Annual Report
Exploratory Fishing and Gear Research
Bureau of Commercial Fisheries Region 2
For Fiscal Year 1965

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

Circular 249

Cover Photograph.--*Oregon* crew setting out swordfish longline gear in the Caribbean Sea.

UNITED STATES DEPARTMENT OF THE INTERIOR
Stewart L. Udall, *Secretary*
John A. Carver, Jr., *Under Secretary*
Stanley A. Cain, *Assistant Secretary for Fish and Wildlife and Parks*
FISH AND WILDLIFE SERVICE, Clarence F. Pautzke, *Commissioner*
BUREAU OF COMMERCIAL FISHERIES, Donald L. McKernan, *Director*

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

For Fiscal Year 1965

By

Harvey R. Bullis, Jr., Director
John R. Thompson, Assistant Director
Bureau of Commercial Fisheries Exploratory Fishing Base
Pascagoula, Miss. 39567

Circular 249

Washington, D.C.

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For Fiscal Year 1965

REPORT OF THE BASE DIRECTOR

By

Harvey R. Bullis, Jr.
Base Director

The fiscal year ended with the award of a contract to Ingalls Shipbuilding Corporation, Pascagoula, Miss., for the construction of a new exploratory fishing vessel that will replace the Oregon in the Gulf of Mexico and the Caribbean Sea. The design was developed by Robert Macy, marine architect of Pascagoula, during fiscal year 1964. Ingalls' low bid was $1,990,000, and the contract provided 2 yr. (years) for construction.

The Gulf Exploratory Fishing Program operated with a much reduced staff this year. Rolf Juhl, who brings broad experience with the U.S. tuna industry, entered on duty shortly after the first of the fiscal year as Program Leader.

Activities in the Gulf Program have centered on four projects. The first of these is a 15-yr. resumé of the Oregon's activities in the Gulf of Mexico. The resumé, combined with a broad outline of recommendations for future activities to start after delivery of the new vessel, is to be presented to the Gulf States Marine Fisheries Commission.

During the last quarter, the Gulf Exploratory staff conducted a 2-mo. (month) fish trawling survey of the Florida west coast in cooperation with the Florida Board of Conservation, Division of Marine Resources. The R/V Hernan Cortez, Florida's exploratory fishing vessel, was used for this project. Two cruise reports were issued during this work, and a final report is nearing completion.

Two small experimental fishing projects were begun in the Mississippi coast area. The first project will determine whether shark is suitable for crab bait. Gear has been assembled, and a series of experiments comparing baits under differing fishing conditions has been designed and will be completed during the coming months. The second of these was designed to determine the possibilities of commercial eel fishing in Mississippi Sound and associated rivers. Test trapping between Biloxi and Pascagoula revealed relatively large concentrations in selected areas. We plan further work to provide a commercial evaluation of the stock.

Off-Season Menhaden Explorations were successfully carried out from November to March with the Bureau's R/V George M. Bowers on four 1-wk. (week) cruises off the Florida west coast. We made fish scouting flights over survey areas prior to each cruise and gained considerable information on the movements of menhaden in this area.

The Faunal Survey Program, headquartered at Pascagoula, has continued to evaluate the exploratory activities in Region 2. Staff activities were divided between developing ADP (automatic data processing) systems and working on a shrimp resource atlas of the Gulf of Mexico.

The ADP unit has completed development of and initiated work with the use of a numerical coding system for biological names, a task that has been under way for 6 yr. The system provides numerical substitutes for scientific names of all marine animals in the western North Atlantic. This system will greatly facilitate machine sorting of catch data and greatly simplify computer processing of data cards. The first computer run has calculated the numbers, pounds, and kilograms of animals per hectare (2 1/2 acres) for 130,000 species records. This is the first successful system of its type in operation in this country and has received widespread interest in the scientific community.

The shrimp atlas depicts the distribution and concentration of pink, brown, and white shrimp by month and season for the entire Gulf Coast.

A section of the dockside netshed has been converted into a specimen storage area, and the former specimen room in the main laboratory

building is now a drafting and cartography room. Specimen shipments to cooperating scientists and institutions were continued through the year. Currently we are providing 140 scientists with research material from exploratory catches. During the year we made 156 shipments including about 110,000 specimens.

The South Atlantic Exploratory Fishing Program moved from Brunswick to St. Simons Island, Ga., taking occupancy of the old lighthouse station for offices and laboratories. Dock facilities and a temporary netshed were constructed on the west side of the island, along the intercoastal canal. The Oregon was transferred to this program at the start of the year and assumed the role held previously by the chartered R/V Silver Bay.

The Oregon was concerned primarily with exploratory studies of swordfish, shrimp, and calico scallops. A notable contribution to the shrimp fishery was the discovery of a winter concentration of mixed brown and pink shrimp along the 30-fath. (fathom) contour south of Cape Kennedy, Fla. Up to 15 shrimp trawlers worked the area for 6 wk., producing 2 to 7 boxes of shrimp per boat each night. This discovery appears to have answered an old question about where the brown shrimp in the east coast fishery go each fall.

One cruise tested a prototype model of a deep-sea electric shrimp trawl on the royal red shrimp beds off Daytona Beach, and a portion of another cruise was spent testing a new model of a scallop shucking and eviscerating machine that is to be used on the unfished grounds off Cape Kennedy.

The Caribbean and Tropical Atlantic Exploratory Fishing Program was continued with two cruises of the Oregon, in cooperation with the United Nations Caribbean Fishery Development Project. Cruise 94, in fall 1964, provided the first exploratory survey of the Windward and Leeward Islands--between Antigua and Trinidad. Trawling and longline fishing yielded few catches, although indications of the availability of pelagic school fish appeared promising. These species belong to Jenkinsia and Menidia, neither of which are now harvested in the western Atlantic region. A few swordfish were captured, but no commercial concentrations were found.

Cruise 101 was devoted to trawling, dredging, and swordfish longlining in the Jamaica-Puerto Rico-Lower Bahamas area. We learned more about the distribution and availability of several snapper species in this area. Faunal collections filled several large gaps in the data series being assembled for zoogeographic analysis of the Caribbean region. Few swordfish were caught, again indicating that these fish do live in the Caribbean in spring and summer, but are not in commercial quantities.

The Gear Research Unit in Panama City, Fla., underwent a major personnel reorganization during the first quarter. Fred Wathne, the Unit Chief since the move to Panama City in 1962, transferred to Washington to assume duties as Assistant Chief, Branch of Exploratory Fishing. He was replaced by Norman Pease. Paul Kruse, heading the underwater photoinstrumentation studies at Pascagoula, transferred his project to Panama City in 1964 and has continued the development of observation instruments that combine motion picture and television cameras. New equipment constructed during this year will enable us to make 16-mm. motion picture sequences of gear behavior and escapement reactions of shrimp and fish to depths of 2,000 fath.

The discovery of important differences in shrimp deburrowing and escapement behavior depending upon bottom type has extended our work on evaluation of electrical trawls. Significantly increased voltages will apparently be required to use this gear on all species of shrimp now being harvested in the Gulf area. Intensive study on responses to electrical stimuli has been made and will continue into the next fiscal year.

Our designs for towed aerial platforms, to be used for fish scouting and oceanographic observations, have reached the point of our making numerous contacts with aircraft and television engineering companies. Industry has been quite interested in the concept of a towed-wing platform with a suspended remote-control TV camera package, and we are looking forward to model tests in the coming year.

STAFF

Harvey R. Bullis, Jr., Base Director
John R. Thompson, Assistant Base Director
Francis J. Captiva, Base Fleet Supervisor
Sven J. Svensson, Assistant to Fleet Supervisor
Marilyn M. Nelson, Secretary to Base Director

GULF OF MEXICO EXPLORATORY FISHING AND GEAR RESEARCH PROGRAM (Pascagoula)

Rolf Juhl, Chief--EOD July 21, 1964
James S. Carpenter, Assistant Chief
Hilton M. Floyd, Fishery Methods and Equipment Specialist
Frederick Weems, Skilled Fisherman--Transferred to St. Simons Island, Ga., Nov. 22, 1964

FAUNAL SURVEY PROGRAM (Pascagoula)

Richard B. Roe, Fishery Biologist, Acting Assistant Chief
Kenneth W. Osborn, Fishery Biologist
Charles M. Roithmayr, Fishery Biologist--Transferred from Galveston Program, Jan. 31, 1965
Bruce W. Maghan, Fishery Biologist
Shelby B. Drummond, Fishery Biologist
Norman L. Pease, Fishery Biologist--Transferred to Panama City, Fla., Oct. 11, 1964
Stanley M. Warlen, Fishery Biologist--Transferred to Beaufort, N.C., Jan. 31, 1964
Tomio Iwamoto, Fishery Biologist--Transferred to St. Simons Island, Ga., July 13, 1964
Luis R. Rivas, Fishery Biologist (summer seasonal)--EOD June 10, 1965
Leslie D. Osborne, Jr., Fishery Aid--Transferred from Galveston Program, Jan. 3, 1965
Bennie A. Rohr, Fishery Technician
Judith C. Gatlin, ADP Technician

OFF-SEASON MENHADEN PROGRAM (Pascagoula)

Johnny A. Butler, Fishery Methods and Equipment Specialist

OFFSHORE SHRIMP (Pascagoula to December 1964; Panama City from December 1964)

Paul J. Kruse, Fishery Biologist
Frank J. Hightower, Jr., Fishery Methods and Equipment Specialist

ADMINISTRATIVE, CLERICAL, AND MAINTENANCE (Pascagoula)

*Bobby Joe McDaniel, Administrative Officer--EOD Feb. 14. 1965
*Dorothy M. Latady, Administrative Assistant
*Edith J. Seamen, Administrative Clerk
*Suzanne W. Drummond, Clerk Typist--EOD Aug. 27, 1964
*Alice Colmer, Librarian
*Lorenza Nathan, Caretaker
Karen Y. Stone, Clerk Stenographer
Kathryn M. Hoffman, Clerk Stenographer--EOD July 13, 1964
Rosetta D. Holloway, Clerk Stenographer--EOD June 7, 1965
T. Arlene Daniel, Clerk Typist
Gloria A. Fetzik, Clerk Typist
Mary E. Severinsen, Clerk Typist--Resigned July 17, 1964

SOUTH ATLANTIC EXPLORATORY FISHING AND GEAR RESEARCH PROGRAM (St. Simons Island)

Robert Cummins, Jr., Chief
Joaquim B. Rivers, Fishery Methods and Equipment Specialist
Paul J. Struhsaker, Fishery Biologist
Tomio Iwamoto, Fishery Biologist--EOD July 14, 1964
Floyd A. Nudi, Fishery Biologist

ADMINISTRATIVE AND CLERICAL (St. Simons Island)

Harriette S. Lamb, Administrative Assistant
Martha N. Huff, Clerk Stenographer
Nadine Watson, Clerk Stenographer--EOD Sept. 2, 1964

OREGON (St. Simons Island)

Howard R. King, Master
A. James Barrett, First Officer
Robert M. Mattos, Chief Engineer
Franklin P. Tippins, First Assistant Engineer
Jake M. Marinovich, First Assistant Engineer

* Assigned to total building-combined facility

Frederick Weems, Steward
Harvey M. Bledsoe, Skilled Fisherman
Edward A. Thompson, Skilled Fisherman
Peter F. Rosetti, Skilled Fisherman
Frank B. Fratus, Jr., Skilled Fisherman--Transferred to George M. Bowers Mar. 28, 1965

GEAR RESEARCH STATION (Panama City)

Research Staff

Frederick Wathne, Chief, Gear Research Station--Transferred Sept. 12, 1964
Norman L. Pease, Chief, Gear Research Station--EOD Oct. 11, 1964
Charles M. Fuss, Jr., Fishery Biologist--Transferred Dec. 13, 1964
Edward F. Klima, Fishery Biologist--EOD Jan. 24, 1965
Paul J. Kruse, Jr., Fishery Biologist--EOD Dec. 7, 1964
Larry H. Ogren, Fishery Biologist
Doyne W. Kessler, Fishery Biologist
John K. Holt, Fishery Methods & Equipment Specialist--Resigned Jan. 29, 1965
David G. Wotherspoon, Fishery Methods & Equipment Specialist--Resigned Apr. 24, 1965
Frank J. Hightower, Jr., Fishery Methods & Equipment Specialist--EOD Jan. 11, 1965
Wilber R. Seidel, Mechanical Engineer--EOD May 23, 1965
William C. Williams, Jr., Fishery Aid

Administrative and Clerical (Panama City)

Joanne E. Creel, Clerk Stenographer
Crystal K. Kelly, Clerk Stenographer

Vessel George M. Bowers (Panama City)

Johnnie H. Tyler, Master--EOD July 13, 1964
Anthony F. Veara, Chief Engineer
Arthur N. Hatcher, Steward--Resigned Feb. 17, 1964
Laurence Vice, Skilled Fisherman--Transferred to First Cook Mar. 28, 1965
Frank B. Fratus, Skilled Fisherman--EOD Mar. 28, 1965

GULF OF MEXICO EXPLORATORY FISHING AND GEAR RESEARCH PROGRAM (Pascagoula, Miss.)

By

Rolf Juhl, Program Chief, and
James S. Carpenter, Assistant Program Chief

During fiscal year 1965, we spent considerable time preparing a 15-yr. historical review of the Gulf Program, which will be ready for printing in fiscal year 1966. With the transfer of the Oregon to St. Simons Island, Ga., Gulf explorations have been limited. The Gulf Program staff was reduced to a two-man evaluating team, with some assistance from the two-man Off-Season Menhaden Program staff. The shellfish, bottomfish, and pelagic fish projects will be reactivated when we have the Oregon replacement, expected during the middle of 1967.

At the request of industry, we made a 2-mo. exploratory survey off the west coast of Florida from Panama City to Cape Romano. This survey was completed in July 1965 under a cooperative agreement between the Florida State Board of Conservation and the Bureau of Commercial Fisheries. The main aims were to make a preliminary survey of the potential of the bottomfish resource, the species present, and their availability to specially designed trawls in 5 to 50 fath. The R/V Hernan Cortez was used for this work. Since much of the area is unsuitable for conventional trawling, modified roller-rigged fish trawls were used. Poor trawling bottom was encountered over much of the survey area, with frequent snags, hangups, and trawl damage. Fish catches were generally small with vermilion snapper, grunts, porgies, goatfish, red grouper, sea bass, and gray snapper the only commercially significant species.

Several observations have been made concerning foreign fishing. Returning snapper fishermen report continued dory-type fishing activities by the Cubans in the Campeche area. Also, sightings of foreign trawlers fishing the Campeche Banks are becoming more frequent. A foreign vessel was reported trawling from 35 to 40 miles southeast of Mobile Bay during late January, and another was reported about 40 miles west of St. Petersburg, Fla. Japanese longliners are reported fishing in the eastern Gulf, especially during the summer and fall.

During a recent visit by a New Zealand fishing expert (sponsored by the State Department under the foreign cultural exchange program), we learned that most of the bottomfish taken in that country were caught by trawling. It is not uncommon for a boat to catch 10,000 lb. (pounds) of snapper per 1- to 2-hr. (hour) drag; however, the average catch is 2,000 lb. per drag. The trawlers, which are in the 60- to 65-ft. (foot) class, are away from port only 4 days at a time.

Figure 1.--Front view of the Fisheries Laboratory building that houses the Gulf of Mexico Fisheries Explorations staff in Pascagoula.

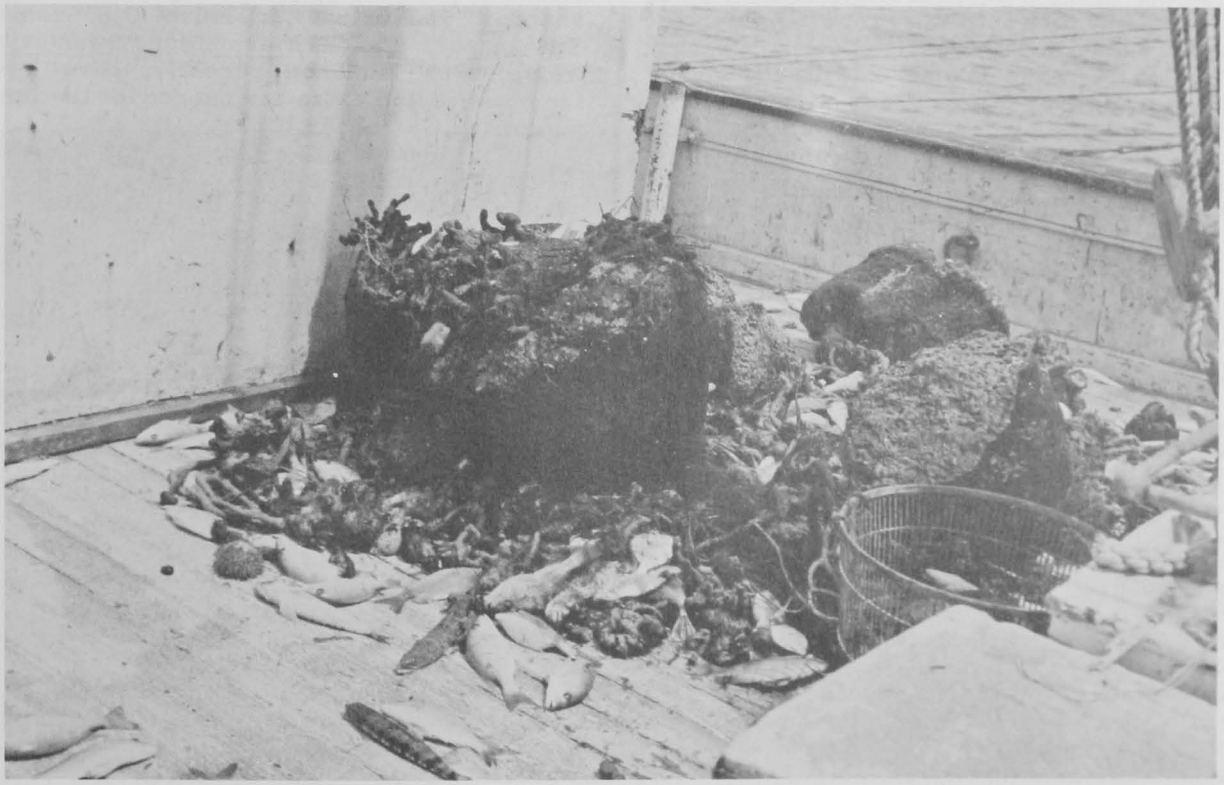

Figure 2.--Typical catch from 20- to 25-fath. depths off Ft. Myers Beach, Fla., showing loggerhead sponges; from a bottomfish trawl survey aboard the Florida Board of Conservation R/V Hernan Cortez.

SHELLFISH PROJECT

This project has been inactive, except for limited work, during this past fiscal year.

Results from the Hernan Cortez cruise (see bottomfish project) included partial information about occurrence of Spanish lobsters (Scyllarids) and related species throughout the depths surveyed. Preliminary identifications indicate three and possibly four species of these lobsters taken in depths from 5 to 50 fath. Quantitative estimates were not possible because special fish trawls were used in the survey.

The lack of an adequate and dependable bait supply for the blue crab fishery of this region has been a problem for many years. We began a project to learn if shark meat is a possible substitute or alternate bait for blue crab pots. If shark meat is satisfactory, the industry could have such benefits as (a) establishment of a profitable shark fishery (b) assistance to the blue crab, stone crab, and spiny lobster fisheries, and (c) reduction of the shark population in areas where sharks are predators.

BOTTOMFISH PROJECT

A preliminary investigation to determine if American eels (Anguilla rostrata) are present in the lower Pascagoula River system in sufficient quantities to warrant a commercial fishery began May 1, 1965.

This short-range project resulted from the interest shown by Florida and Virginia commercial eel fishermen, who stated that they would consider starting a fishery in this area if large numbers of eels were in the coastal rivers. They further stated that whether or not they began fishing here, they would pay the local commercial fishermen 15 cents per pound, plus shipping costs, and would supply containers for almost any amount of eviscerated eels they could supply.

Early results of the eel investigation on the lower reaches of the Pascagoula River have been generally poor; however, when the fishing was expanded in June to include waters of the Mississippi Sound and its estuaries, excellent catches of eels were made.

Eels were taken in traps from most of the river areas fished, but the catches were not large enough to make commercial fishing worthwhile. Twenty traps and 10 trotlines baited (on separate runs) with menhaden, croaker, shrimp, shrimp heads, crayfish, canned catfood, and cheese and blood bait were fished three times a week for 12 wk. The fishing area covered represents a stretch of about 30 to 35 river miles on the east and west prongs of the Pascagoula River. We set traps under different bottom conditions, depths, and currents.

Figure 3.--Removing eels from an eeltrap.

Traps set near the waste effluents of crab and shrimp processing plants in the shoal waters off Biloxi and in Bayou Casotte in Pascagoula have made far better catches than the river sets. Catches from these areas have been as high as 30 lb. per trap in 1 night of fishing.

Snapper smacks from Mississippi, Alabama, and Florida are now fishing the Caribbean Sea. The areas off Honduras and southeast of Swan Island are currently producing full loads of red snapper and attracting more U.S. vessels. The snapper smacks Carmen and Swan Island, which were launched recently, have larger ice bins for the extra ice needed for the longer run to the Caribbean banks.

A new concept in the construction of handline snapper fishing vessels is unfolding now. Some of the innovations being incorporated are:

1. Steel hulls, with compartmentalized double bottom for water and fuel, thus saving space and giving greater unsinkable qualities.
2. Chill tank on deck to keep fish cool until iced.
3. Larger ice bins and greater fuel capacity for longer run time to the Caribbean banks.
4. Holds insulated with 5-in. (inch) styrofoam[1] and covered with fiber glass facilitate cleaning with steam or bactericidal agent.
5. Relocation of crew quarters to amidships, providing more stable sleeping area.
6. Showers and heads.
7. Mercury vapor lamps on deck, great possibility for light attraction of bait fish, thus reducing the amount of purchased fish.
8. Whiteline depth recorders.
9. Greater horsepower engines.
10. Ten-kw. (kilowatt), a.c. (alternating current), generators for refrigeration and deck lights.

[1] Trade names referred to in this publication do not imply endorsement of commercial products.

Shortly after Hurricane Hilda, fishing improved. The industrial fish landings of the Pascagoula-based fleet rose considerably. One vessel caught 90 tons in 7 fishing days. During this period, the Campeche snapper fleet also reported improved fishing. Catches were up one-third to one-half, as the fish moved into shallow depths.

PELAGIC FISH PROJECT

A survey and development of the southeastern U.S. shark resources was proposed during the 1965 fiscal year. We proposed that the work begin in fiscal year 1966 and be divided into three phases--fishery survey, technological and economic evaluation, and production fishing. The project aims are to determine whether commercial shark fishery is feasible in the area, develop techniques to process and profitably market shark products, and encourage industry to use the resource. A secondary but vital goal is to reduce the shark population in certain areas to a level where sharks will no longer be serious predators in other fisheries.

Phase I of the program will include a 1-yr. survey of the Florida waters to determine species, distribution, and seasonal abundance of the sharks. Phase II calls for a 4-yr. technological and economic evaluation of shark products. Past research will be reviewed, a pilot processing plant will be installed, and studies will be performed to develop products and processes suitable for industry use. Phase III will involve development and implementation of a commercial-scale production shark fishery to include gear development and efficient handling methods of sharks. This work will be concurrent with Phase II and cover the same period.

We believe that research on the sharks of this area may provide the information needed to renew the fishery, which was once quite profitable.

A light attraction, electric guidance, and pump fishing project was proposed during fiscal year 1965. For the past several years some of the Oregon's cruises in the Caribbean and south and southwestern Gulf areas have had dip net stations. On numerous occasions large concentrations of small schooling fish have been seen during night-light attraction tests in reef areas of the Campeche Gulf and eastern and southern Caribbean. Silversides (Atherinidae) and dwarf herring (Jenkinsia), which generally comprise the greater part of the concentrations, have been caught with dip nets and modified plankton nets used as lift nets. We feel that this type of fish, very difficult to harvest by standard gear, could support localized bait, fish meal, or fresh fish industries and that electric guiding, light attraction, and pump fishing techniques could be used profitably to capture these small schooling reef fish.

Interest in the tuna resources of the Gulf were stirred again this year. On several occasions persons in the tuna fishing industry inquired about purse seining tuna. Also, several tuna fishermen visited the Base for information on the Gulf tuna stocks.

Figure 4.--Troll caught little tuna (Euthynnus alletteratus) taken 15 to 20 miles off Cape Romano, Fla.

OFF-SEASON MENHADEN EXPLORATIONS - GULF OF MEXICO

(Pascagoula, Miss.)

By

Johnny A. Butler, Project Leader

Explorations for off-season menhaden and related species continued in fiscal year 1965 along operational plans determined by our experience during fiscal year 1964. We performed aerial scouting and gill net sampling this fiscal year in the northeastern and eastern Gulf.

Project aims were to determine the presence and availability of off-season menhaden and related species, study migratory patterns, and sample areas of the northeastern and eastern Gulf for school fish within the 20-fath. curve. The work was carried out in cooperation with the Bureau's Biological Laboratory, Beaufort, N.C. Accomplishment of these aims is becoming increasingly important because of the importance of the fish-meal industry in the Gulf.

Menhaden landings in the Gulf of Mexico during 1963-64 exceeded the production of the entire Atlantic coast fishery. Continued decline of menhaden catches in the Atlantic fishery creates additional demands on the Gulf fishery, which has increased the fishing intensity on the Gulf stocks. New plants and additional vessels became operational in the 1965 fishing season. The need to expand fishing areas, extend seasonal limits, and use related fishery stocks, is becoming more apparent and desireable.

We made off-season explorations from November through March. Two simultaneous approaches were used--aerial scouting and sampling with gill nets. Five monthly scouting flights were flown between Pascagoula, Miss., and the Florida Keys commencing in November. Four coordinated sampling cruises were made immediately subsequent to each flight beginning in December. Sampling was limited to an area between Panama City and Cedar Key, Fla., within the 20-fath. curve. All preplanned stations, selected by depth contours, were not sampled because adverse sea and weather conditions curtailed operations during some of the cruises.

A twin-engine land-based aircraft was again used for aerial scouting. (fig. 5). The aircraft had AM, VHF, and OMNI radios for communication and navigation; an infrared radiation thermometer to measure sea surface temperatures; and lifesaving equipment required for overwater flights. It was manned by a licensed instrument-rated pilot and one or two Bureau observers. During one flight, a commercial menhaden spotter and an oceanographer were passengers.

Figure 5.--Aircraft used for aerial scouting.

The flight tracks, surface water temperatures, and areas of fish sightings are shown for each flight (figs. 6, 7, 8, 9, and 10).

A total of 232 observation stations were made during five monthly flights over the northeast and eastern Gulf. Some 1,355 schools of herringlike fish were seen. More schools (1,006) were seen during November than in other months. Most of the schools (87 per cent) were found inside the 10-fath. contour. Some of the schools in the Cape San Blas - St. George Island area were identified as menhaden, and subsequent gill net sampling caught menhaden in this area. Between Anclote Key and south of Cape Romano 425 schools were seen; however, 399 schools were seen within the 20-fath. curve between Cedar Key and Apalachicola Bay. From Apalachicola westward to Panama City, mostly inside the 10-fath. curve, 337 schools were noted. Tentative identification of clupeids other than menhaden were: thread herring, Opisthonema oglinum; Spanish sardines, Sardinella sp.; and scaled sardines (razorbellies), Harengula pensacolae.

The sea and weather during the five flights were generally good. Frontal movements through the area brought strong winds, rough seas, and lower surface temperatures, but

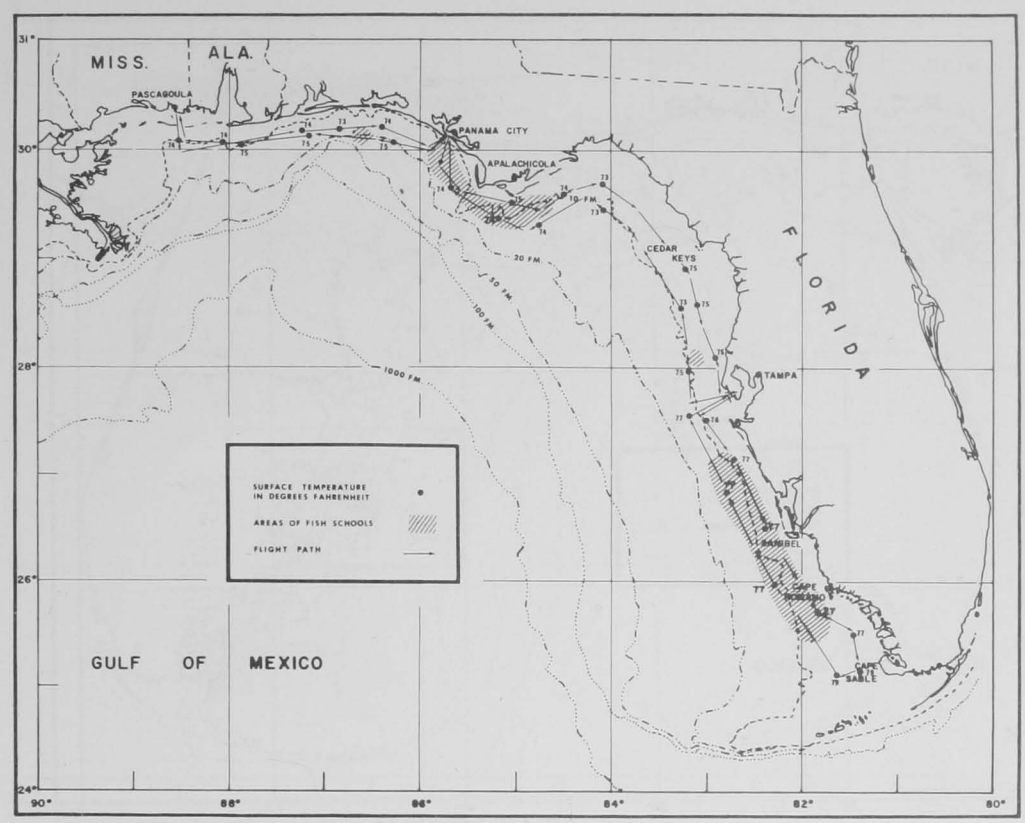

Figure 6.--Flight No. 6 - November 1964.

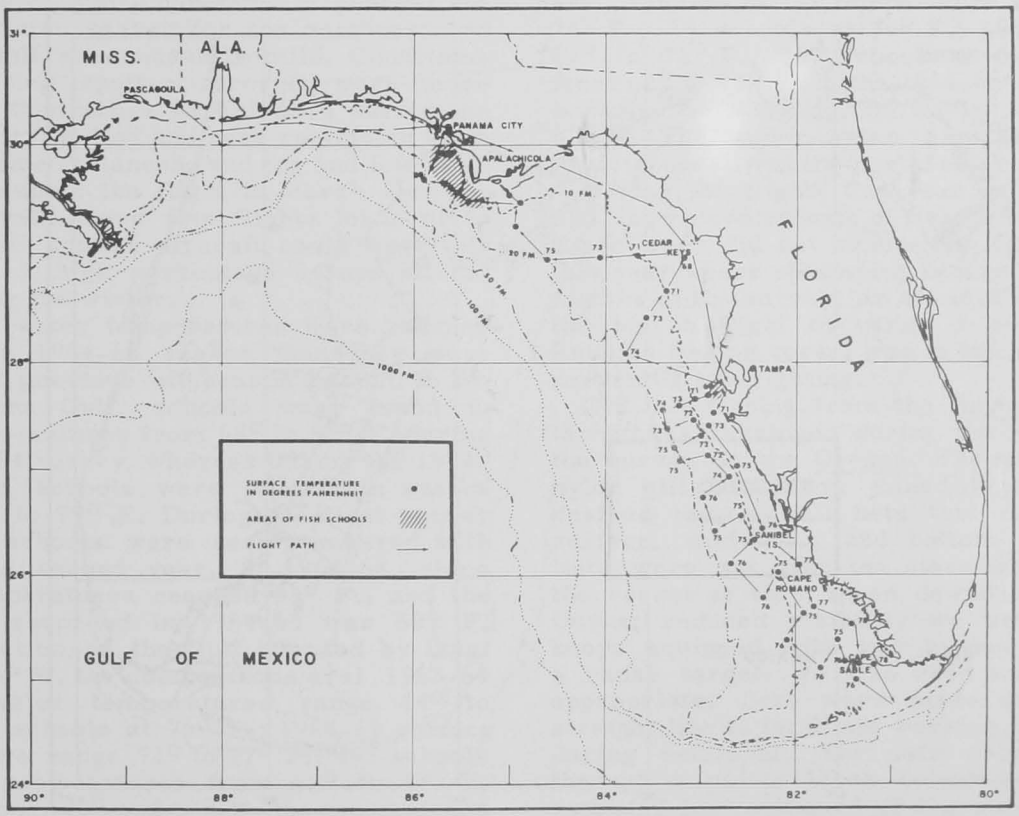

Figure 7.--Flight No. 7 - December 1964.

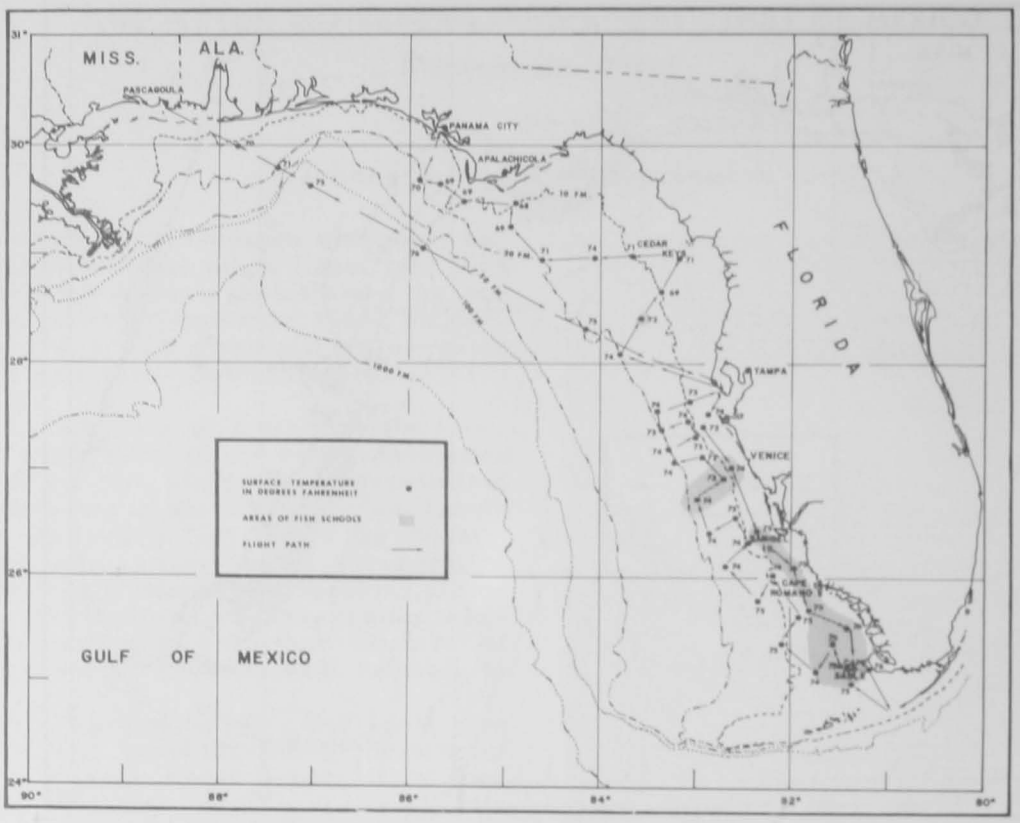

Figure 8.--Flight No. 8 - January 1965.

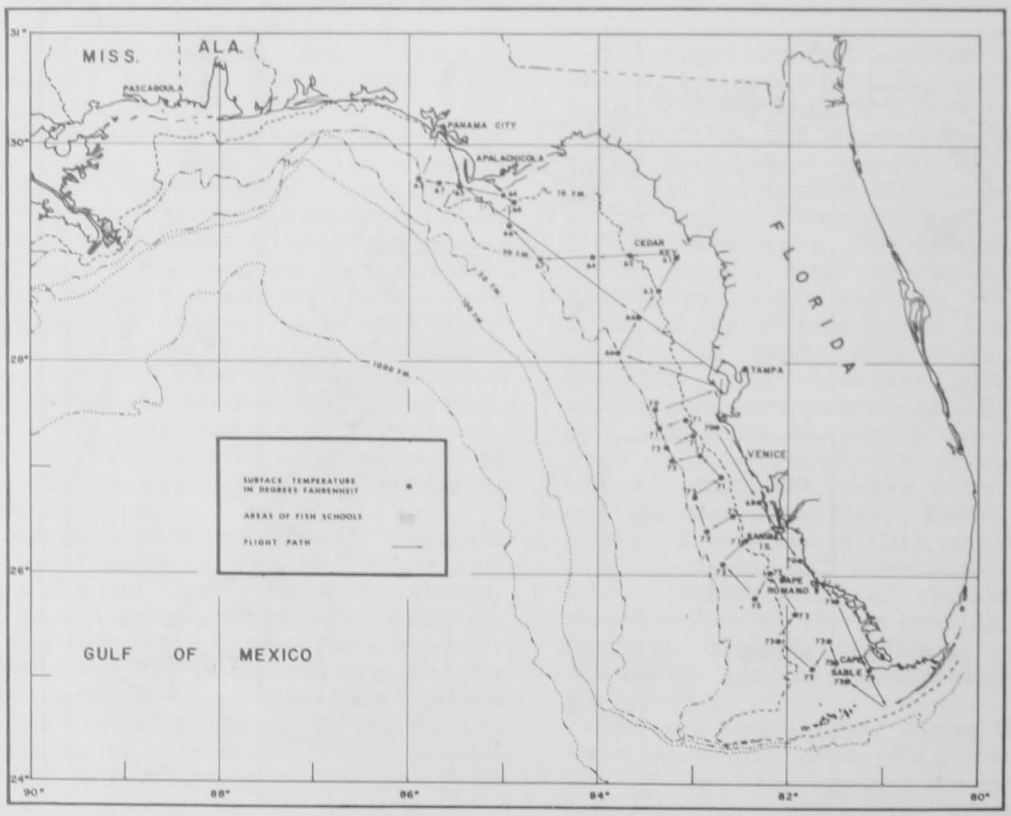

Figure 9.--Flight No. 9 - February 1965.

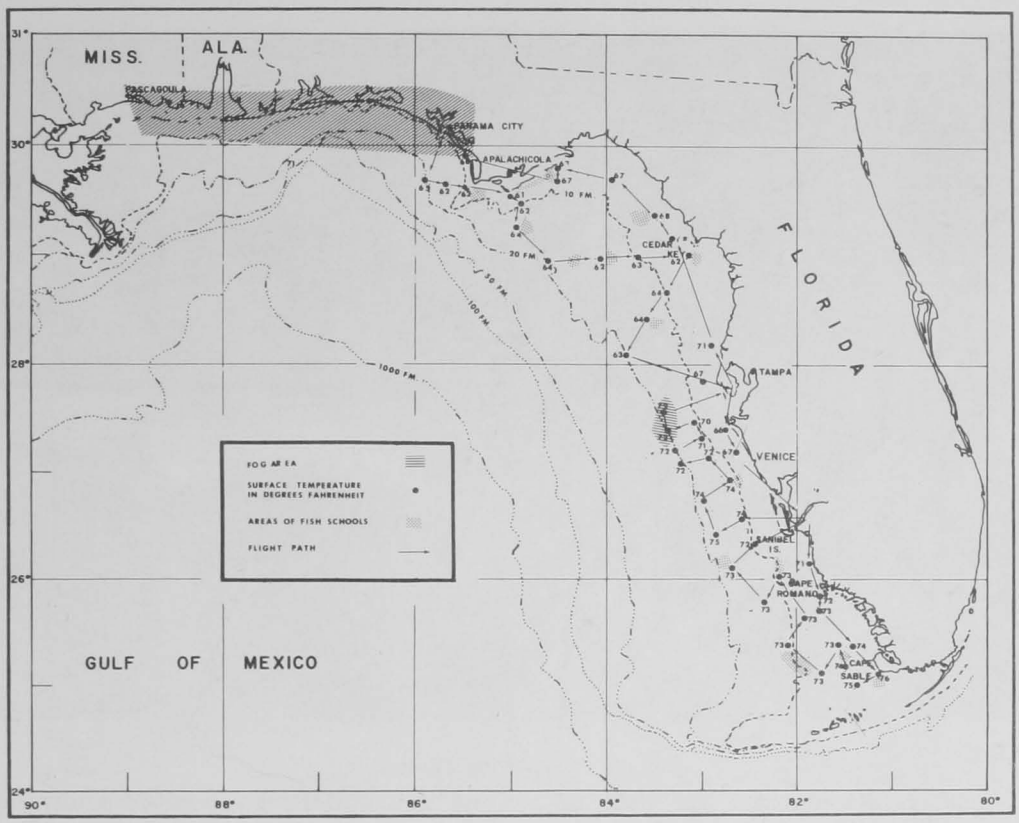

Figure 10.--Flight No. 10 - March 1965.

these were of short duration. In general the 1964-65 winter season for the northeast and eastern Gulf was unusually mild. Conditions for operating spotter aircraft were more favorable than those experienced during the 1963-64 survey. Fog and haze restricted visibility in some instances, and fog and low ceilings interrupted the flight in March. Our experience with these five flights leads us to assume that spotter aircraft could work this area with a high percentage of operational days during the winter.

Surface water temperatures were warmer during the 1964-65 season than they were during the previous off-season period. In the southeastern Gulf, schools were found in water temperatures from 68° to 81° F. during the 1963-64 survey, whereas during the 1964-65 survey, schools were present in waters from 70° to 79° F. During the first survey year, 23 schools were seen compared with 564 in the second year. In 1963-64, some water temperatures reached 55° F., and the minimum recorded in 1964-65 was 58° F. In the section of the Gulf bounded by long. 83° and 85° W. the comparisons are: 1963-64 surface water temperatures range 44° to 76° F., 8 schools at 76° F.; 1964-65 surface temperature range 71° to 77° F., 443 schools in water temperatures from 62° to 75° F. Between long. 85° and 87° W. the comparisons are: 1963-64 water temperature range 55° to 74° F., 25 schools at 74° F.; 1964-65 range 61° to 76° F., 337 schools at temperatures from 62° to 75° F. In the 1964-65 survey, fish schools were found in waters as cold as 62° F. The colder water temperatures were found generally in the northeastern Gulf.

During the flights this year we saw no significant concentrations of fishing vessels. The flight track did not include the Tortugas area this year where shrimping is carried on during months of the survey. An attempt was made on the March flight to verify a report that a Russian fishing vessel was in the area, but fog prevented any sighting.

Gill net fishing from the Bowers followed techniques developed during the first year of the survey on the Oregon. The monofilament nylon gill nets were joined together to the desired length. Gill nets that fished at the surface, midwater, and bottom were used. Nets were set over the stern while running the vessel at slow speed downwind (fig. 11). During reduced visibility we used marking buoys equipped with two blinker lights and a radar target. We also used anchors when appropriate. Sets were made usually in a straight line to facilitate working into the wind during retrieval. The nets were retrieved through a power block mounted on a boom extended just outboard of the starboard gun-

Figure 11.--Setting gill net.

wale. Fish were removed from the nets on deck as the nets were being restacked on the afterdeck for resetting. We preserved specimens either by freezing or in formalin. All clupeoids and plankton net specimens were forwarded to the Bureau's Biological Laboratory at Beaufort. A biologist from that laboratory participated in each cruise.

At all sampling stations for menhaden we used gill nets with 2-5/8-in. stretch mesh. Gill nets made with 1-3/8-in. stretch mesh were fished at times to sample smaller herringlike fishes such as Spanish sardines and anchovies. To catch fishes attracted at night by a 500-watt light fitted onto the ship's boom, we used dip nets and drift gill nets. Plankton was collected with a 1/2-meter (20-in.) plankton net.

During the four cruises, we made 67 sets with 2-5/8-in. stretched mesh monofilament nylon gill nets, 7 sets with 1-3/8-in. mesh gill nets, and 37 plankton net tows; 1 nightlight dip net station was sampled. A total of 1,888 menhaden were taken, 88 were identified as Brevoortia smithi and 1,800, as B. patronus. All gill nets were 10 ft. deep, and the total length fished during all cruises was 77,100 ft. Surface nets accounted for 24,300 ft., bottom nets 45,600 ft., and midwater nets 7,200 ft. Surface nets fished a total of 1,288 min. (minutes) and caught 318 menhaden. Bottom nets fished 1,920 min. and caught 1,304 menhaden. Midwater nets during 385 min. of fighing caught 266 menhaden.

Analyses of the limited sampling data collected during the four cruises reveal the following information: (1) Adverse weather and sea conditions limited sampling with gill nets; (2) adult menhaden were caught in the areas fished during each of the 4 mo., December through March; (3) the dominant Gulf commercial species, B. patronus, was taken each month, whereas B. smithi was taken only during the December and March cruises; (4) bottom and midwater gill nets caught more menhaden per unit of effort than surface nets; (5) echo sounder tracings (fig. 17), indicated that menhaden were dispersed throughout the water column; (6) all catches of menhaden were made in depths of 10 fath. or less (however, fishing effort in deeper waters was too limited to establish a firm depth preference for menhaden in the areas and during the periods of the cruises.); (7) the length-frequency data show that adult menhaden of comparable sizes were present in areas fished throughout each of the 4 mo.; (8) catch rates during March were higher than during the 3 earlier months; (9) no definite lateral migration pattern was evident; and (10) observations and sampling revealed the presence of other related species, including Spanish sardines, round herring (Etrumeus sp.), anchovies (Anchoa sp.), shad (Alosa sp.), Atlantic bonito (Sarda sarda), harvestfish (Peprilus paru), and others.

After each flight and cruise we distributed reports to interested industry members and other agencies. A current status report of menhaden explorations and a report on related species in the Gulf were presented at the National Menhaden Association meeting in Old Point Comfort, Va., in February 1965. We made quarterly progress reports.

Figure 12.--Clearing the net of menhaden at the end of a set.

Figure 13.--A portion of a typical catch of menhaden on deck.

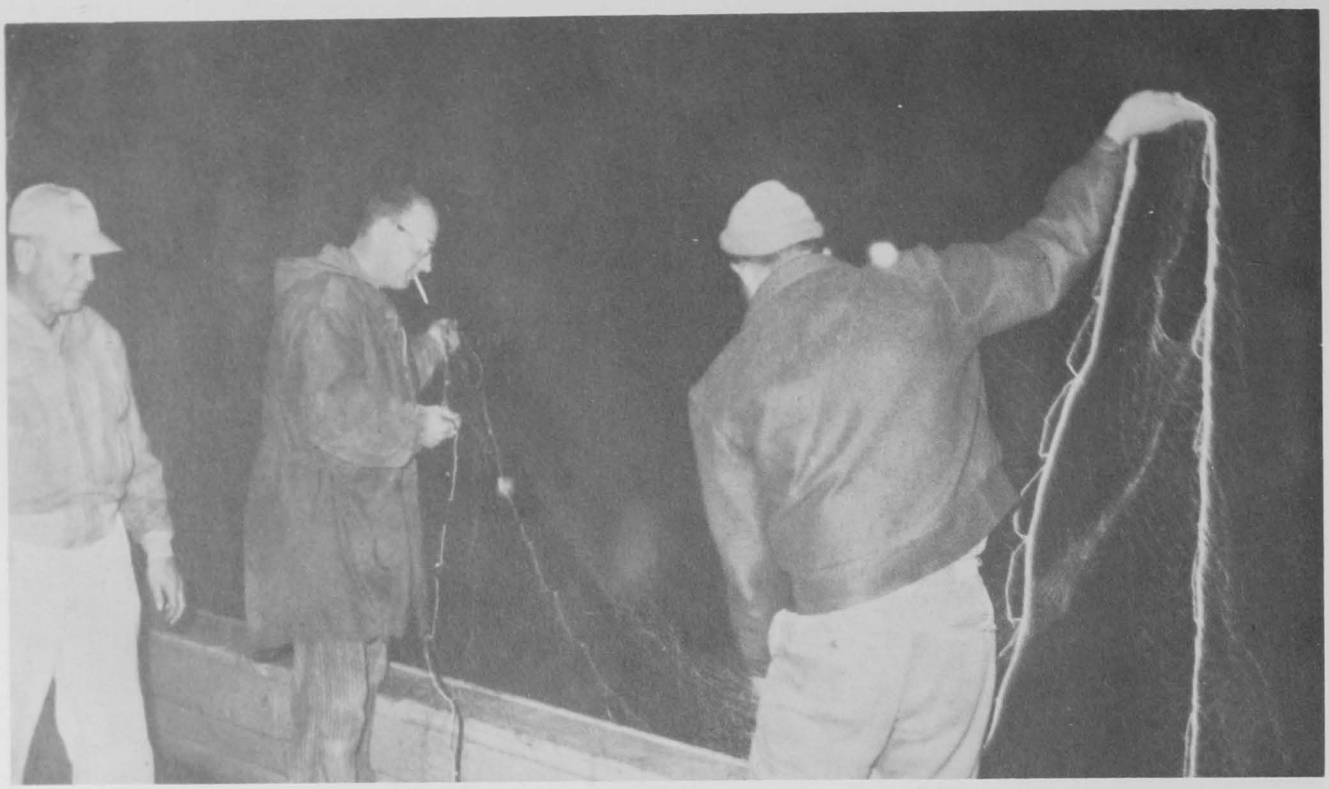

Figure 14.--Hand hauling a short section of gill net at night.

Figure 15.--Taking a bottom temperature on station during menhaden explorations.

Figure 16.--R/V George M. Bowers used in menhaden explorations.

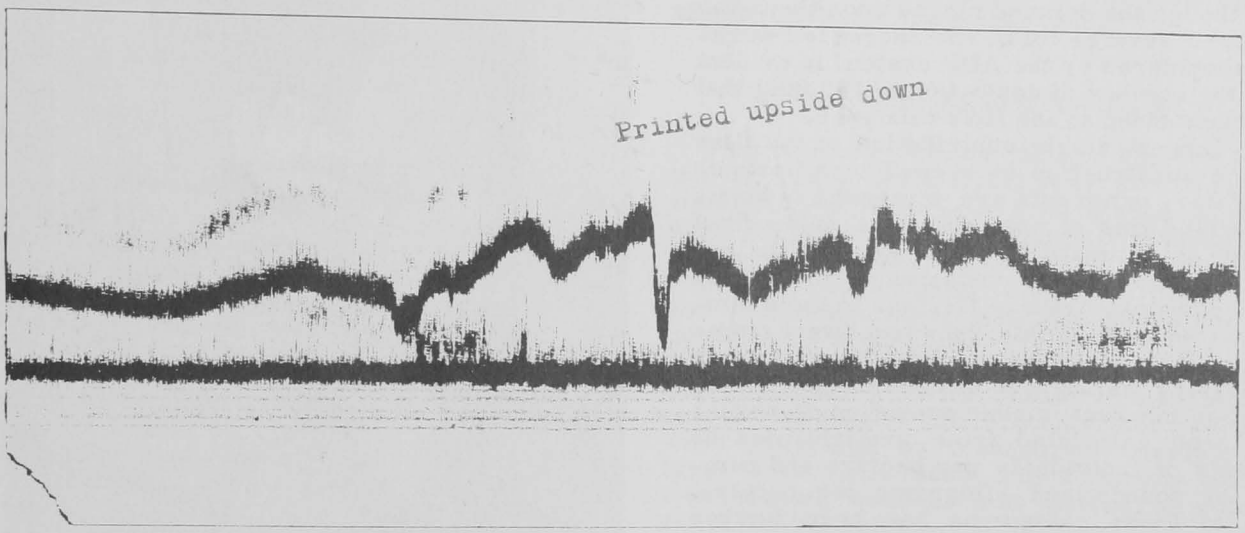

Figure 17.--Echo tracing of menhaden.

FAUNAL SURVEY PROGRAM
(Pascagoula, Miss.)

By

Richard B. Roe, Acting Assistant Program Chief and
Kenneth W. Osborn, Fishery Biologist

The principal purpose of any exploratory fishing program is the evaluation of aquatic resources through accumulation and interpretation of data. Our information reservoir, into and out of which these data flow, is the Faunal Survey Program, which provides accomodations for the storage and analysis of data, supervision of the distribution of specimens to the scientific community, and evaluation of zoogeographical distributions. This year we have emphasized the operations of the Faunal Survey Program because the Oregon has been reassigned to St. Simons Island, Ga. We are analyzing now our exploratory fishing efforts with respect to the seasonal distribution and abundance of known marine resources. Findings from these investigations will provide a sound foundation for future exploratory fishing efforts.

The Faunal Survey Program has four current projects: (1) ADP (automatic data processing); (2) atlas preparation; (3) specimen distribution, and (4) distribution analyses. Each project will be detailed on the following pages by the project leader.

ADP PROJECT

Evolution and development of the ADP facilities at Pascagoula were outlined in the annual report for fiscal year 1964. These facilities have remained unchanged through fiscal year 1965, though the demand placed upon them has increased several fold. The increased workload shouldered by the ADP system is evident from the number of cards (some 150,000) that have been added to the files this year.

The largest single contribution to the files was the construction of a card deck in which exploratory catch data are expressed in terms of availabilities of animals. This is the first attempt to estimate the abundance of the resources within the boundaries of the region covered by exploratory fishing. In the calculations we use in this program, we assume certain factors to be relatively constant in exploratory fishing but allow for the normal variation inherent in gear operation. Densities have been calculated from availabilities as numbers of individuals per hectare and numbers of pounds and kilograms per hectare. Each of these categories has been further coded in a logarithmic fashion so that densities of populations may be compared more easily.

Our program uses the UNIVAC model 1004C automatic data processor, maintained at the Mobile County School Board, Mobile, Ala. Because of the complexity of programming this machine, the project leader attended a UNIVAC sponsored programming school in New Orleans, La. Instructions for programming, operating, and wiring were given, and the program for the density card was developed. Processing began in November with 120,000 cards. At that time a "bug" developed in the program, but in March the difficulty was remedied and an additional 12,000 cards were processed under the revised program.

Although the cards have not been analyzed extensively, the most promising use of these calculations is that they will enable us to analyze the distribution of the fauna and note the composition of faunal structures. These computations may also be used in our construction of resource atlases.

This year a species code has been added to the modified FAO (Food and Agriculture Organization) phylogenetic coding system, enabling us to compile lists of species collected

Figure 18.--High-speed card sorter used at Pascagoula.

Figure 19.--ADP technician preparing a printed tabulation.

by exploratory vessels. Under this system, each major taxon, from phylum to species, is punched on ADP cards and tabulated in phylogenetic form. As additional families, genera, or species are collected and referenced, they are added to the deck and a printed tabulation is prepared. Lists for fishes and crustaceans have been compiled and are being edited for publication. These lists have revealed that exploratory vessels in the Gulf of Mexico, Caribbean Sea, and the southwest North Atlantic have taken about 1,200 species of fish and 500 species of crustaceans. In all, we have recorded more than 3,000 species of marine animals, including fishes and crustaceans.

We made a strenuous effort this year to show field station personnel how to operate the ADP system and how to apply it to field problems. As a result several new field forms were developed. One form is for recording information on the behavior of penaeid shrimp in an electrical field. Data compiled from this form should greatly facilitate the development of an electrical shrimp trawl. We also designed and distributed a new form for sightings of schoolfish and for trolling records. In the future, similar specialized forms will be developed for many of our programs and projects.

Early in the year we realized that we needed a system of organized application for ADP tabulations, so we designed a requisition form and distributed it to personnel needing tabulated materials. This form was used, furnished a valuable record of ADP activities, and enabled us to use ADP time and manpower more effectively. By the end of the fiscal year we had made over 100 tabulations with these forms since we began to use them in late October.

Data from several Oregon cruises and the normal influx of identifications from collaborators have contributed to the increase of the card file for the fiscal year.

ATLAS PREPARATION PROJECT

This project became active shortly after the beginning of the fiscal year, and five persons from other projects were reassigned to work fulltime on the atlases. The specimen room in the main building was converted to a drafting room, complete with drafting tables and equipment, materials, and media for the preparation of atlases.

A preliminary presentation using red snapper exploratory fishing results was submitted to the Washington Office. Exploratory results were presented on transparent overlays of large base maps (about 3 by 4 ft.) with colors representing seasons and shades of colors representing relative catch rates.

Most of the effort during the rest of the year was expended in developing and perfecting an atlas format, techniques, and methods of

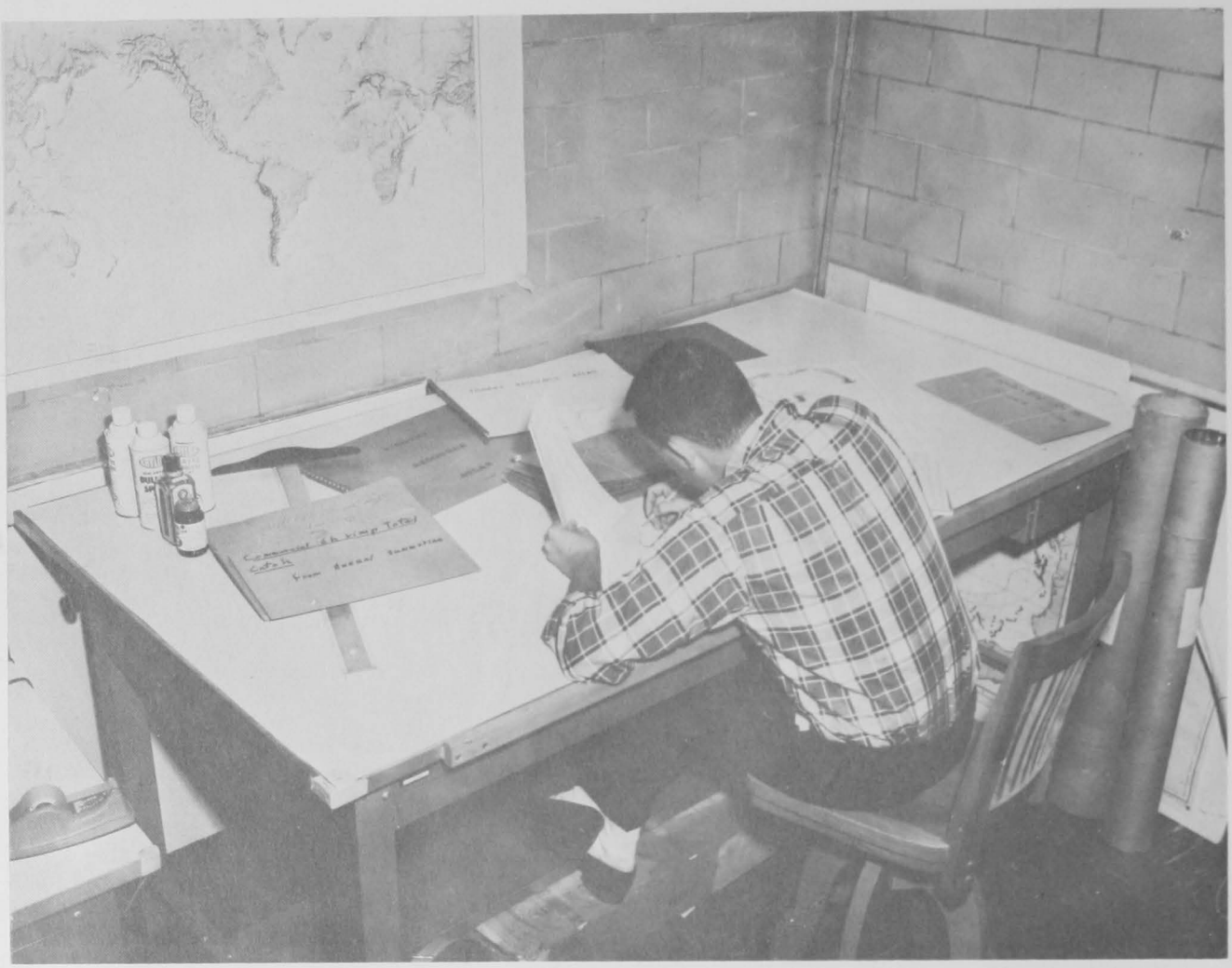

Figure 20.--View of the drafting room in the main building, used for preparation of Atlases.

presenting data, which could be standardized and applied to all species and all areas in the region. For this purpose, brown, white, and pink shrimp in the Gulf of Mexico were selected to serve as models. The final format had a page of 13 by 19 in., and each species formed a section of the atlas with catch data presented on a monthly, seasonal, and annual basis. Commercial catch statistics, collected from the fleet, were presented on the base maps, and relative catches in pounds were color coded. Exploratory fishing results from the ADP tabulations were on transparent overlays, coded by relative catch rates. The project leader took the completed atlas format to the Washington Office, and spent 2 mo. conferring with Branch, Bureau, and Geological Survey personnel on format, style, cartography, and other aspects of atlas presentation for a national fishery resources atlas. In addition, preliminary atlas samples of the industrial bottom fishery of the northern Gulf of Mexico were prepared and other preliminary presentations have been started.

Also ADP tabulations have been prepared of exploratory catches of bottomfish, calico scallops (Aequipecten gibbus), and shrimp on the east coast of the United States.

SPECIMEN DISTRIBUTION PROJECT

Facilities were improved by adding a specimen room at the rear of the net shed. This room takes the place of the museun previously housed in the main building and provides more floor space for specimen sorting. A full-time technician is now responsible for specimen distribution. The combined benefits of these improvements enabled us to reduce considerably the tremendous backlog of collected materials, and future shipments of specimens should parallel their deposition from exploratory cruises.

A total of 156 lots of specimens were distributed this year (124 of fishes, 14 of crustaceans, 12 of miscellaneous invertebrates, 5 of mollusks, and 1 of oceanic birds). The

Figure 21.--Technician preparing specimens for shipment.

shipment of oceanic birds, collected near Serrana Bank on Oregon Cruise 92, was sent to the U.S. National Museum. These shipments contained some 110,000 specimens.

More than 100 scientists and 50 institutions and museums, in 20 States and 8 foreign countries, received materials from our Base during fiscal year 1965. The identifications we receive from the scientific community are of great value to us.

DISTRIBUTION ANALYSIS PROJECT

We improved our analysis of faunal distributions by dividing into faunal zones the region explored by our operations. We have now delineated 27 such zones, coded them numerically, and punched them into the ADP card decks.

These zones have already provided a valuable insight into the relations of the faunal populations in the Gulf of Mexico, Caribbean, and southwestern North Atlantic. Placement of the zone code on punchcards has made it easier to handle the cards and has accelerated the speed of tabulating.

A report on the faunal collections in the southwestern North Atlantic for 1956-60 has been completed and is in press. This edition updates the previous report on collections in 1950-55 and expands the faunal coverage beyond the Gulf of Mexico. We prepared two manuscripts on zoogeography this year: One on caridean shrimp, the other on fish from the Caribbean coast of Panama.

SOUTH ATLANTIC EXPLORATORY FISHING AND GEAR RESEARCH PROGRAM
(St. Simons Island, Ga.)

By

Robert Cummins, Jr., Program Chief

The South Atlantic Exploratory Fishing and Gear Research Program has continued to assess and appraise marine resources in the western Atlantic Ocean off the southeast coast of the United States. The program assists the domestic commercial fishing industry by (1) locating new fishing grounds and delimiting latent stocks of fish and shellfish; (2) developing new, modified, more efficient, and more economical fishing gear and fishing methods; and (3) directly assisting fishermen to locate undeveloped resources and use the techniques, methods, and procedures required for their harvest. In addition, we collect specimens, which are used by the program staff and many other research workers for cataloging the fauna and recording the standing crop of fish and shellfish.

Beginning with fiscal year 1965 and until the Oregon replacement becomes operational, line supervision of the Caribbean and Tropical Atlantic Exploratory Fishing and Gear Research Program has been transferred from the Base in Pascagoula, Miss., to the Field Station at St. Simons Island, Ga.

FACILITIES

Operations are administered now from the former St. Simons Light Attendant Station that was acquired and renovated for an office. At this location, we have also provided office space for the use of the local staff of the Office of Economic Opportunity. From this reassigned home port on the U.S. east coast the Oregon made nine cruises and spent 196 days at sea during fiscal year 1965. Completed during the year was a vessel dockage and storage facility on the Intracoastal Waterway.

INDUSTRY DEVELOPMENTS

Fish: Several fishermen asked us about bottomfish we had located during earlier explorations. Using this knowledge, some fishermen caught and landed fish in Georgia, including large Atlantic croakers (Micropogon undulatus), which command good ex-vessel prices.

Shrimp: During Oregon Cruise 97 we caught large brown (Penaeus aztecus) and pink shrimp (P. duorarum) off the Florida east coast in January. These shrimp were in 30 to 32 fath. between Bethel Shoal and Cape Kennedy. The bottom was suitable for trawling generally between 26 and 43 fath. We gave information about these shrimp to local fishermen, and some began fishing immediately. For several

Figure 22.--Commercial shrimp trawlers anchored off the east coast of Florida awaiting nightfall.

weeks individual vessels caught from 2 to 7 boxes (200 to 700 lb.) of heads-off shrimp per night until reduced catches indicated that the shrimp had dispersed gradually or moved out of the area. These shrimp may have been migrating outside of the known fishing grounds. With further investigation, we hope that these grounds may annually provide catches during an otherwise inactive shrimping season.

Sporadic attempts at daytime fishing for royal red shrimp (Hymenopenaeus robustus) were made by several vessels that were fishing at night in shallower water for brown shrimp during January. Small catches of royal red shrimp and reduced prices discouraged this combination fishing; however, at least two shrimp vessels have continued to drag for royal red shrimp almost exclusively, and attempts to improve marketing problems have had some success. From February to June, catches have averaged 6 to 8 boxes of heads-off royal red shrimp per 24 hr. of fishing or about 2 boxes per drag with a single rig.

Scallops: The Bureau and private interests continued the development of automatic shucking and eviscerating machines for scallops. A production model eviscerator using a new principle was successfully tested at sea. A 100-ft. scallop vessel has been outfitted with the latest shucking and eviscerating equipment and has had preliminary sea trials for a factory-type operation. The machinery will continue to be modified, and initial intermittent production may begin soon.

BOTTOMFISH EXPLORATIONS

By

Paul J. Struhsaker, Fishery Biologist

No bottomfish explorations were scheduled or performed during the past year; however, we are preparing a report on the previous 5 yr. of demersal fish explorations off the southeastern coast of the United States and a manuscript describing the basic composition and distribution of the bottomfish in this region.

SHELLFISH PROJECT

By

Floyd A. Nudi, Jr., Fishery Biologist

We located large brown and pink shrimp while exploring outside known grounds off the Florida east coast between Cape Kennedy and Stuart. In depths from 10 to 70 fath. we made 104 drags. Trawlable bottom was in 18 to 43 fath.; however, occasional tearups indicated scattered broken bottom areas and an intermittent ridge about 2 fath. high along the 39- to 40-fath. contour. Best catches were at night and consisted of 16 to 20 count brown and pink shrimp in 30 to 34 fath.

Initial catches by commercial fishermen during January and February were reported as high as 7 boxes (700 lb.) of heads-off shrimp per night, but fishing was interrupted by storms that apparently dispersed the shrimp, and catches dropped off to 1 to 2 boxes per night during March, April, and May. Pink and brown shrimp each made up about 50 per cent of the shrimp catch during January, but by March brown shrimp were dominant in catches. The area is new to commercial shrimp fishing, and we plan further explorations to determine the likelihood of the shrimp appearing annually and the feasibility of an off-season fishery.

We explored in deep water for royal red shrimp off St. Augustine, Fla., while we were experimenting with the Bureau's electrical shrimp trawl and deepwater motion picture camera. We made 89 drags in 150 to 300 fath. We used a standard 40-ft. flat trawl at 57 stations as a control to compare the effectiveness of the 40-ft. electrical shrimp trawl and to locate concentrations of royal red shrimp for the Deep Water Motion Picture System (DMPS-1). This system is an underwater 16-mm. motion picture camera attached to the headrope of a modified 40-ft. flat trawl and capable of operating to 300 fath. To record photographically the behavior of royal red shrimp in relation to trawls we used 2,400 ft. of black and white film and 800 ft. of color film.

The trawl doors were equipped with a deepwater pulse generator to furnish electrical power to the net. Mechanical and physical conditions precluded operating two nets simultaneously in deep water. Therefore, consecutive drags were duplicated for comparisons. Results were inconclusive although the largest single catch was made with the electric net. The catches of the standard trawl were divided equally by weight between shrimp and "trash species" whereas the catches of the electrical trawl had half the weight of "trash species".

The best fishing depth was 220 to 225 fath., and the largest single catch was 95 lb. (heads-on) of shrimp per 2-hr. drag with the electrical trawl.

Marketing royal red shrimp continues to be a problem because of erratic production in a market oriented toward the more easily and economically produced shallow water penaeid shrimps. Continued efforts to develop a market appear to have some success. Some Florida boats have continued to produce royal red shrimp in the area south of Cape Kennedy where catches have been fairly consistent, averaging 6 to 8 boxes of heads-off shrimp per 24 hr. with a single trawl.

A brief resurvey of the Cape Kennedy calico scallop (Pecten gibbus) beds located by the R/V Silver Bay in 1960 was made in January 1965, at the request of the commercial

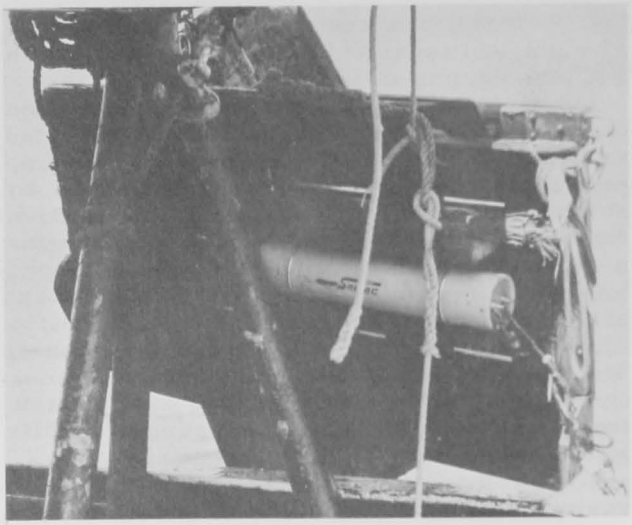

Figure 23.--Deepwater pulse generator on 6-ft. chain door, used to supply energy to the electric nets.

Figure 24.--A clean catch of about 20 bushels of live scallops on deck.

fishing industry. We dredged at 46 stations in the area with 6- and 8-ft. tumbler dredges and caught from 0 to 20 bushels (1,500 lb.) of scallops per 30-min. drag. Most were medium-sized scallops, averaging 1-3/4- to 2-in. shell width, which yielded 112 to 142 meats per pint (1 lb.). We found commercial concentrations in 28 fath. off Cape Kennedy where catches had 35 percent dead shells. Incidental catches of scallops were taken in quantities of up to 2 bushels (145 lb.) per 60-min. drag with 40-ft. flat shrimp trawls.

PELAGIC FISH PROJECT

By

Tomio Iwamoto, Fishery Biologist

Investigations of the pelagic fish resources of the Florida-Antilles Current System accounted for a major portion of the operational sea days of the R/V Oregon during fiscal year 1965. Three cruises (No. 93, 96, and 100) were devoted entirely to this phase of work. Longline gear was the the chief sampling tool used in the subsurface swordfish and tuna resources investigation. Trolling gear and visual observations of surface school fish were used to define and delineate the surface school-fish resources in the region.

During the year we made 32 sets of longline gear in scattered areas covering the region from the northern Bahama Islands to Cape Hatteras. Twenty-eight sets were made in the early evening and retrieved the following morning; the remainder were set in the morning and retrieved the same afternoon. The night sets were primarily for swordfish, which are seldom caught on longline gear fished during daylight. Since retrieval of the gear takes most of the morning, night sets also fish a portion of following day. A set consisted usually of 50 baskets with 10 hooks per basket. A basket contained 138 fath. of mainline and 10 gangions with each gangion comprised of 3 fath. of branchline and 1 fath. of wire leader. A large variety of baits were fished including the following: croakers, spot (Leiostomus xanthurus), butterfish (Poronotus triacanthus), herring (Clupea sp.), scad (Decapterus sp.), menhaden, and squid (Loligo). Bait preference could not be detected, but the incidence of bait loss was highest with herring, scad, and butterfish. Various lengths of buoy drops were tried. Although 5-, 10-, 20-, and 30-fath. drops were fished most frequently, 50- and 100-fath. drops were occasionally used. During Cruise 96, experimental deep drops to 275 fath. were tried with varying success.

Although commercial concentrations of subsurface swordfish and tuna were not located, a widespread temporal and geographical distribution of these fish is indicated by the data. Of note are the large bigeye tuna captured during the three longline cruises. The 22 we caught were generally quite large, up to 280 lb. and averaged over 100 lb. Yellowfin tuna (Thunnus albacares) and skipjack tuna (Katsuwonus pelamis) were taken infrequently, and blackfin tuna (T. atlanticus) and albacore (T. alalunga) were taken only once.

On the three longline cruises we caught 16 swordfish (Xiphias gladius), which averaged

Figure 25.--Retrieval of the radar-light buoy marks the beginning of the haul-in operation of the longline set.

Figure 27.--Biologists examine bigeye tuna (Thunnus obesus) taken with longline gear.

Figure 26.--The longline hauler coils the mainline neatly into the tub.

Figure 28.--A 60-lb. white marlin (Tetrapturus albidus) is brought aboard the Oregon.

90 lb. Three swordfish were caught on 100-fath. buoy drops; one, on a 50-fath. drop; and the rest, on 5-, 10-, 20-, and 30-fath. drops. Sharks frequently mutilated the catch, especially in the area between Georgia and Cape Hatteras in waters shoaler than 200 fath.

We encountered large numbers of sharks on all cruises. Of over 400 individuals captured, sickle (Carcharhinus falciformis), whitetip (C. longimanus), and scalloped hammerhead (Sphyrna lewini) sharks were taken in the greatest numbers in that order. Lesser numbers of mako (Isurus oxyrinchus), blue (Prionace glauca), dusky (C. obscurus), and night (Hypoprion signatus) sharks were taken.

We saw two schools of skipjack tuna on Cruise 100; these were the only schools of tuna seen during the longline cruises. During May and June, we saw five tuna schools (three of skipjack, one of blackfin, and one of yellowfin) along the outer Bahama Islands. In this area three Japanese longline vessels, one of which was observed setting out gear, were also seen.

The development and installation of a trolling alarm system have greatly increased the effectiveness of the troll-fishing operations. Troll catches taken in less than 100 fath. were mostly little tuna (Euthynnus alletteratus). These fish were found in abundance throughout the year. Beyond 100 fath., we caught dolphin (Coryphaena hippurus) frequently by trolling, but very few other fish.

We must do much more exploratory fishing before we gain a comprehensive understanding of the seasonal and spatial distribution of large pelagic fishes of the western tropical Atlantic.

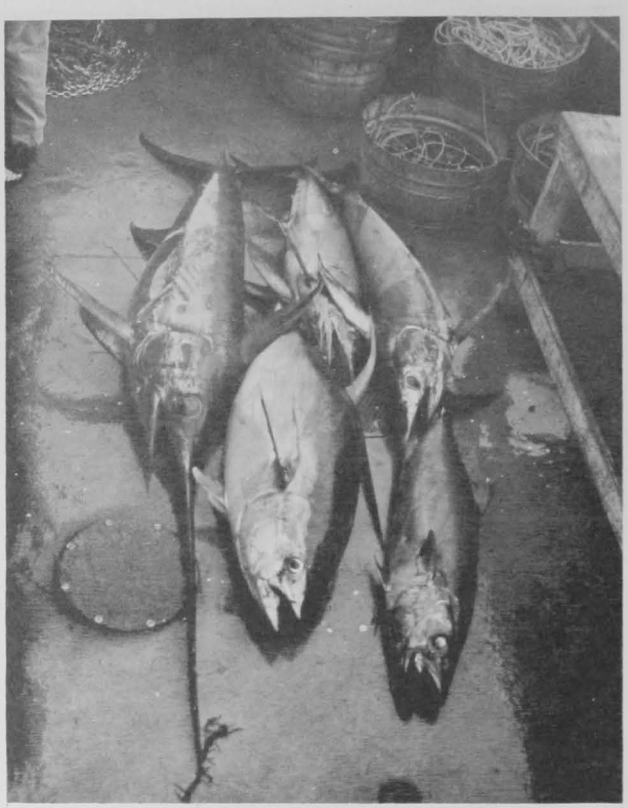

Figure 29.--A portion of a longline catch showing three swordfish, a yellowfin tuna, and a member of the snake mackerel family.

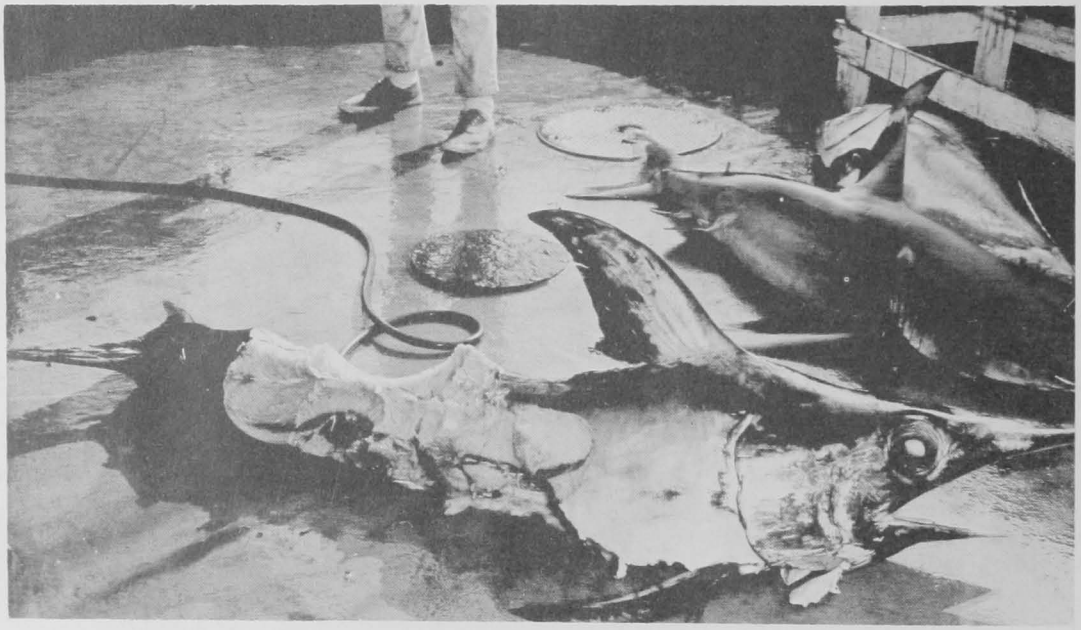

Figure 30.--Shark damage is an important factor to be considered in any commercial longline venture.

CARIBBEAN AND TROPICAL ATLANTIC PROGRAM
(St. Simons Island, Ga.)

During fiscal year 1965 two exploratory fishing cruises of 42 and 45 days were scheduled for the eastern and northern Caribbean Sea with the Oregon. These cruises were the first two in cooperation with the United Nations Special Fund - Caribbean Fisheries Project and a continuation of the general Caribbean and Tropical Atlantic faunal survey and fishery resource evaluation started by the Bureau in 1957. Longline fishing, trawling, dredging, trolling, and other exploratory fishing operations were carried out during both cruises. United Nations observers and trainees from Trinidad, Barbados, Guadeloupe, Antigua, Jamaica, Puerto Rico, and Korea participated in different phases of the cruises.

Day and night longline sets were made at 18 localities in the Windward Passage, Mona Passage, and the Windward and Leeward Islands. Tuna catches were poor. We caught only an occasional medium-sized yellowfin and bigeye tuna (T. obesus). Swordfish catches were also discouraging with the exception of three captures at a set 20 miles southeast of Mona Island. Other species taken on longline gear included dolphins, wahoo (Acanthocybium), white marlin (Tetrapturus albidus), the

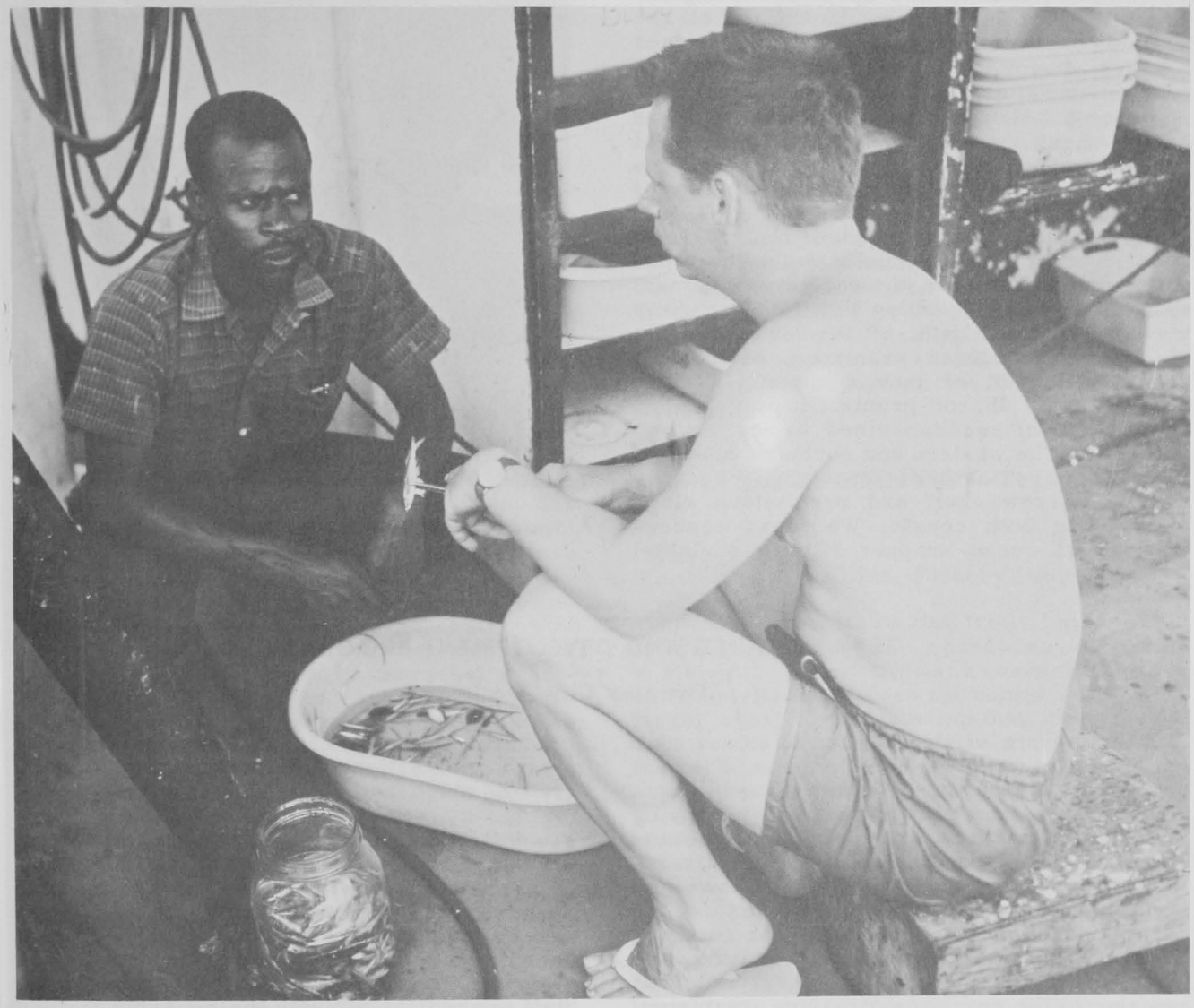

Figure 31.--Bureau biologist aboard the Oregon tells a United Nations fishery trainee from Jamaica how to identify flying fish.

gempylids (Lepidocybium and Ruvettus), and the common species of pelagic sharks.

Although constant watches were maintained, we saw only a few surface schools of tunas. Trolling demonstrated that these schools were composed of skipjack, blackfin, and small yellowfin. Other species regularly taken on trolling lines included dolphins, barracuda, and little tuna. Length, weight, sex, and stomach contents were recorded for each fish.

During the fall (Oregon Cruise No. 94) we made 24 trawling and 38 dredging stations in the general vicinity of Barbados, Tobago, Los Testigos and the western side of the Windward and Leeward Islands from Grenada to St. Christopher. Off the southwest edge of Tobago, catches of 5 to 45 lb. per hour were made of large (10 to 15 count tails) brown shrimp in a limited area at depths of 35 to 50 fath. Much time was spent searching for suitable trawling bottom in the royal red shrimp depth range throughout the Lesser Antilles. Deepwater shrimp trawl operations were successful only on the upper Continental Slope zone between Tobago and Isla de Margarita where we caught up to 40 lb. of royal red shrimp, 80 lb. of Penaeopsis megalops, and 10 lb. of lobsterettes (Nephrops binghami) per drag.

During the spring (Cruise No. 101) we trawled and dredged at 55 locations in waters contiguous to Jamaica, the southern Bahamas, and Puerto Rico. Trawling with a 40-ft. shrimp trawl in 20 to 25 fath. off the southern coast of Jamaica produced promising catches as great as 13 lb. of lane snapper (Lutjanus synagria), 30 lb. of grunts (Haemulon sp.), and 15 lb. of medium-sized brown shrimp per hour. The western and northern coasts of Jamaica were virtually untrawlable because a very narrow shelf and precipitous slope exist along both coasts. We found concentrations of queen snapper (Etelis oculatus) south of Great Inagua Island. Largest catch of this species with small trawls was 30 lb. per hour drag in depths from 250 to over 360 fath. We found rough bottom and steep slope near Mouchoir, Silver, and Navidad Banks. Trawling in depths of 12 to 15 fath. on the outer shelf off Mayaguez, Puerto Rico, made only small catches of fishes and sessile invertebrates.

Nocturnal dip net stations and 1-m. nekton-net stations were made at various localities to collect pelagic fishes for study by Bureau biologists.

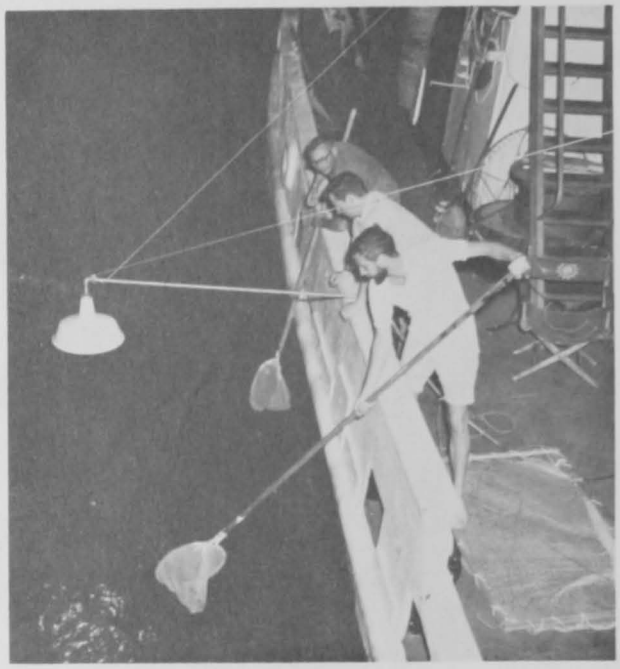

Figure 32.--Light attraction stations are an integral part of a program to assess the fauna of a given area.

GEAR RESEARCH AND DEVELOPMENT PROGRAM

(Panama City, Fla.)

The program of this station has been concerned with three research projects. The first project has been to determine how a commercial species of shrimp responds to varying electrical impulses under different oceanographic conditions. The second project, using information acquired from the behavior staff, is concerned with engineering aspects of the design, development, and testing of an electrical shrimp trawl. A third project is devoted to the development of camera systems that can record the reactions of marine organisms. This last project was transferred from the Base in Pascagoula to the Gear Research Station in Panama City in December 1964.

At the beginning of this fiscal year we received a watertight, self-contained pulse generator, which had been manufactured according to the specifications of our Gear Staff. Field trials with the generator rigged to a shrimp trawl indicated modifications would be necessary to improve the catch rate. We observed the electrical shrimp trawl under various oceanographic conditions to determine what changes were needed. In this study the Gear Staff and Photo Instrumentation Staff worked closely with the Behavior Staff.

We made vigorous efforts to obtain information on shrimp behavior patterns in various electrical fields so that we could determine

how shrimp escape from the net on different types of bottom. SCUBA divers used movie cameras to record some of the results. We also used movies to determine how shrimp react when the electrode array and footrope of the electric shrimp trawl pass over their burrows. To obtain this information we attached a television camera to the watertight housing of the movie camera and mounted it on the headrope of the electrical shrimp trawl. The image on the television camera was monitored aboard the vessel, and movie film was exposed at the discretion of the observer.

Through these two approaches we have exposed more than 3,000 ft. of movie film. Our preliminary analysis of early film sequences indicates that shrimp leave their burrows more rapidly when stimulated with increased voltage and that a correlation exists between voltage and escape patterns. These studies will be continued until we have enough information to enable us to produce a successful electrical shrimp trawl.

GEAR DEVELOPMENT PROJECT

In the commercial shrimp fishery of the Gulf of Mexico the pink and brown shrimps are normally active between sunset and sunrise and are then available to standard shrimping gear. During daylight these species burrow in the bottom and are difficult to catch. Laboratory and field studies have demonstrated that when shrimp are stimulated with electricity, they involuntarily leave their burrows even during daylight. Consequently, we made an intensive effort to develop an electrical shrimp trawl that could use this reaction to electricity. We experimented with varying voltages, pulse rates, pulse widths, and electrode array designs using different pulse generators until we determined the minimum shrimp response level.

During this fiscal year we acquired a compact battery-powered pulse generator that eliminates the electric wires from the vessel to the trawl. Last year we compiled specifications for this unit and submitted them to private industry for manufacturing. After we received the pulse generator, we encapsulated it in a 6-in. diameter polyvinyl-chloride tube. It is secured to the trawl door. The electric wires for this array are attached to a legline, then lead aft, and are secured in a transverse configuration in front of the footrope of the net (fig. 33).

In three areas in the Gulf of Mexico we tested a shrimp trawl equipped with the battery-powered pulse generator. Results indicated, in most instances, that the electric net caught slightly more shrimp than the non-electric net when both nets were fished simultaneously at night. The daytime catch rate, however, was insignificant and indicated that

Figure 33.--An electrical shrimp trawl equipped with mud rollers. Four transverse electrodes are visible ahead of the trawl footrope.

we had to spend considerable effort to improve the performance of the electrical shrimp trawl. To determine what modifications were necessary we had first to learn what electrical characteristics would consistently produce a significant response from shrimp under various oceanographic conditions. When we have obtained this information, the Gear Development Staff can modify the gear and check the performance of the trawl in the field. To accomplish this work the Gear Development Staff has been working closely with the Behavior Staff since about midyear. This phase is discussed in the report on the Shrimp Behavior Studies.

SHRIMP BEHAVIOR STUDIES

By

Edward F. Klima, Fishery Biologist

Results of initial fishing trials tend to indicate that electrical shrimp trawls are superior to standard shrimp trawls; however, the present electrified net does not consistently catch larger quantities of shrimp than the standard net. We are not able to devise a more efficient electrical net because we don't know enough about gear performance and shrimp behavior. To develop this gear into an efficient tool for harvesting shrimp, we must understand various aspects of natural and artificially stimulated behavior for each species.

As a portion of the overall gear research program, we intensified our investigations of the pink shrimp's burrowing behavior and response to electrical stimuli. We continued laboratory and field electrical stimulation studies to learn how shrimp behave in various electrical fields. The laboratory experiments were concerned primarily with determining

the minimum voltage to which shrimp are capable of responding--an escape reaction consists of contractions of the abdominal muscles. Voltages necessary to produce such a response are lower when shrimp are parallel to the electrical field and facing the positive electrode.

Average voltages necessary to elicit an escape reaction for animals oriented at various angles to the field were up to four times greater than response voltages for shrimp parallel to the field. Shrimp positioned at 45° to the field required only 1.4 times as much voltage as shrimp paralleled to the field, whereas those oriented at 75° to the field required about 3.8 times as much voltage.

It appears that relation between voltage necessary to produce a response when the animal is parallel to the field (0°) and at any angle can be expressed as:

$$\text{Response voltage at ith angle} = \frac{\text{Response voltage at } 0^\circ}{\text{cosine of ith angle}}$$

This relation is identical to the physical law of electricity which states that the voltage at any angle is equal to the voltage times the cosine of that angle. Consequently, we can assume that electrical stimulation occurs from the anterior portion to the posterior portion of the shrimp's nervous system.

We made laboratory experiments to determine how high shrimp jump when stimulated with low and high voltages (0.2 to 8.0 volts). Generally, when stimulated with high voltage the shrimp jumped to a greater height and about twice as far as when shocked with low voltage.

Our laboratory studies that indicated that the type and amount of electricity affect the behavior of shrimp have stimulated an intensive field study to learn how shrimp behave in various electrical fields. The aim is to determine rates of escapement and behavior patterns of shrimp burrowed in various types of bottom when they are exposed to different electrical voltages and pulse rates. SCUBA divers record these reactions on hand-held movie cameras as individual shrimp are stimulated (fig. 34 and 35).

We obtained preliminary information on the deburrowing rate and escape reaction of shrimp from the Dry Tortugas and St. Andrew Bay fishing areas. Although we have not completed a detailed analysis of the film sequences, shrimp appear to escape from their burrows faster when stimulated with high voltage than with low voltage.

We continued studying the normal behavior of adult pink shrimp. We completed our initial studies on the effects of certain environmental and physiological factors on burrowing activity. Light appears to be the most important single factor affecting the normal burrowing behavior of the shrimp, which usually remain burrowed during daylight and become active at night,

Figure 34.--SCUBA diver ready to record on movie film reactions of shrimp in an electrical field. Underwater housing with light that is simultaneously activated with electricity provides time base for calculating rate of jumping out of burrow (deburrowing) whereas grid zone provides data on escape patterns.

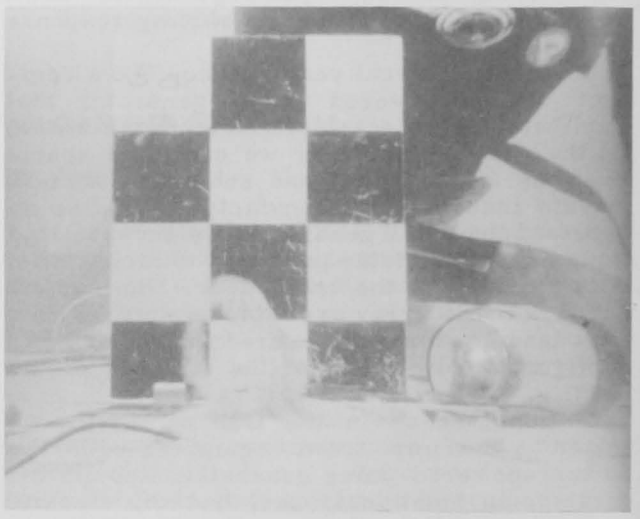

Figure 35.--Enlargements of 16-mm. film sequences depicting escape reaction of shrimp burrowed in sand bottom when exposed to 0.8 volts of pulsating d.c.

with moonlight appearing to inhibit somewhat their nocturnal activity (fig. 36). No significant correlation existed between salinity and burrowing behavior within the salinity range 18.7 to 35.8 p.p.t.

In the laboratory we investigated the effects of prolonged periods of continuous light and darkness on shrimp burrowing behavior. No inherent 24-hr. periodicity was observed under continuous darkness, for the shrimp remained active (at least deburrowed) for the most part. A slight but noticeable daily pattern of activity occurred, however, when the shrimp were held under continuous light (fig. 37).

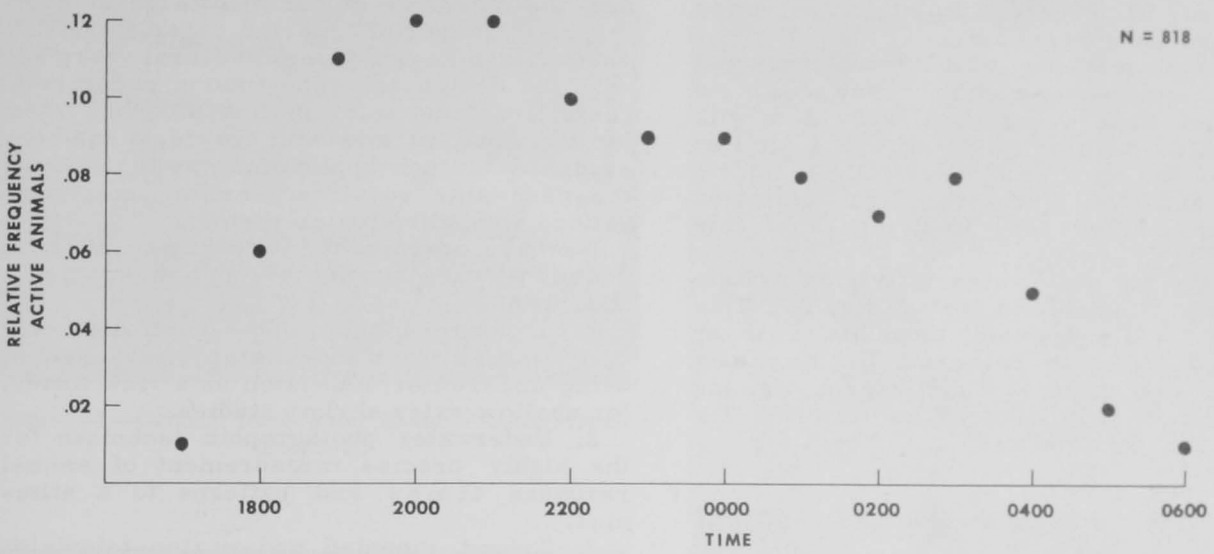

Figure 36.--Relative frequency of active shrimp emphasizing time of diel activity peaks. Data collected from observations taken over a period of 1 yr.

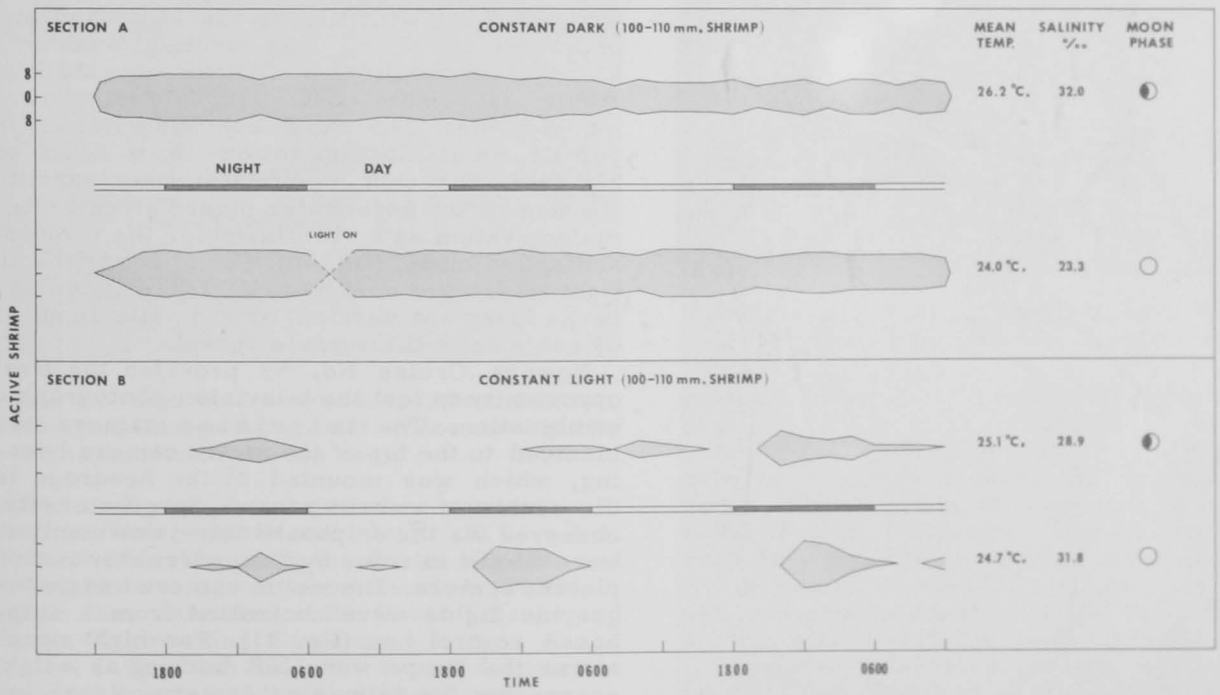

Figure 37.--Effect of prolonged periods of consistent darkness and constant light on pink shrimp activity.

Field studies were undertaken to determine the effects of bottom water current on the burrowing orientation of shrimp. Results show a direct correlation between current speed and the burrowing angle of the shrimp to the current axis. When current speeds exceeded 0.4 kn (knots), 94 percent of the shrimp burrowed positive to the current axis; below 0.4 kn. only 57 percent of the shrimp burrowed positive to the current axis.

Studies on methods of observing nocturnal shrimp movements were continued. An ultraviolet underwater light was used with luminescent tagged shrimp. The limited range of the apparatus, especially in turbid water, and the excessive light emission definitely limited the effectiveness of this method.

Recently an underwater television system was satisfactorily field tested (fig. 38). This equipment will undoubtedly be useful for many facets of behavior research. To eliminate abnormal reactions the television lighting requirements will have to be modified for viewing nocturnal behavior.

Figure 38.--Underwater TV system with tripod mounted camera and floodlight.

PHOTO-OPTICAL UNDERWATER INSTRUMENTATION STUDIES

By

Paul J. Kruse, Jr., Fishery Biologist

Photo instrumentation techniques are playing a major role in both the study of fishing gear and the extension of our knowledge of commercially important marine organisms. This endeavor in Region 2 began several years ago with the design and construction of a remote controlled underwater motion picture system for the study of midwater trawls. It has been expanded to such applications as the study of the deepwater royal red shrimp and observations on shallow water shrimp.

We have operated the following cooperative photo instrumentation systems and techniques this year:

1. Trawl mounted, remote-controlled motion picture and underwater light system, using underwater television as a view finder, for shallow water shrimp studies.
2. Underwater photographic technique for the highly precise measurement of animal response times and patterns to a stimulus.
3. Tripod mounted underwater television camera and remote operated light source complex for extended periods of sea floor surveillance.

Photo Instrumentation

The original Deep Water Motion Picture System (DMPS-1, (fig. 39) is still used and operating reliably. This system was constructed originally as a shallow water (50 fath. maximum) remote-controlled, midwater trawl mounted unit. The capability was extended to permit automatic operation to a depth of 220 fath. A recent modification now permits the use of an underwater closed circuit television system as a viewfinder for the remote-controlled model (fig. 40). Power for artificial light needs are met by self-contained battery packs (deep sea version) or 115 volts supplied by cable from the surface vessel.

Bowers Cruise No. 59 provided the first opportunity to test the television-photographic combination. The television camera was clamped to the top of the movie camera housing, which was mounted at the headrope in the center of a shrimp trawl. Specific events, observed via the shipboard television monitor, were filmed in color by the underwater motion picture camera. The movie camera and photographic lights were controlled from a shipboard control box (fig. 41). For night operations the lamps were left burning as a light source for the television camera. Recording directly on photographic film, instead of from a cathode ray tube, permits colored as well as higher resolution photographs.

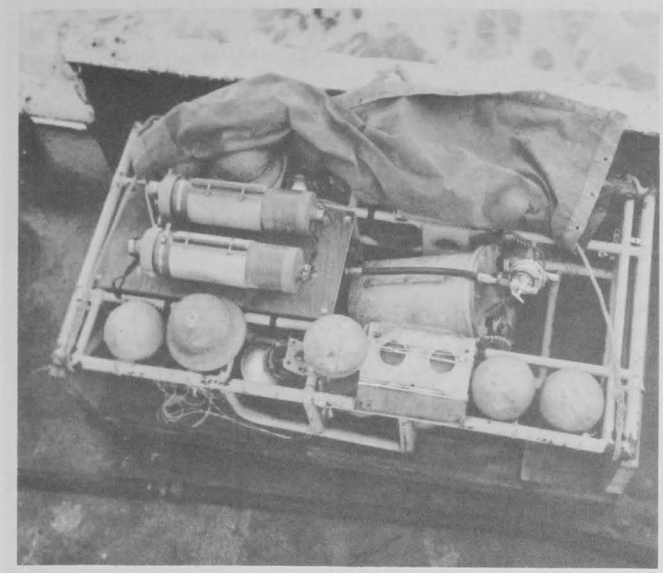

Figure 39.--Original Deep Water Motion Picture System (DMPS-1).

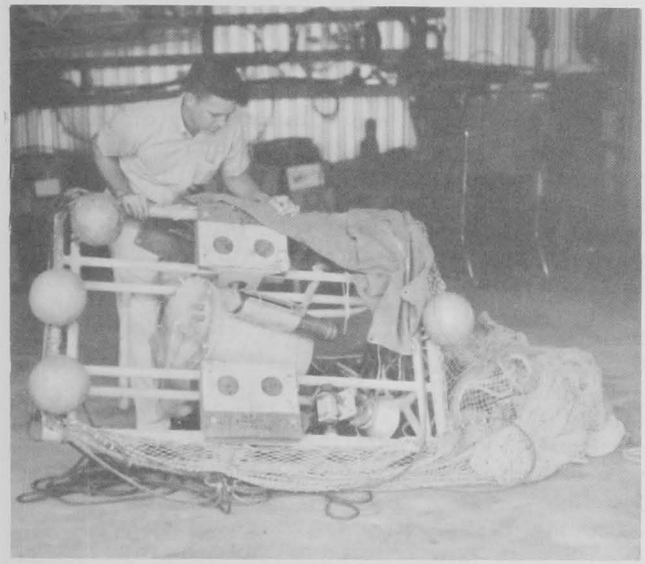

Figure 40.--Deep Water Motion Picture System (DMPS-1). Trawl mounted remote-controlled version showing television camera and lights (top view).

We designed a new camera system with a maximum operational depth of 2 miles. Private industry built the frame (fig. 42) and pressure housing for this new system, DMPS-2, which they exhibited at the Ocean Science and Ocean Engineering Conference held in Washington, D.C., June 1965. We expect delivery in the first quarter of the next fiscal year.

The DMPS-1, although it cannot be used deeper than 220 fath., has provided valuable data for the design of the DMPS-2, which is to

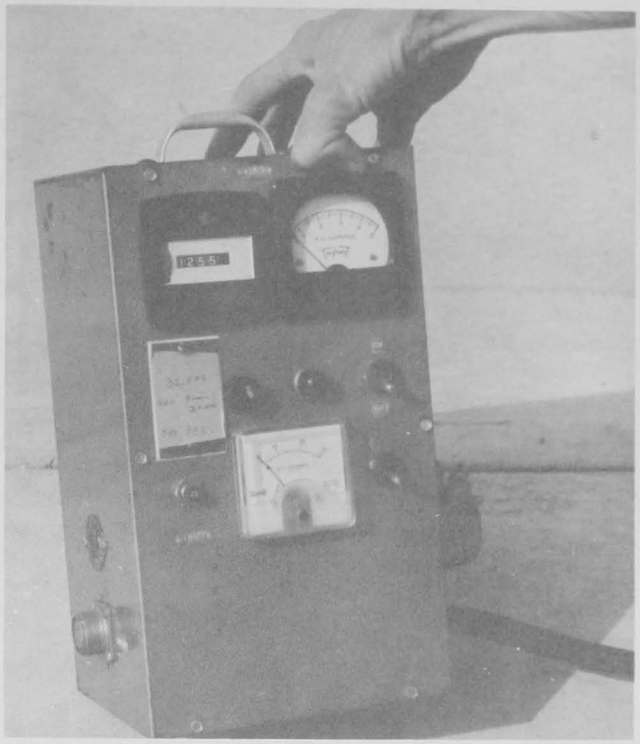

Figure 41.--Control box for remote-controlled version of Deep Water Motion Picture System (DMPS-1).

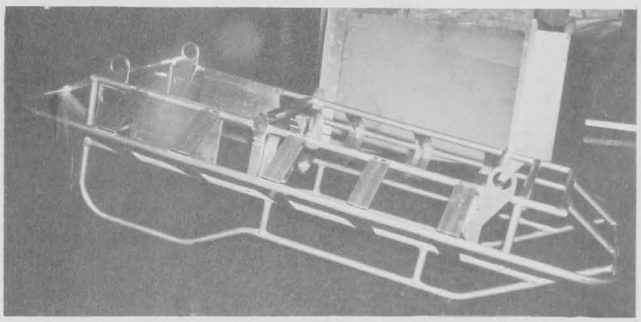

Figure 42.--Deep Water Motion Picture System (DMPS-2). Bare frame (Photograph courtesy of Alcoa).

be used to depths of 2 miles. The new system (fig. 43) will be first trawl mounted for deep-water royal red shrimp studies. We will be able to remotely control the operations by using a closed circuit television camera as a viewfinder. Its various components (pressure housing, lithium floats, and underwater lights) can be removed for use on other undersea systems. As with the DMPS-1, the new system will accept film loads up to 550 ft.

The CA-8 camera system (fig. 44) and sled is still the major method of obtaining deep-sea still photographs. Although several thousand pictures have been taken, maintenance problems will result in its eventual replacement by

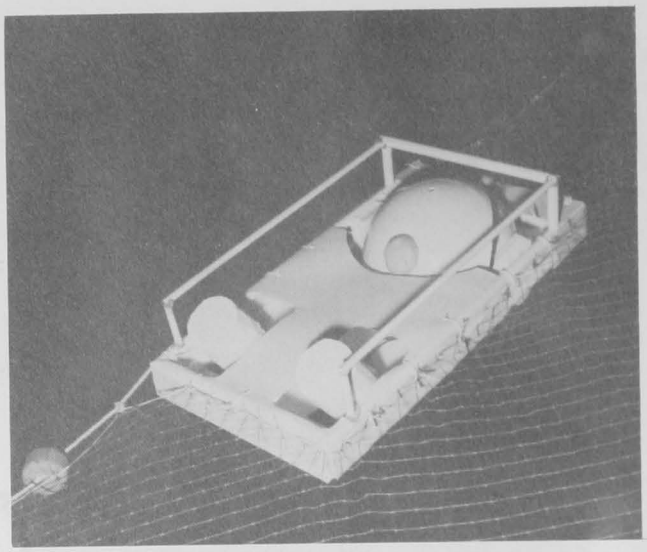

Figure 43.--Deep Water Motion Picture System (DMPS-2). Rough model showing pressure housing and light positions.

Figure 44.--CA-8 camera sled. Lithium float in housing on top.

a Gear Research Station designed unit. Sled flotation was supplied originally by several aluminum deep-sea fishing floats, but these have been replaced by one of the lithium floats from the DMPS-2.

The CA-8 sled was designed for work in the Gulf of Mexico and a maximum towing speed of 2.5 kn.; however, during the past year we have shifted our work to the royal red shrimp grounds in the Gulf Stream off Cape Kennedy, Fla. Strong currents in this area have occasionally caused the sled to become instable. When the design speed of the sled is exceeded, a kiting effect rolls it over and lifts it to a safe height above the sea floor. Although this maneuver prevents possible damage to the vehicle, it also prevents further bottom photography. We have planned shallow water tow tests to discover how we can modify the sled so that it will be stable at higher speeds.

The operation of underwater instrument systems from a vessel equipped with a single-speed fishing winch imposes serious strains on all components during heavy weather. The CA-8 frame has already been damaged during rough weather on board the Oregon. To reduce this type of damage, we have devised a shock absorbing system to be installed on the camera frame.

Behavior - Royal Red Shrimp

The growing file of motion picture and still pictures accumulated during several cruises of the Oregon has added much to our knowledge of the habits of royal red shrimp. Photographs have shown these animals walking on the sea floor but have not shown them burrowing. Our present photographic techniques may not be well enough developed to detect burrowing. By using closed circuit television, time lapse photography, and aquarium studies we expect to clarify this question.

The shrimp trawl mounted DMPS-1 has supplied data on escape reactions of shrimp to approaching fishing gear. The quantitative and qualitative information that we have obtained has increased our knowledge of how shrimp move in relation to trawling gear and how efficient that gear is. We have also a better knowledge of shrimp escapement speeds. Although the shrimp trawl equipped with the DMPS-1 is constructed without an overhang, we have not noted any shrimp escaping over the headrope. When shrimp are startled by contact with the footrope, their escape reactions are limited to 2 or 3 seconds, and during this time they tend to move mainly at an angle to the substrate. Vertical escape patterns have thus far been observed only rarely. The combination of short swimming duration and low escape angle usually prevents royal red shrimp from passing over the headrope of a standard 40-ft. flat trawl. A royal red shrimp has been observed swimming as fast as 2.5 kn. for the short time it was trying to escape. Comparative drags with both a standard trawl and the camera trawl have resulted in identical catch rates.

The effects of light and current speeds upon the habits of royal red shrimp are still largely unknown, and suitable instrumentation systems to measure these factors on the shrimp grounds (220 fath.) are not available for our specific needs. We are designing the necessary equipment. A Carruthers deep-sea current bottle has been purchased, and a free diving vehicle is being designed to permit its launch and recovery without the necessity of anchoring the surface vessel at that depth.

Aerial Observation Platform

The basic concept of the Aerial Observation Platform (A.O.P.) calls for an unmanned, captive, aerial reconnaissance vehicle for fish spotting. The A.O.P., with a 1,000-ft maximum altitude, will be visible for several miles during good atmospheric conditions. A significant increase in area coverage will be realized even when meterological conditions reduce visibility at the horizon. Also, the additional height will enable us to observe subsurface school fish. Continuing studies indicate that such a system could service fishing industries seeking either individual fish (swordfish, whale, and basking shark) or school fish (tuna, menhaden, and herring).

We are evaluating several possible designs for such a platform. Our present plans call for an airborne television camera and transmitter that would send a picture to a monitoring screen in the wheelhouse of the fishing vessel. This feature will be valuable during the search for fish schools and during the setting of a purse seine. Through this medium the captain of a purse seiner could actually maintain visual contact with the school during a set and watch its subsurface movement in relation to the net and purse boats. This procedure could be further sophisticated by the use of portable television receivers in the purse boats. If desired, several vessels could receive the signals from one A.O.P.

Our research into possible vehicle designs now indicates four general categories that may offer a practical end product. These designs use lift generated by (1) airstream, (2) gas, (3) airstream and gas, and (4) self-propelled rotors. We plan further engineering studies and field tests to determine which of these will be most practical for the commercial fishing industry. Present plans call for a system capable of using existing shipboard winches and operating from a limited stern area with minimum handling requirements. Further, the system will have to withstand occasional water landings and be quickly disassembled for storage in limited space. The major emphasis is being placed on a system that will fit into standard fishing operations, pay its way, and require a minimum of special attention.

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