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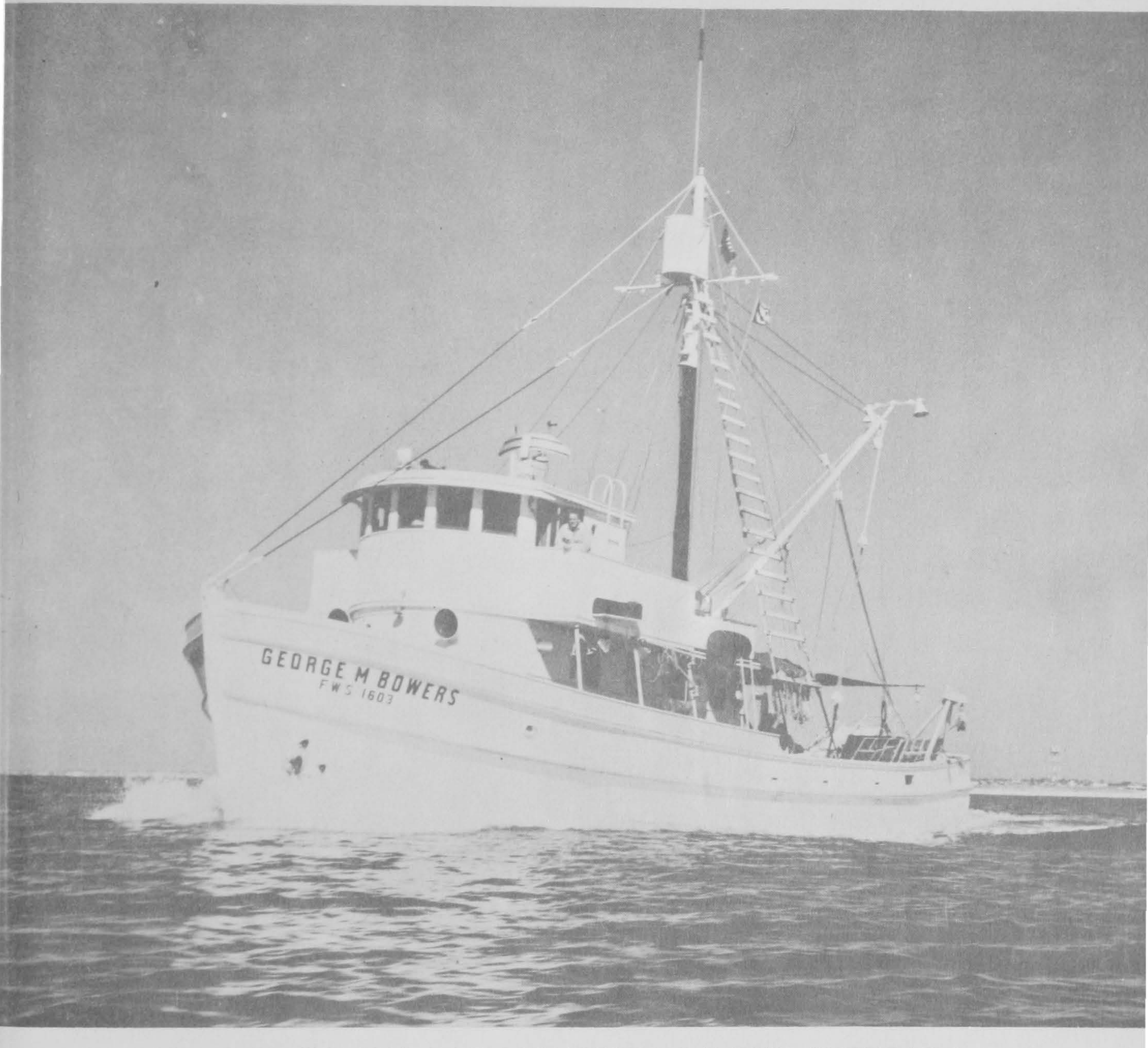

UNITED STATES DEPARTMENT OF THE INTERIOR

FISH AND WILDLIFE SERVICE

BUREAU OF COMMERCIAL FISHERIES

Circular 265

UNITED STATES DEPARTMENT OF THE INTERIOR
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Progress in Exploratory Fishing and Gear Research in Region 2

Fiscal Year 1966

by

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and
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Assistant Base Director

Circular 265

Washington, D.C.

September 1967

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By

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ABSTRACT

Activities of the past year included explorations by the R/V Oregon in the South Atlantic Ocean and Caribbean Sea, collection of data on shrimp behavior, and work on other research projects.

INTRODUCTION

This year our report takes on a new form--primarily for the interested public outside the Bureau of Commercial Fisheries and for BCF administrators, who are not all scientists--to explain our research and services from July 1, 1965, through June 30, 1966.

Highlights of our research and service results reported here are:

1. Continuing systematic exploration for fish and shellfish off the South Atlantic and in the Caribbean by the R.V. Oregon.
2. Testing fish-pump and night-light fishing in the Windward Islands.
3. Summarizing 16 years of raw data from the Gulf of Mexico and analyzing them as a basis for scheduling of R.V. Oregon II, which was expected to be delivered in mid-1967.
4. Observing shrimp behavior--to aid the fishermen in making a profitable harvest and to help the researchers in designing components for an electro-shrimp trawl.
5. Recording on Automatic Data Processing cards data from field explorations, hundreds of specimen identifications, records on surface school fishes, and data on gear research.
6. Completing an atlas showing how commercially valuable concentrations of brown, white, and pink shrimp are distributed in the Gulf of Mexico.

FISHERY EXPLORATIONS AND SERVICE

Fishery explorations, one of the most exciting phases of fishery research, takes several forms depending upon the purpose: (1) one making for an inventory of plants and animals in a designated area and (2) another for extending limits of known commercial fishing grounds, seasonally or geographically, or for finding commercial concentrations of species not harvested now.

Vessels in Region 2 explored an area extending from Cape Hatteras, N.C., to southern Brazil in the western Atlantic, including the Caribbean Sea and Gulf of Mexico. Bottom explorations extended from shoreline to 2,000 fathoms. Pelagic explorations spanned all international waters in this region in addition to inshore coastal areas of the southeastern United States. Seagoing activities in the Gulf have been curtailed sharply since the R.V. Oregon was transferred to the Exploratory Fishing Station at St. Simons Island, Ga.; these explorations will resume sometime next year after delivery of the R.V. Oregon II. In the meantime, emphasis has been placed on analyzing exploratory records and developing plans for future operations.

Searching for Menhaden in the Eastern Gulf of Mexico

On a small scale, attempts have been made by sea and air to locate stocks of menhaden in the Gulf that would permit the industry to expand production. The menhaden fishery is the largest fishing industry in the United States, representing more than 40 percent of the total tonnage landed. The fishery is carried out along the Atlantic and Gulf coasts. The Gulf fishery is comparatively young; its production for the past 5 years, however, has exceeded that of the Atlantic coast. This is due partly to an apparent lack of fish on the east coast and partly to increased fishing efforts on the Gulf stocks. In the Gulf, fishing usually occurs from April through October and is concentrated in the northern portions.

The five aerial observation flights made this year were only moderately successful in locating surface schools. All but 10 of the 365 schools observed were seen in November and December. This correlates with results of previous off-season survey periods and is probably related to more turbulent seas in January to March, making surface schools hard to detect or possibly causing them to disperse. On all flights, surface temperatures were taken with an infrared thermometer (fig. 1) and will be used to determine the correlation, if any, between temperatures and occurrence of fish schools.

Gill nets were used from the R.V. George M. Bowers to determine the fish species in the surface schools. During the four cruises, 162

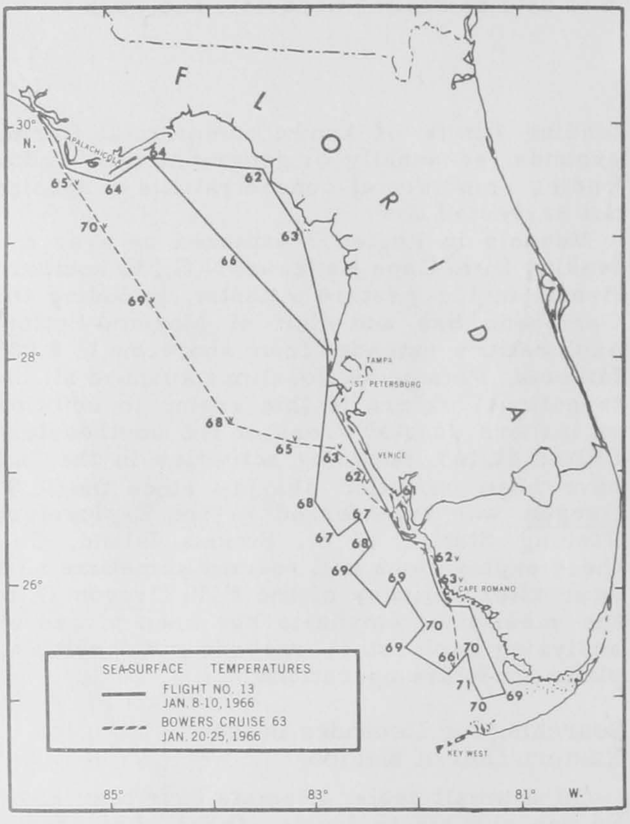

Figure 1.--Airplane and surface vessel tracks with observed temperatures in degrees Fahrenheit, west coast of Florida, January 1966.

stations were sampled. Menhaden were found in Florida waters off Apalachicola and from St. Petersburg Beach to Cape Romano in less than 5 fathoms. Echo tracings indicated that these fish were generally not concentrated enough to be captured efficiently with purse seines (fig. 2). Other fish schools sampled contained thread herring, scaled sardines or razorbellies, and Spanish sardines. Thread herring was by far the predominant species south of Tampa Bay along the west coast of Florida.

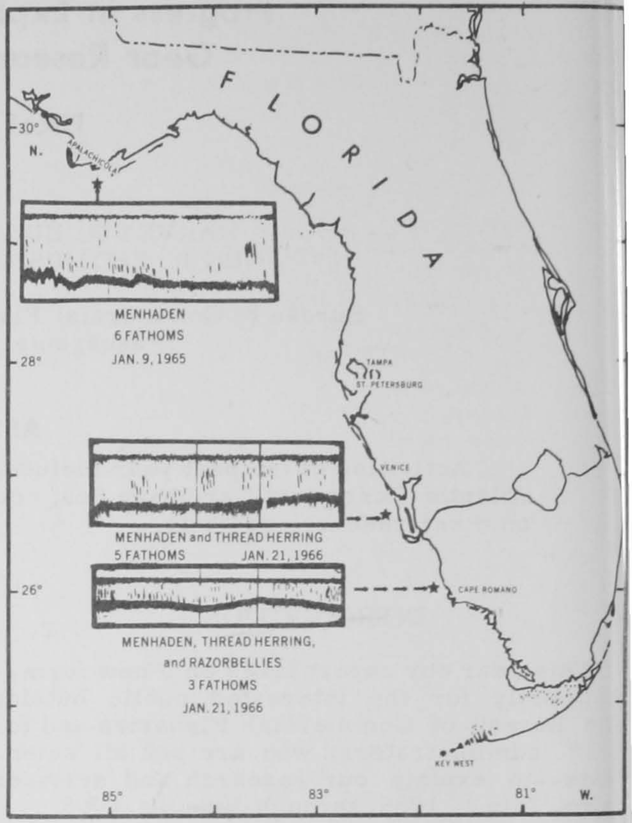

Figure 2.--Echo sounder tracings of fish schools during menhaden survey with R.V. George M. Bowers along the west coast of Florida, January 1966.

To date, results indicate that menhaden are not sufficiently concentrated to support an off-season fishery, except in the fall and early winter off Apalachicola. There is additional support to earlier findings that stocks of herringlike fishes, especially thread herring, are present in great numbers and would, after further harvesting research, sustain an off-season meal and oil fishery.

A Gulf Fishery Potential for American Eels

Traps and trotlines were fished experimentally for American eels during the summer. Traps caught more eels than the trotlines, and fishing was best around effluents from seafood processing plants. The best one-night catch of 67 pounds of eels was made near the outfall of a shrimp processing plant. Traps should be set on a rising tide because decomposition products occasionally kill trapped eels at low tide. At the end of the preliminary study, the results indicated that trap fishing at seafood plants would support a small commercial fishery for eels.

Fishery Explorations on the Southeastern Atlantic Coast

Field activities of the R.V. Oregon, operating from the Exploratory Fishing Station at St.

Simons Island, Ga., were spread widely off the southeastern coast of the United States, Bahama Islands, and in the Caribbean Sea. Four cruises were made from the Florida Straits to South Carolina: one off the Florida east coast and northern Bahamas; one in the Bahamas in cooperation with the Woods Hole Oceanographic Institution, University of Miami, and Bureau of Commercial Fisheries Laboratories; and two in the Caribbean Sea in cooperation with the United Nations Special Fund Caribbean Fisheries Development Project. A total of 195 days was spent at sea.

Resources of brown, pink, and rock shrimp were assessed in the outer Continental Shelf from Sebastian Inlet, Fla., to Charleston, S.C. Small and commercially unimportant catches of brown and pink shrimp were made south of Cape Kennedy off Melbourne between 25 and 45 fathoms. Small quantities of rock shrimp were uniformly distributed from Charleston to central Florida. South of Cape Kennedy in 26 to 27 fathoms, 40-foot trawl catches of 21-25 count (heads on) rock shrimp increased from 12 to 65 pounds per hour.

Some observations were made on swordfish. Near the Great Bahama Bank during May and June, 14 night sets caught only five swordfish. During July in the northern Bahamas and off the Florida east coast, on the other hand, night longline sets were made at nine locations and 17 swordfish were taken--six on one 500-hook set, 70 miles east of St. Augustine, Fla. Nekton net hauls, in November, caught several juvenile swordfish off the northern Florida coast (fig. 3).

Dredge surveying during August showed that calico scallops of commercial size (over 2 inches in diameter) were available in the Cape Kennedy area. Half-hour catches with 6-foot tumbler dredges were as high as 595 pounds (in the shell) in 14 to 37 fathoms. The most productive depths were in 27 to 33 fathoms, where scallops were in prime condition and averaged 63 meats per pound. In April, scattered small scallops were found in 40 fathoms northward from Sapelo Island, Ga.

Concentrations of bottomfish were found several times during explorations with 40-foot shrimp trawls off the north-eastern Florida coast. January catches ranged up to 1,900 pounds per one-hour drag, with largest catches consisting of spot, croaker, black seabass, and flounder.

A 32-day cooperative study of pelagic fishes in the Florida Straits and along the Great Bahama Bank was made during May and June. Participants were from the Bureau Laboratories, Woods Hole Oceanographic Institution, University of Miami, and International Gamefish Association. The Bureau and Woods Hole Oceanographic Institution jointly controlled the Oregon's operations. During the study, 31 longline sets were made in the migratory path of giant bluefin tuna schools to determine the

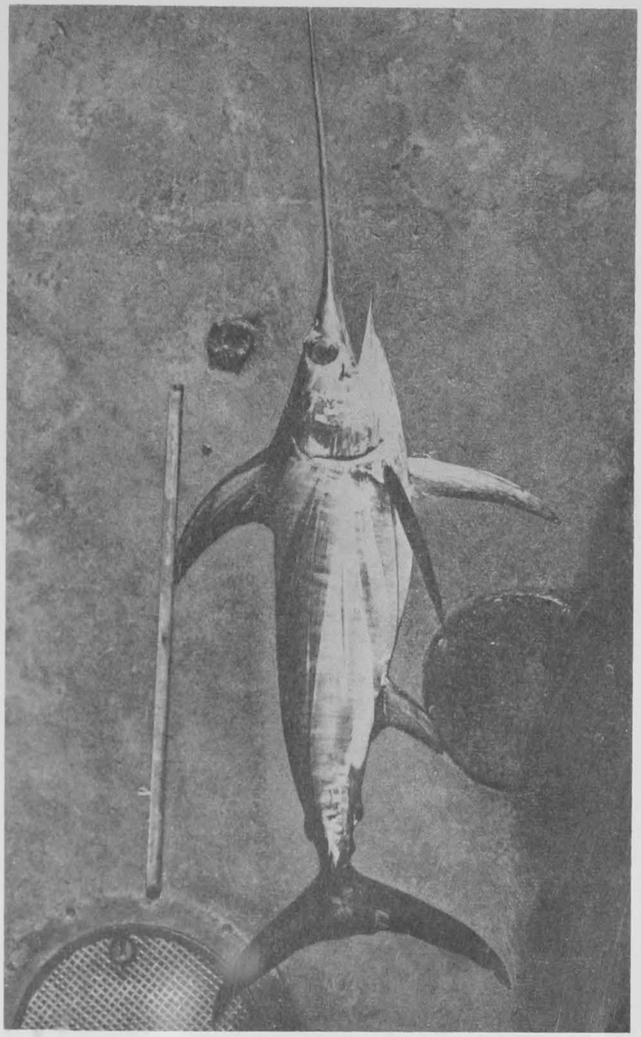

Figure 3.--Small swordfish taken during longlining by R.V. Oregon off northeast Florida in November 1965. (Rule = 1 meter or 39.37")

depths at which the fish are swimming. Our failure to catch any bluefin tuna implies that none was in the area at that particular time. Bluefin apparently are concentrated in shallow water where longlines are not effective. Numerous schools of blackfin tuna were seen prior to the passage of Hurricane Alma. Various billfishes and tuna were tagged; shark meat and liver were collected for technological studies; dolphin were caught for marketing tests; gonad and stomach samples were taken for laboratory study; and oceanographic observations were made and recorded at each longline station.

Caribbean and Tropical Atlantic Explorations

Explorations were made during September and October off central and western Venezuela, in the Gulf of Venezuela, around Aruba (Netherlands West Indies), and off southern Colombia, in cooperation with the United Nations Special

Fund Caribbean Fisheries Development Project and the Instituto Venezolano de Investigaciones Cientificas. Night longline fishing was coordinated with the cruise path of the Bureau's R.V. Geronimo. Two to four swordfish, ranging from 25 to 225 pounds each, were on all longline sets except one which produced 103 sharks, of which 101 (7 1/2 tons) were silky sharks. Foodfish catches were small. The best drag off Guajira caught 88 pounds of snapper and grouper. Dredge sampling west of Aruba indicated a bottom that was almost void in living organisms. Off Venezuela and Colombia, 12 schools of tuna were sighted: 5 schools of blackfin, 2 of yellowfin, 4 of skipjack, and 1 of little tuna. Numerous large schools of small blackfin were sighted and photographed off Punto de San Blas, Panama (fig. 4).

Catches of shallow-water and deepwater shrimp were generally low. Double-rigged drags east of long. 70°w. did not exceed 5 pounds per hour; in the Gulf of Venezuela, however, brown shrimp were caught at rates of 20 pounds per hour or less and white shrimp at rates of 12 pounds per hour or less. Off southern Colombia between Punto San Bernardo and Cabo Tiburon, catches of mixed brown shrimp (average 31-35 count tails) were less than 200 pounds of tails per night, which was lower than those obtained in the spring of 1964. Royal-red shrimp catches were 20 to 35 pounds per hour, whereas other deepwater shrimp and mixed catches were 50 pounds per hour in 250 to 275 fathoms off Golfo de Triste, Venezuela. Catches were less than 10 pounds per hour off Reno de Paraguana, Pena de Guajira, and southern Colombia.

The eastern Caribbean (Windward Islands) between Puerto Rico and Trinidad was again surveyed in cooperation with the United Nations Program during February and March. In addition, a survey of the fishery potential of Dominica, West Indies, was undertaken in cooperation with the Smithsonian Institution, and field studies were begun on use of fish pumps. Combinations of one to four submerged 1,000-watt lights with precise intensity control were used with an experimental 6-inch (1,500 gallons per minute) fish pump to see if schooling fishes were attracted to a night light. Anchovies, silversides, and scaled sardines were more responsive to the various light intensities than were thread herring, cigarfish, and jacks. All could be taken with the pump; however, the highest catch rates were made at Grenada where 234 pounds of anchovies and sardines were pumped in 1 hour (figs. 5 and 6).

Figure 4.--Birds over school of blackfin off Punto de San Blas, Panama, October 1966.

Limited longline fishing in the eastern Caribbean caught small quantities of swordfish, blackfin tuna, spearfish, and marlin (fig. 7). Two experimental deep-set longlines (41 hooks each) were fished in 200 and 400 fathoms off Dominica and St. Lucia respectively. Two small sharks were taken in 200 fathoms; however, the 400-fathom gear was lost.

Trolling-line catches included 25 dolphins, 4 skipjacks, 4 blackfin, 1 wahoo, 13 great barracuda, 1 king mackerel, 2 Spanish mackerel, and 1 cero.

Eight fish schools identified as blackfin and skipjack tuna were seen between Puerto Rico and Tobago.

Grunt dominated the catches of a 40-foot trawl in 30 to 40 fathoms off Tobago; however, between 5 and 16 pounds (heads on) of brown shrimp per hour were caught. Size of shrimp varied from 11-15 count to 26-30 count.

In 250 to 450 fathoms off Dominica, on the other hand, deepwater shellfish of potentially commercial value included scarlet prawns, striped shrimp, and lobsterettes.

Handline catches off Dominica, St. Lucia, Grenada, and Tobago were low, consisting of silk snapper, Caribbean croaker, tilefish, yelloweye grouper, Warsaw grouper, and wenchman.

Industrial Followup on Explorations

Developers of automatic processing equipment for calico scallops field-tested equipment in North Carolina waters where scallops are plentiful (shrimp boats made day trips from the dock to the grounds in 2 1/2 hours and took about 600 bushels of scallops per boat per day). During the year, many problems have been solved with mechanical shucking devices and various machinery components have been modified. Up to 100 percent recovery of meats from both the shucker and eviscerator has been demonstrated, and a second processing unit is now nearing completion.

Landings of royal-red shrimp continued on the Florida east coast. Four double-rigged shrimp vessels are in the fishery. These boats are averaging catches of 140 to 280 pounds of 21-25 count to 41-45 count tails per 3- to 4-hour drag, with landings at 2,300 to 2,500 pounds per 4-day trip. Marketing problems have lessened, and ex-vessel prices are comparable with those for fresh local white shrimp.

Figure 5.--Fish taken during night-light pump experiments in drying trays aboard R.V. Oregon.

Figure 6.--A portion of catch taken by fish pump aboard R.V. Oregon.

Figure 7.--Marlin being hoisted aboard the R.V. Oregon. Marlin in good condition are tagged and released.

ROYAL-RED SHRIMP STUDIES

Royal-red shrimp live on slope areas off the Continental Shelf having mud or ooze bottom, in temperatures ranging from 46° to 52° F. The areas of high abundance are located (1) along the southeastern Atlantic coast off central Florida, (2) in the Gulf of Mexico south of the Dry Tortugas, and (3) southeast of the Mississippi River Delta. Each high abundance area was divided into sections of one degree latitude and longitude, extending from 100 to 400 fathoms, to facilitate studies on distribution and abundance of royal-red shrimp and associated species.

The grounds are geographically similar, though the distance down the slope from 100 to 400 fathoms varies considerably, being almost a third greater on the Mississippi River slope than on the Atlantic grounds where depth distribution of temperature follows a shallower pattern. When considering the large size variation of the areas, the difference in relative abundance becomes dramatic. Bureau of Commercial Fisheries and commercial fishermen have found the greatest abundance (in terms of yield) to be on the Atlantic grounds, followed by the Dry Tortugas and Mississippi River grounds.

Distribution of fish and crustaceans in each of the areas is similar to the royal-red shrimp population; however, factors responsible for patterns of distribution are not fully understood and more studies are needed.

CALICO SCALLOPS

Study of the Cape Canaveral scallop bed was resumed after a 1-year interruption for work on a shrimp atlas. The data analysis is now in full progress. Apparently calico scallops have seasonal but somewhat ill-identified patterns of distribution in 10 to 30 fathoms between lat. 27°30' N. and lat. 29°00' N.

GULF OF MEXICO EXPLORATORY FISHING ANALYSIS

Since the Gulf Program was without an exploratory vessel during the year, major effort was placed on analyzing the 16 years of data from Oregon, Silver Bay, and George M. Bowers explorations in the Gulf.

Scheduling of R.V. Oregon II and George M. Bowers cruises to fill the gaps in our knowledge of seasonal and geographic distribution of fish and shellfish was continued, and several phases of this project were completed.

Several briefs were completed on underutilized and unutilized fish resources in the Gulf and southwest Atlantic. The following is a resumé of these reports.

Bottomfish Stocks

Stocks of industrial bottomfish in the Gulf of Mexico, which are immediately available year-round for fish meal or fish protein concentrate, are located on the inner and mid-shelf grounds out to 50 fathoms between Texas and the northwest coast of Florida. Over 177 fish species have been caught off Louisiana, Mississippi, and Alabama. The average annual commercial yield is about 42,000 tons, which is processed for canned pet food and frozen mink food. Catch rates by commercial fishing vessels using two 65-foot balloon trawls average 1 ton per hour in 7 to 30 fathoms during the winter and spring, 1 1/3 tons per hour in 1 to 7 fathoms during the summer and fall. Croaker, spot, silver seatrout, sand seatrout, cutlassfish, and longspine porgy are the most important species, composing 83 percent of the total catch.

Analysis of the fishery has indicated that the bottomfish stock maintained itself at reasonably productive levels over a recent 5-year period despite increased catches and effort. The fishing area now includes some 5,500 square miles; however, we estimate that more than 600,000 tons are available if fishing is extended to the northern Gulf where BCF vessels and off-shore shrimpers have found commercial quantities of bottomfish.

Surface and Subsurface Stocks

Many questions on relative abundance and availability of herringlike and other pelagic species schooling over the Continental Shelf in the Gulf of Mexico are unanswered. We do know that these stocks, as indicated by our aerial and shipboard observations, are apparently present in quantities close to those of menhaden, now being fished near the levels of maximum sustainable yield.

Several species of pelagic schooling fishes have frequently appeared in exploratory records. These fishes are widely distributed over the Continental Shelf year around and occasionally large numbers have been caught. Predominant species of schooling fishes taken during exploratory operations are thread herring, anchovy, Spanish sardine, scaled sardine, round herring, scad, bumper, butterfish, harvestfish, and chub mackeral.

The thread herring has appeared more often in catch samples and has been seen probably more often than all other surface school species combined. Thread herring stocks in the Gulf of Mexico are roughly estimated to be 1 million tons. This statement is based on data from Bureau of Commercial Fisheries shipboard and aerial observations and from commercial fishing activities. Commercial trials with purse seines have averaged about 30 tons of thread herring per set (fig. 8).

Figure 8.--Catch of thread herring taken by the commercial vessel Sea Rover off the west coast of Florida.

The estimated density of thread herring observations along the Florida west coast is one school per square mile inside the 20-fathom curve. Although observations on thread herring stocks in the northern Gulf are not as numerous as those for the Florida west coast, surface schools are present in the northern Gulf during the summer and subsurface schools throughout the year. This is well illustrated in BCF exploratory data, which show that thread herring have been caught at 216 midwater trawl stations.

R.V. OREGON II CONSTRUCTION

Though the contract for Oregon II construction was awarded in July 1965 to Ingalls Shipbuilding Corporation, Pascagoula, Miss., actual fabrication did not commence until June 1966. Meanwhile, review of vessel specifications, ordering of materials, and other preconstruction tasks were completed, as was the construction and testing of a scale model. Final delivery was tentatively set for May 5, 1967.

HARVESTING RESEARCH AND DEVELOPMENT

Behavior of Shrimp as Related to Harvesting

Gear research personnel in Panama City, Fla., continued developing an electro-shrimp trawling system. The shrimp fleet now remains idle about half the time on the grounds because brown and pink shrimp burrow into the bottom in the daytime and, hence, cannot be caught with trawls. A method of catching shrimp during daylight was needed so that costs of fishing could be reduced by making better use of manpower and equipment; therefore, gear research personnel began experiments with a trawl equipped with an electrically charged cable.

Repeated trials with early models of electric trawls were not especially successful and indicated that basic information on how shrimp react to electric charges had to be obtained.

Information was also needed on the type and amount of electrical energy required to make shrimp leave their burrows and thus be caught by trawls. Laboratory and field studies showing how electricity affects shrimp behavior provided our staff with criteria necessary to design and develop the electro-shrimp trawl system.

The specific type and amount of electricity required to force burrowed shrimp out of and off the bottom, within the time it would take a trawl to cover the distance from the front of the electrical field to the footrope, had to be determined. Thus, if the experimental animals could be forced to jump to the desired height within 2 seconds, a trawl, traveling at 2.5 knots, with an electric field 8 feet in length, should be capable of catching burrowed shrimp.

The first series of field tests was to determine the optimum electrical characteristics necessary to deburrow brown and pink shrimp from a white sand bottom. These tests will show how long it takes an individual shrimp to escape its burrow and how high it jumps above the bottom, as well as its escape pattern when stimulated with various electrical charges. SCUBA divers with 16-millimeter movie cameras recorded the escape reactions of several hundred shrimp burrowed in white sand bottom. Experimental electrical voltages ranged from less than 1 to more than 3 volts, and repetition rates varied from 3 to 6 pulses per second.

Analyses of movie film sequences indicate that pulse rate and voltage affect the shrimp's escape reactions. The percent activity (i.e., proportion of animals reaching a height of 3 inches or more above the bottom within 1.9 seconds) is significantly greater for the groups stimulated with high voltage than for those stimulated with low voltage (fig. 9).

Examination of the average height the experimental animals jumped off the bottom when stimulated at 4 pulses per second at different voltages indicates that the greater the voltage, the higher the animals jump (fig. 10). Further, as voltage increases, the percentage of animals that deburrow also increases; however, in relation to trawl speed and electrical field, 3 volts at 4 pulses per second proved to be optimum.

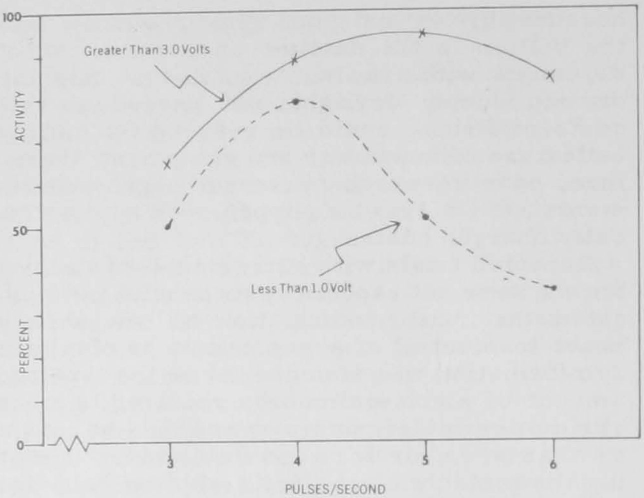

Figure 9.--Relation between pulse rate, voltage, and percent of experimental animals reaching a height of 3 inches or more above the bottom within 1.9 seconds.

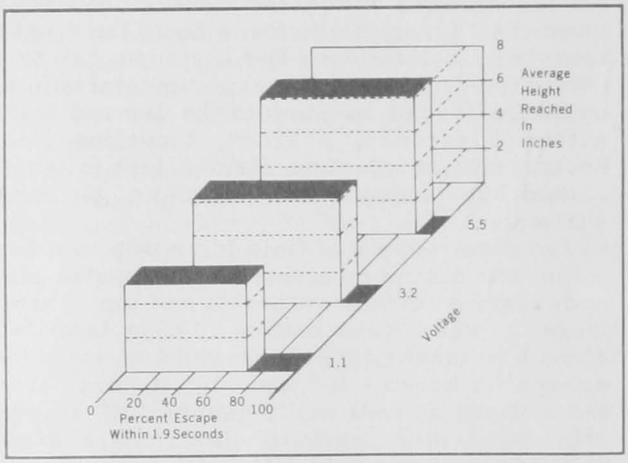

Figure 10.--Relation between percent of animals that "deburrow" within 1.9 seconds and the average height they jump off the bottom when exposed to 4 pulses per second at different voltages.

The second series of field tests was aimed at determining the effect of substratum on escape reaction of shrimp stimulated with 4 pulses per second at 3 volts. The percentage of animals escaping from sand is considerably lower than those from clay or mud (fig. 11). Further, the average height reached above the bottom is less for animals escaping from sand than for those from either clay or mud. The escape was the same for animals burrowed in either clay or mud.

Laboratory experiments were conducted to find a method of observing and recording nighttime activity of shrimp without altering normal shrimp behavior. Two automatically controlled 35-millimeter cameras were rigged to record the activity of two groups of nonburrowed experimental shrimp at 1/2-hour intervals throughout the night. One group of shrimp was

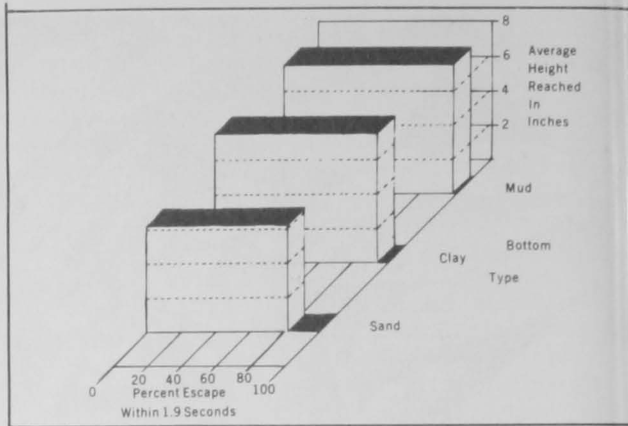

Figure 11.--Relation between bottom type and percent of animals that "deburrow" within 1.9 seconds and the average height they jump above the bottom when stimulated with 4 pulses per second at greater than 3 volts.

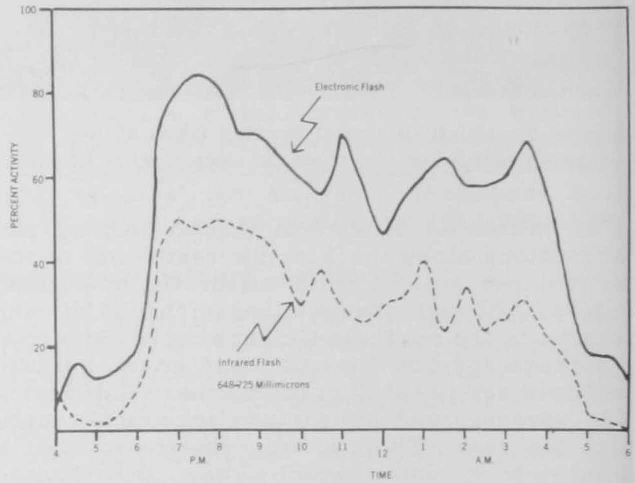

Figure 12.--Nocturnal activity of pink shrimp subjected to flashed infrared light and electronic flash of white light.

subjected to three different wave lengths of light in the infrared range for various time intervals between sunset and sunrise. The other group was exposed to flashes of white light of different durations during the same time interval.

Activity was greater for shrimp subjected to intermittent electronic flashes than for those exposed to either continuous or flashed infrared light. To observe shrimp, we found that flashed white light was clearly superior to flashed infrared light (fig. 12). Two peaks of nighttime activity can be seen for the animals exposed to the electronic flashes. The activity level increased from 20 to over 80 percent 1 hour after sunset, remained at a relatively high level for several hours, and decreased to less than 50 percent at midnight. A second peak of activity occurred after midnight and lasted until slightly before dawn. At sunrise, activity decreased rapidly. The experimental animals exposed to the flashed infrared also had two peaks of daily activity, although the peaks were much less pronounced.

To date, the best method of observing shrimp at night appears to be with electronic flash; any prolonged exposure to light, regardless of wave length, increases the time shrimp remain burrowed.

Work in the laboratory was supplemented by 24-hour observations of shrimp in cages attached near viewing ports of the underwater observation chamber at the dock in Panama City, Fla. A specially designed 35-millimeter camera was used to record the observations. Late in the year, gear research engineers believed that these observations and their accompanying data were adequate for the design of a much modified electrical trawl, tailored to suit the behavior of shrimp.

Developing the Electro-Shrimp Trawl System

The present electro-shrimp trawl system has four basic components: the power control panel, power cable, electronic pulse generator with its underwater housing, and the electrode array (fig. 13). The system operates in the following manner: Electrical power is supplied through the power control panel and power cable to the electronic pulse generator on the trawl door, where it is converted to direct

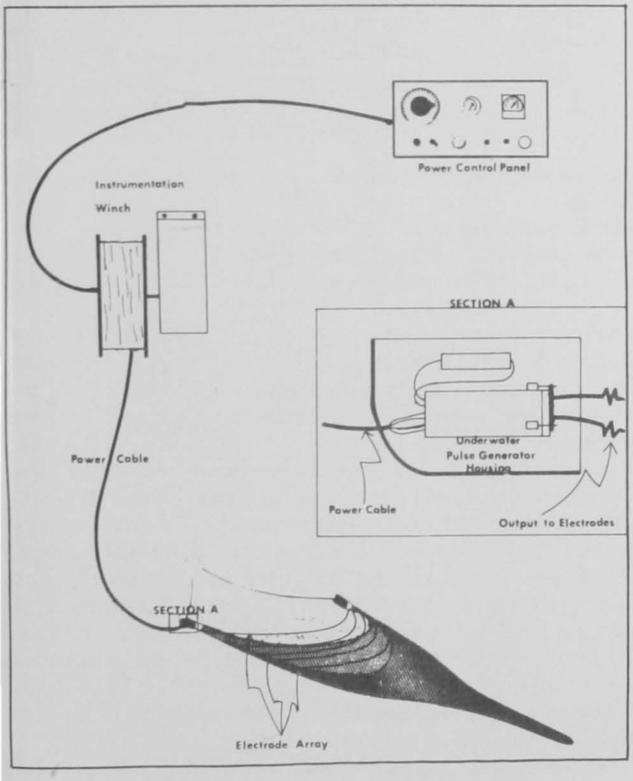

Figure 13.--Diagrammatic sketch of the components in the Bureau developed electro-shrimp trawling system.

current, stored in a capacitor bank, and discharged through the electrode array.

The power control panel aboard ship is a sheet metal panel on which is installed a variable transformer to control the alternating current and two voltmeters--one alternating current and one direct current (fig. 14A). The alternating current meter shows the voltage being supplied to the underwater electronics unit, and the direct current meter shows voltage on a capacitor bank in the electronic pulse generator.

A 4-conductor, neoprene-coated cable is used for a power cable. Two conductors supply alternating current to the underwater electronic unit, and two conductors return pulse generator, direct-current voltage readings to the power control panel.

The electronic pulse generator is enclosed in a watertight housing made of polyvinyl chloride pipe (fig. 14B). The housing is attached to the inboard trawl door on either the starboard or port trawl. The housing is oversized to simplify repair and to provide space, when necessary, for redesign of the electronic pulse generator.

The electronic pulse generator is the heart of the electrical trawl system (fig. 14C). Components of the pulse generator are (1) direct current rectifier circuit, (2) capacitor storage bank, (3) unijunction transistor trigger circuit, (4) silicon controlled rectifier "on-off" switch, and (5) commutation circuit. Generator characteristics such as pulse rates, pulse width, and field voltages satisfy the requirements producing optimum response by the shrimp.

Five individual electrodes, with the ends attached to each side of the leadline and equally spaced ahead of the footrope, constitute the electrode array (fig. 14D). Each electrode is a cable that is composed of three strands of insulated, stainless steel wire to provide strength and three strands of exposed, copper conducting wire. Several designs of electrode material have been tried, but at present this commercially purchased cable is the best.

The prototype system was tested initially during R.V. George M. Bowers cruise 64, and several problems immediately arose. The electrodes were not durable enough to withstand the constant chafing of rough bottom. Underwater electrical connectors on the pulse generator housing leaked and shorted out. The most serious problem encountered was overheating and deterioration of the generator circuits because of overloading due to the high conductivity of salt water. From the beginning of the project this physical characteristic of sea water had made it difficult to obtain acceptable voltages. At the end of cruise 64, the pulse generator was redesigned and other deficiencies of the system corrected.

An improved electrical shrimp trawl system was tested during Bowers cruise 65. Although the cruise was short and field testing limited,

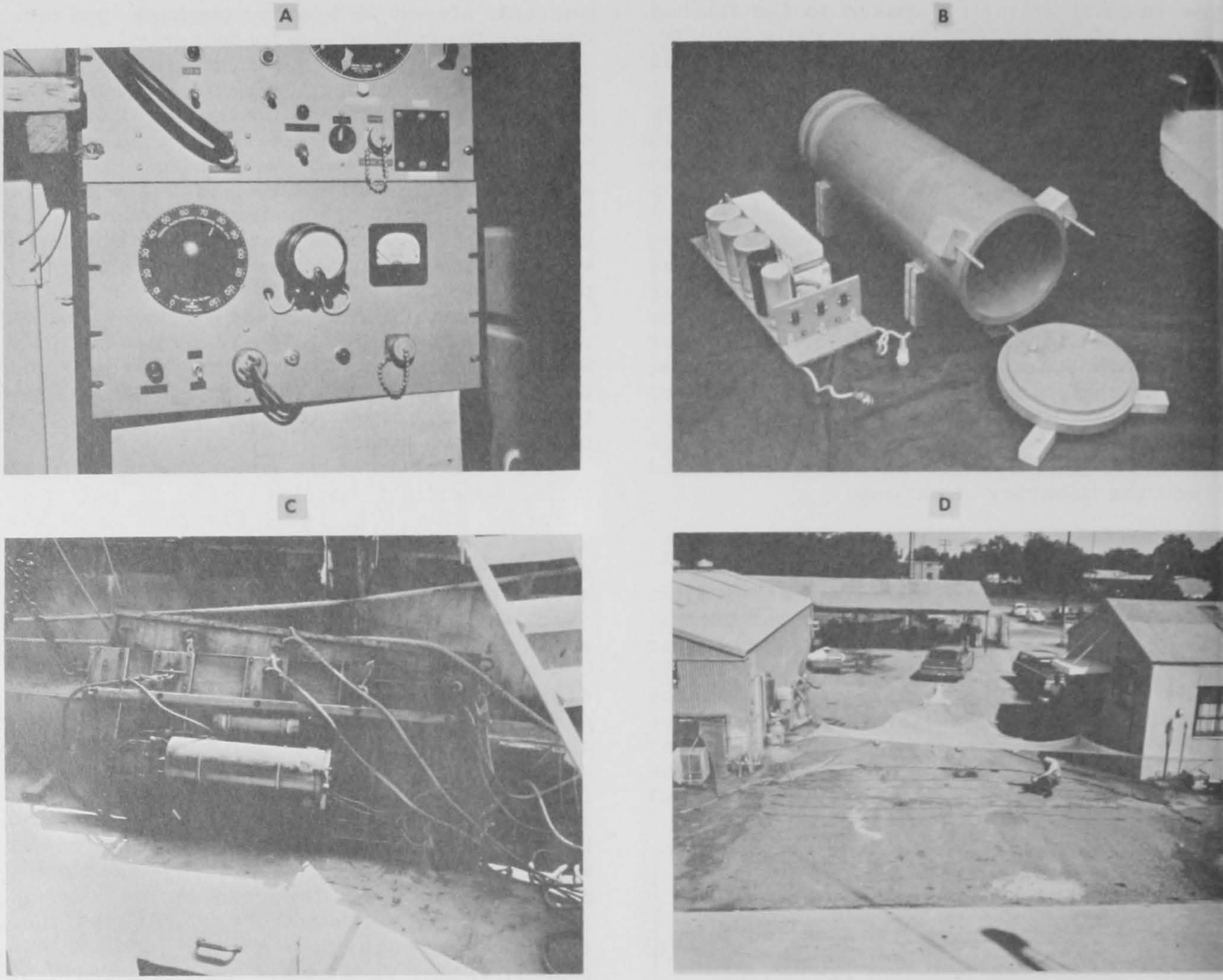

Figure 14.--Components of the prototype electro-shrimp trawl.
A. Power control panel.
B. Pulse generator and underwater housing.
C. Electric pulse generator mounted on trawl door.
D. Electrode array on a 40-foot Gulf of Mexico trawl.

the catches were good. Overloading of the commutation circuit and leaking of the underwater connectors again gave trouble; however, these problems were corrected later.

Within 6 months, an electrical trawl system had been designed and constructed. Although not a final product, the system could operate dependably as well as make encouraging catches. Tests showed that with more improvements and field testing, a system could be developed that would catch shrimp in commercial quantities during daylight. These field tests are being made.

Photo-Optical Underwater Instrumentation Studies

The development and adaptation of improved equipment for underwater photography continued this fiscal year. Space limitations and normal motion of research vessels at sea created continuing problems with delicate instruments. In an attempt to lessen this condition, we installed a camera control center aboard the R.V. George M. Bowers (fig. 15). This unit secures the television monitor and camera controls for the closed circuit television system and remote controls for underwater lights and film cameras in a small area. Also included in the center are controls and monitoring meters that are used for compensating voltage drops in the underwater cables.

The lighting system for the remote-controlled camera was improved by a 1,000-watt quartz-halogen lamp that is highly efficient and doubles the amount of light.

In the past, problems were encountered in determining water clarity when using remotely controlled underwater cameras. The usual practice was to stop the vessel while SCUBA

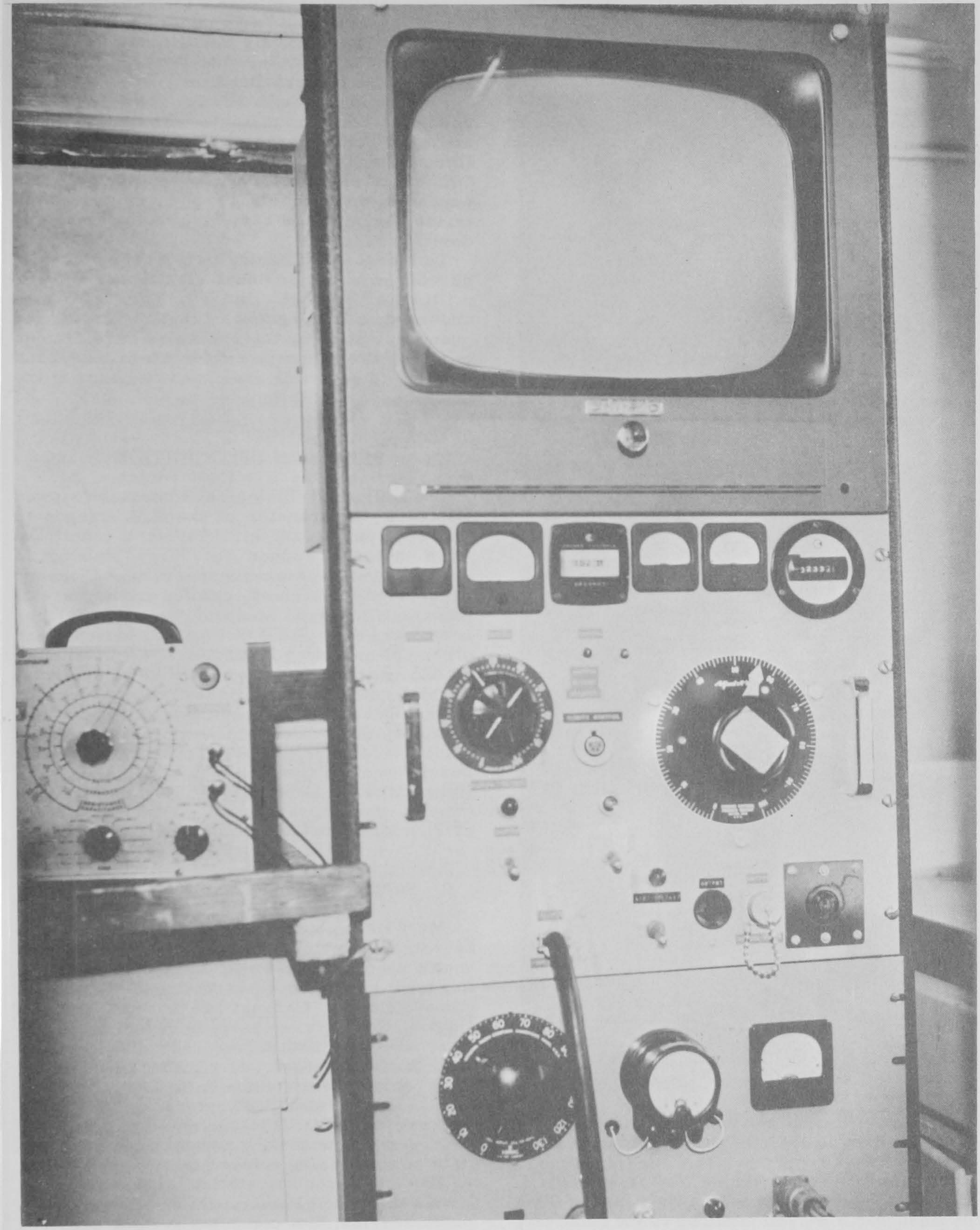

Figure 15.--The camera control center installed on the R. V. George M. Bowers

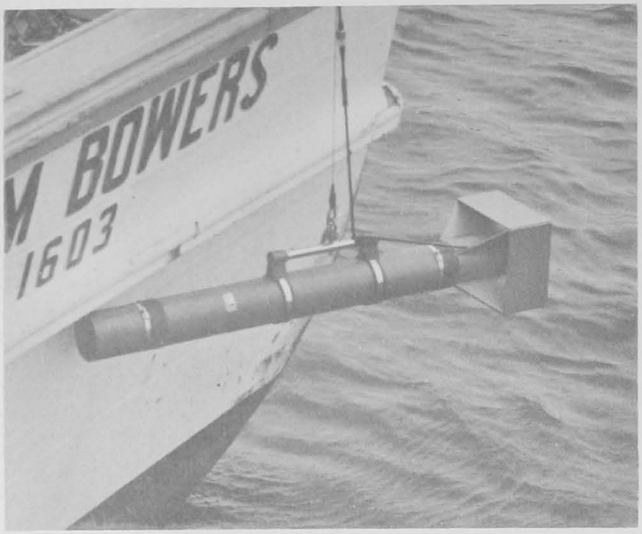

Figure 16.--A towable transmissometer used to provide continuous water turbidity readings.

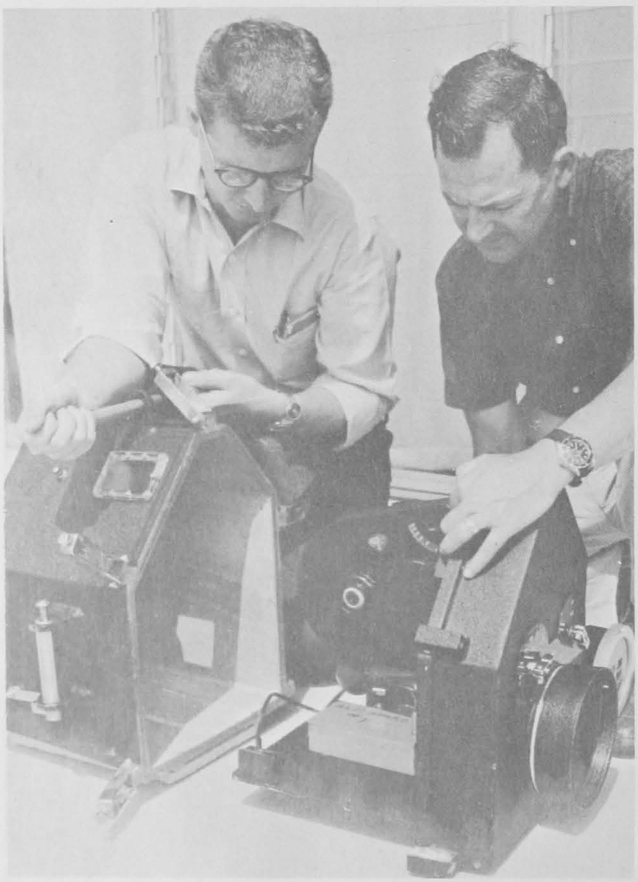

Figure 17.--A 16-millimeter reflex camera and its underwater housing used by SCUBA divers to photograph trials of gear.

divers took readings with a light meter. This method was slow and confined to the relatively shallow depths in which divers could work. To overcome these difficulties we purchased a commercially available transmissometer, which provided us with continuous turbidity readings (fig. 16). By using these readings, we could locate water that transmits enough light for the camera and film.

Photographers with SCUBA gear have taken underwater motion pictures with spring-wound cameras containing a maximum of 100 feet of film. Because of limitations of this equipment, 500 feet of underwater film was a normal day's exposure, and important sequences were often missed because the camera's motor drive ran down.

To increase efficiency of field operations, we purchased a professional electric-drive, 16-millimeter reflex camera, complete with underwater housing (fig. 17). Continuous sequences lasting up to 12 minutes at 24 frames per second are now possible. The battery pack for the camera was developed and built at the Gear Research Station.

SPECIMEN DISTRIBUTION

The influx of biological materials slowed following the transfer of the R.V. Oregon to the U.S. east coast in 1964; as a result, we were able to reduce the large backlog of accumulated specimens. Several thousand crustacean specimens, chiefly crabs, were of principal concern. Much of the material has been shipped to the U.S. National Museum and other collaborating institutions. We distributed 10,426 specimens in some 80 shipments. Special collections of fishes were sent to the Brazil Oceanographic Institute, Central Connecticut State College, and University of Southern Mississippi. A collection of 100 hake hearts went to the Commonwealth Bureau of Helminthology at St. Albans, England, and 360 annelid worms were sent a graduate student at Florida State University.

AUTOMATIC DATA PROCESSING

All data collected during field exploration is retrievable through the use of ADP (Automatic Data Processing) equipment. Several hundred specimen identifications from eight Oregon, seven George M. Bowers, and two Hernan Cortez cruises required some 15,000 new ADP cards that were added to the data file. Surface school and trolling records that have accumulated since R.V. Oregon cruise 1 in 1950 have also been entered on ADP cards and are now available for studies of tuna and other surface schooling fishes. Gear research data now are being entered on ADP cards and, as these data require statistical treatment, we have established liaison with an off-base computer service. The computer service provides us with printed data sheets at the rate of one every three working days.

SHRIMP ATLAS PREPARATION

A Gulf of Mexico shrimp atlas is nearly complete. This atlas is a statistical and graphical portrayal of the white, brown, and pink shrimp fishery in the Gulf of Mexico from 1959 through 1963. It includes annual, seasonal, and monthly catch analyses for each species, as well as a portrayal of exploratory shrimp trawling survey results that have been gathered over the past 15 years.

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Hilton M. Floyd, Fishery Methods and Equipment Specialist

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Shelby B. Drummond, Fishery Biologist
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Bennie A. Rohr, Fishery Technician
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Johnny A. Butler, Fishery Methods and Equipment Specialist

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Dorothy M. Latady, Administrative Assistant
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Alice Colmer, Librarian
Lorenzo Nathan, Caretaker--Died 3/29/66
Lawrence A. Polk, Caretaker--EOD 4/18/66
Robert Richardson (summer trainee)--Terminated 9/7/65
Betty H. King, Clerk-Stenographer--EOD 8/2/65
Kathryn M. Hoffman, Clerk-Stenographer
T. Arlene Daniel, Clerk-Typist
Rosetta D. Holloway, Clerk-Typist
Gloria A. Fetzik, Clerk-Typist--Resigned 7/16/65

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Floyd A. Nudi, Fishery Biologist
Raymond D. Nelson, Fishery Biologist--EOD 1/3/66
Ray Hoffarth, Fishery Biologist--EOD 1/3/66

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Martha N. Huff, Clerk-Stenographer
Nadine Watson, Clerk-Stenographer
David L. McDonald (summer trainee)--Terminated 9/3/65

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Howard R. King, Master--Transferred to George M. Bowers 12/20/65
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Robert M. Mattos, Chief Engineer
Franklin P. Tippins, First Assistant Engineer
Jake M. Marinovich, First Assistant Engineer
Frederick Weems, Steward
Harvey M. Bledsoe, Skilled Fisherman
Edward A. Thompson, Skilled Fisherman
Peter F. Rosetti, Skilled Fisherman
Ernest Williams, Skilled Fisherman

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Frank J. Hightower, Jr., Fishery Methods and Equipment Specialist
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Doyne W. Kessler, Fishery Biologist--Transferred to Juneau, Alaska, 9/25/65
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John D. Schlotman, Biological Aid--EOD 7/6/65
William C. Williams, Jr., Fishery Aid--Resigned 11/12/65
William M. DeGrove, Physicist--EOD 9/26/65, Resigned 4/30/66
Douglas D. Hodge, Electronics Technician--EOD 2/21/66

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Joanne E. Creel, Clerk-Stenographer--Resigned 3/4/66
Alma C. Pflaum, Clerk-Stenographer--EOD 4/4/66
Rosalie W. Potts, Clerk-Stenographer--EOD 2/28/66, Resigned 6/17/66
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Frederick L. Moree, First Cook--EOD 1/10/66, Resigned 5/6/66
William F. Whitehurst, Cook--EOD 4/28/66, Resigned 5/13/66
Laurence Vice, Skilled Fisherman
Julius W. Harper, Skilled Fisherman--EOD 9/9/65, Resigned 12/24/65
Frank B. Fratus, Skilled Fisherman--Resigned 8/14/65

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