	42, 43, 69, 71, 72, 84 (S.A.), 78
Deep-water faunal assessment	31, 51, 60, 68, 78, 79, 82, 83, 86
Commercial shrimp	47, 53 (S.A.), 76A
Surface fishing for tuna (Jackpole)	45, 46.
Fish trap Lampara Trap lift net	54 61, 64, 70 70
Camera trials with midwater and bottom trawls	74, 75, 76, 77, 85

INDEX BY CRUISE NUMBERS - R/V OREGON

[NOTE: Cruises 1 through 21 not indexed since exploratory objectives were general.]

CRUISE NO.	TYPE OF CRUISE
22	Royal red shrimp
23	Longline tuna Royal red shrimp
24	Longline tuna
25	Longline tuna
26	Longline tuna
27	Longline tuna
27A	Longline tuna
28	Longline tuna
29	Royal red shrimp
30	Longline tuna
31	Deep-water faunal assessment Longline tuna
32	Royal red shrimp
33	Longline tuna (Comm. scale)
34	Royal red shrimp
35	Longline tuna
36	Royal red shrimp
37	Longline tuna
38	Royal red shrimp
39	Royal red shrimp
40	Longline tuna
41	Longline tuna
42	Bottomfish and industrial fish Midwater trawl
43	Bottomfish and industrial fish Calico scallop
44	Red snapper Calico scallop
45	Surface fishing or tuna (jackpole)
46	Longline tuna (E. Coast, Central Amer.) Royal red shrimp Tuna jackpole
47	Longline tuna (So. Amer.) Commercial shrimp Royal red shrimp
48	Midwater trawl
49	Midwater trawl
50	Midwater trawl
51	Deep-water faunal assessment
52	Midwater trawl
53	Commercial shrimp (S.A.)
54	Fish trap
55	No report issued
56	Midwater trawl
57	Midwater trawl
58	Midwater trawl
59	Midwater trawl
60	Deep-water faunal assessment
61	Lampara
62	Royal red shrimp (Puerto Rico)
63	Midwater trawl
64	Lampara & traplift net
65	Midwater trawl
66	Longline tuna Royal red shrimp (S.A.)
67	Midwater trawl Calico scallop
68	Deep-water faunal assessment
69	Midwater trawl Bottom fish and industrial fish
70	Lampara & traplift nets Calico scallop
71	Bottomfish and industrial fish
72	Bottomfish and industrial fish
73	Midwater trawl
74	Midwater trawl with movie camera
75	Midwater trawl with movie camera
76A	Commercial shrimp
76	Midwater trawl with movie camera
77	Midwater trawl with movie camera
78	Bottomfish and industrial fish Deep-water faunal assessment
79	Royal red shrimp Deep-water faunal assessment
80	Royal red shrimp
81	Calico scallop Hard clam
82	Royal red shrimp Deep-water faunal assessment
83	Royal red shrimp Deep-water faunal assessment
84	Red snapper Bottomfish and industrial fish Royal red shrimp (N.E. Coast of S.A.)
85	Deep-water motion picture camera system trials and Edgerton CA-8 still camera sets
86	Royal red shrimp Deep-water faunal assessment Gill net tuna

APPENDIX A2

INDEX BY TYPE CRUISE - R/V SILVER BAY

TYPE CRUISE	CRUISE NUMBERS
Royal red shrimp	5, 9, 17, 21, 23, 30, 34, 36, 37, 41, 42
Longline tuna	33,46
Red snapper	1, 4, 6, 7, 8, 11, 12, 14, 15, 16, 30, 31, 32, 34, 35, 37, 40, 45, 48
Scallop	2, 10, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 35, 36, 39, 41, 42, 47
Hard clam	2, 3, 10, 20, 21, 22, 25, 27, 28, 29
Midwater trawl	33, 43, 36
Bottomfish and industrial fish	3, 13, 18, 19, 20, 21, 22, 23, 25, 27, 28, 29, 39, 40, 45, 48
Deep-water faunal assessment	9
Commercial shrimp	18, 19, 20, 22, 25, 26, 27, 28, 34, 38, 44, 49
Fish trap	15
Trap lift net	2

INDEX BY CRUISE NUMBERS - R/V SILVER BAY

CRUISE NO.	TYPE OF CRUISE
1	Red snapper
2	Calico scallop Hard clam Trap lift net
3	Hard clam Bottomfish and industrial fish
4	Red snapper
5	Royal red shrimp
6	Red snapper
7	Red snapper Bottomfish and industrial fish
8	Red snapper
9	Royal red shrimp
10	Hard clam Calico scallop
11	Red snapper
12	Red snapper
13	Bottomfish and industrial fish
14	Red snapper
15	Red snapper
16	Red snapper
17	Royal red shrimp
18	Commercial shrimp Bottomfish and industrial fish
19	Commercial shrimp Bottomfish and industrial fish
20	Commercial shrimp Bottomfish and industrial fish Hard clam Calico scallop
21	Bottomfish and industrial fish Red snapper Royal red shrimp Hard clam Calico scallop
22	Bottomfish and industrial fish Commercial shrimp Calico scallop Hard clam
23	Calico scallop Royal red shrimp Bottomfish and industrial fish
24	Calico scallop Red snapper Bottomfish and industrial fish
25	Commercial shrimp Hard clam Calico scallop Bottomfish and industrial fish
26	Commercial shrimp Calico scallop
27	Commercial shrimp Calico scallop Hard clam Bottomfish and Industrial fish
28	Commercial shrimp Calico scallop Hard clam Bottomfish and industrial fish
29	Calico scallop Clam Bottomfish and industrial fish
30	Red snapper Royal red shrimp Calico scallop
31	Red snapper Calico scallop
32	Red snapper Calico scallop
33	Midwater trawl Longline tuna Calico scallop
34	Red snapper Commercial shrimp Royal red shrimp
35	Red snapper Calico scallop
36	Royal red shrimp Calico scallop
37	Royal red shrimp Red snapper
38	Commercial shrimp (stained and tagged shrimp for mortality and migration studies)
39	Calico scallop Bottomfish and industrial fish
40	Red snapper Bottomfish and industrial fish
41	Royal red shrimp Calico scallop
42	Royal red shrimp Calico scallop
43	Midwater trawl
44	Commercial shrimp (stained and tagged shrimp for mortality and migration studies)
45	Red snapper Bottomfish and Industrial fish
46	Longline tuna Midwater trawl
47	Calico scallop
48	Red snapper Bottomfish and industrial fish
49	Commercial shrimp (staining and tagging shrimp for mortality and migration studies)

APPENDIX B

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