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Report of the National Marine Fisheries Service Southeast Fisheries Center, Pascagoula Laboratory, Fiscal Years 1970 and 1971

EDWARD F. KLIMA and RICHARD B. ROE

SEATTLE, WA.
June 1972

U.S. DEPARTMENT OF COMMERCE
Peter G. Peterson, Secretary
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
Robert M. White, Administrator
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Philip M. Roedel, Director

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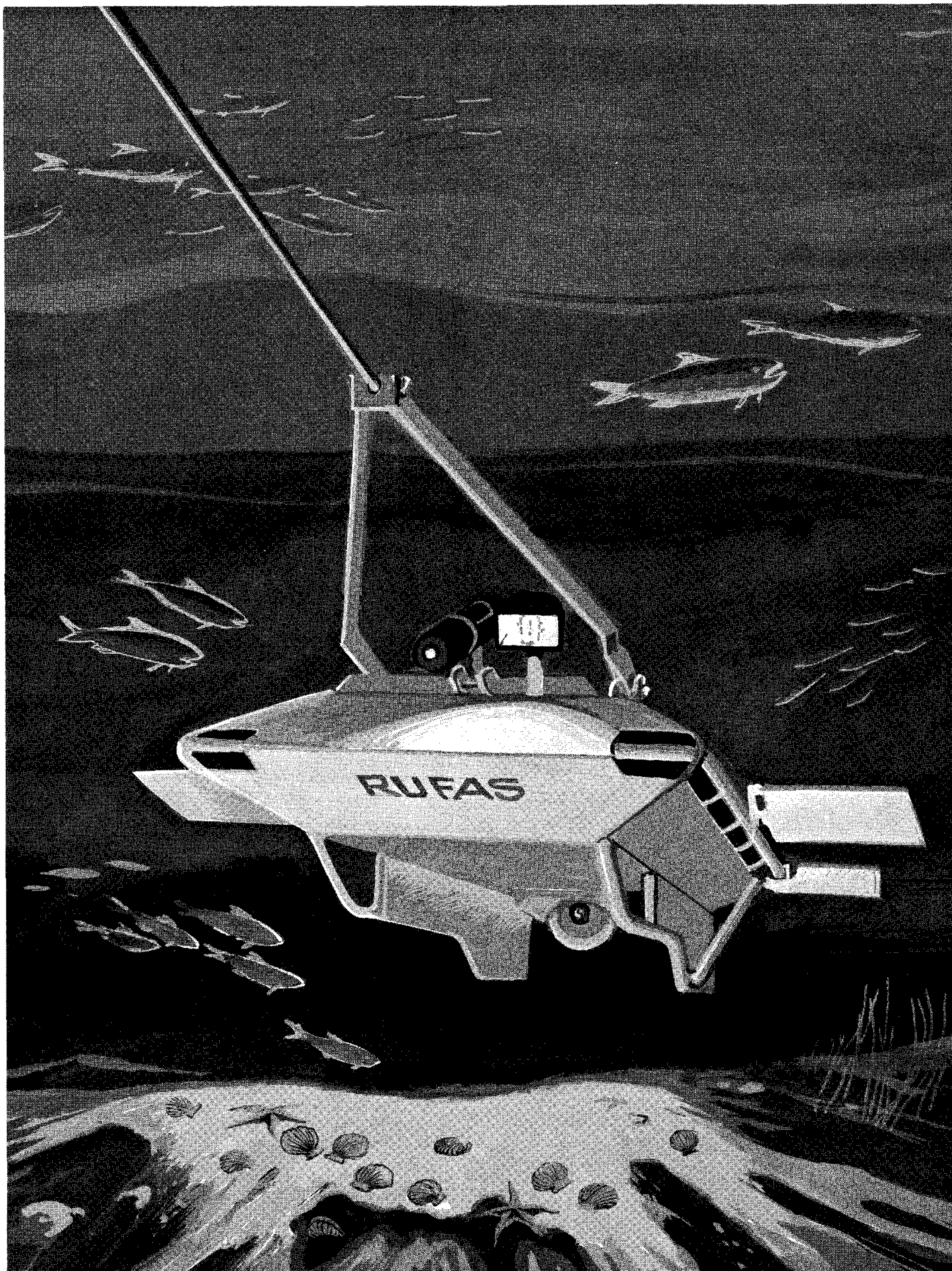

Artist's conception of Remote Controlled Underwater Fishery Assessment System (RUFAS).

Contents

Abstract

The National Marine Fisheries Service Southeast Fisheries Center, Pascagoula Laboratory (formerly the NMFS Exploratory Fishing and Gear Research Base) conducted research in a wide range of activities during Fiscal Years 1970 and 1971. Investigations into the application of remote sensors for resource detection were advanced using aerial photography, pulsed lasers, spectrophotometry, and low-light-level imagery. This program received national status in September 1970 with the establishment of a National Marine Fisheries Service Remote Sensing Program (now the Southeast Fisheries Center, Mississippi Test Facility Engineering Laboratory) at the Mississippi Test Facility, Bay St. Louis, Mississippi.

Assessment surveys were conducted along the outer Continental Shelf and upper Continental Slopes of the Gulf of Mexico and Caribbean Sea where deepsea prawns, crabs, and silver hake were often taken in quantity. Benthic shelf explorations were greatly facilitated by the development of a remote controlled underwater fisheries assessment vehicle (RUFAS) used successfully in assessing, monitoring, and predicting the calico scallop resource off the eastern seaboard.

A budding fishery for swordfish in the Gulf of Mexico suffered an untimely death with the discovery of high mercury concentrations in swordfish.

Hydroacoustical assessment of pelagic marine resources was bolstered with the acquisition of a signal processing computer-echosounder unit (SAS) which prints out real-time information on the location and relative size of underwater targets. The system is currently undergoing extensive field testing.

New approaches were taken to sampling and harvesting coastal pelagic fishes. Underwater lights and light arrays were successfully used to attract and lead schooling fish. Artificial structures of various design and complexity were found highly successful in attracting large quantities of pelagic fishes. These applied behavior studies will provide a prime component in a new concept in harvesting coastal pelagic fishes, an automated harvesting platform.

Electrical harvesting gear is being developed at Pascagoula to increase the efficiency of available gear and to provide the technology for sampling resources presently impossible to harvest. An electrical shrimp trawl has proven highly successful and an electrical midwater trawl is under construction. A 120 kva pulse generator is currently under construction for application in the automated fishing platform, electrical fish trawls, and electrical rough-bottom shrimp trawls.

REPORT OF THE NATIONAL MARINE FISHERIES SERVICE SOUTHEAST FISHERIES CENTER, PASCAGOULA LABORATORY, FISCAL YEARS 1970 AND 1971[1]

by

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Introduction

Conventional resource assessment methodology using trawls, dredges, and traps is severely limited in application. Often the collected data are generally too sparse or disjointed to furnish accurate estimates of living resources and frequently considerable time elapses between conclusion of the survey and dissemination of reports. Although these techniques are adequate for some groundfish resources, they are totally inadequate for assessment of pelagic marine resources. Therefore indirect assessment and sampling techniques such as aerospace remote sensors, hydroacoustics, remote unmanned undersea vehicles, and submersibles which supplement or replace conventional methods are now being developed to provide real-time acquisition systems for the great majority of our marine resources.

Eventually continuous biological and environmental data will be concurrently processed in real-time to provide an accurate forecasting capability for fishery resources. This does not, however, signal the end of conventional sampling. Conventional sampling is a vital link in understanding the interaction between the animal and its environment, to provide groundtruth for remote sensors, and to evaluate those resources not suitable for detection by the new technology.

The accumulation of information on marine resources by remote and conventional sampling is a basic function of this Base. Data are rapidly disseminated by our computer to scientists and industry for optimum resource utilization. They are also used to detect harvesting problems such as the need for an efficient method of exploiting the coastal pelagic resources in the Gulf of Mexico and Atlantic.

Historically, locating and assessing bottom resources such as shrimp, lobster, and scallops are time consuming and costly, particularly where general distribution patterns are unknown. Base personnel, therefore, have conceived and developed, with the assistance of the General Electric Corporation (GE), an unmanned underwater observation vehicle for resource assessment. The vehicle, known as RUFAS (Remote Underwater Fisheries Assessment System), was first used with outstanding success on the Cape Kennedy calico scallop grounds in the summer of 1969. Surveys have continued during the springs of 1970 and 1971. These surveys have provided information on the standing stock, delineated the high scallop density areas, and greatly enhanced the harvest and management of the resource.

The problem of locating and assessing midwater species is quite another matter. Not only must a large volume of ocean be sampled, but the midwater trawl, the most commonly used sampling gear, is ineffective for a large number of species. The Pascagoula Laboratory (which, during the

1/ Contribution No. 233, National Marine Fisheries Service Southeast Fisheries Center, Pascagoula Laboratory, Pascagoula, MS 39567.

reporting period, was known as the Exploratory Fishing and Gear Research Base, Pascagoula) is developing a sophisticated electronic fish-finding device called SAS (Stock Assessment System) to expand midwater fishery resource assessment.

Cognizant of the application of remote aerospace sensors to the field of marine resource management, the Pascagoula Base initiated studies on a variety of sensors such as image intensifiers, lasers, and spectrophotometers. In Fiscal Year 1971 the National Marine Fisheries Service (NMFS) established a Remote Sensing Program at the Mississippi Test Facility (MTF) specifically charged with the responsibility of investigating the application of remote sensors in resource utilization. (This organization is now known as the NMFS Southeast Fisheries Center, Mississippi Test Facility Engineering Laboratory.)

Longlining explorations delineated a large, untapped resource of swordfish in the Gulf of Mexico. As a result of *Oregon II* surveys, five commercial boats began longlining for swordfish in the northern Gulf in the spring of 1970. Over 240,000 pounds of swordfish were landed valued at \$200,000. Unfortunately, concentrations of mercury in swordfish were determined to exceed the FDA minimum allowable level, resulting in a complete collapse of the fishery in 1971.

Deepwater trawling has uncovered a potentially commercial resource of scarlet prawns *(Plesiopenaeus edwardsianus)* off the northeastern coast of South America. Deepsea red crabs *(Geryon quinquedens)* have been taken in potentially commercial quantities in several areas of the Gulf of Mexico. During Fiscal Year 1971 a large stock of silver hake *(Merluccius albidus)* was delineated in the northeastern Gulf in 300 to 400 fathoms.

General exploratory surveys have indicated that harvesting of the latent stocks of coastal pelagics in the Gulf of Mexico and Atlantic is not feasible with nets. Our staff is now in the initial stages of developing a netless fishing system using submerged structures and lights to attract fish and electricity and a pump to extract them. This new system, when fully developed, will allow profitable exploitation of the coastal pelagic fishes.

Personnel from the Resource Assessment Program were temporarily assigned to several diverse field projects outside the Laboratory during Fiscal Years 1970-71 (July 1, 1969 to June 30, 1971). A biologist spent two months on the purse seiner *Queen Mary* searching the Caribbean, southern Bahamas, and eastern Gulf of Mexico for commercial quantities of surface tuna. While numerous sightings and troll catches were made, no areas were discovered that could support the American tuna purse seine fleet. A paper on the results of this trip was prepared.

In April 1970 we provided an observer for a two-week jackpole tuna trip aboard the FAO MV *Fregata* out of Bridgetown, Barbados. This trip met with limited success off Grenada where most of the 4,500-pound catch consisted of skipjack, blackfin, and yellowfin tuna.

We again provided a biologist in 1971 to serve as Cruise Leader aboard the FAO MV *Calamar* during Cruise 71-2 February 9-26. During the cruise the *Calamar* fished the mid-shelf and shelf dropoff zone from Tobago to Guyana with Australian D-pots and West Indian Z fish pots and caught 2,300 pounds of commercial size fishes. On the outer shelf in 50 to 80 fathoms, snapper and grouper were the dominant species taken and in the mid-shelf area in 15 to 40 fathoms, Caribbean red snapper and grunts predominated in the catches.

We furnished support for the Washington Office of the MARMAP Program by supplying a biologist who participated in the RV *Albatross IV* Cruise 71-1-II. The cruise was a combination bottomfish and ichthyoplankton survey from Nantucket Shoals to Cape Hatteras. With the establishment of the MARMAP Groundfish Program, bottom trawling gear was standardized and design and construction of deepwater crab and fish pots were begun in 1971.

Personnel from the Development of Fishing Strategy Program assisted the Barbados FAO Project in May 1971 through provision of expertise in passive attraction gear.

Application of Remote Sensors to Fishery Assessment

Large areas of the southwestern North Atlantic and Gulf of Mexico support many species of pelagic fish which cannot be reliably assessed with current techniques because of the nature of both the environment and the resource. In the future, conventional technology is anticipated to give way to detecting systems using satellite remote sensors to locate and identify significant features of the marine environment which, when combined with observations from aircraft and surface vessels, will permit assessment of the resources and forecast of the location and abundance of fish stocks.

There are several characteristics of schooling fishes that seem to lend themselves to remote sensing. Among these are color and movement of the school and certain associated phenomena such as bioluminescence and surface oil slicks. Projects have been undertaken by the Pascagoula Base to evaluate the usefulness of these factors in using remote sensors to detect, quantify, and qualify schooling fishes. Many of these projects have been continued by the MTF program.

COLOR

The subtle color differences associated with fish schools have been used by spotter pilots of the commercial fishing industry to locate and identify stocks of certain species. This phenomenon provided the basis for a series of studies by this Base and the TRW Corporation off Panama City, Florida, to evaluate the potential applicability of spectrophotometry in distinguishing fish species. These studies were not conclusive and further modifications of the spectrophotometer were undertaken by TRW. Current developments in this direction are reported on by the MTF program.

OIL SLICKS

The feasibility of detection and identification of fish schools from surface oil films was investigated by Baird-Atomic, Inc., Bedford, Mass., under contract with the U.S. Naval Oceanographic Office Spacecraft Oceanography Project. Body oils from six Gulf of Mexico species were supplied for analyses through the assistance of the Pascagoula Fishery Products Technology Laboratory. Two samples, the first taken during the fall of 1969 and the second during the spring of 1970, were supplied. The samples contained four variants of each oil designated as follows: pure body oil, pure body oil plus BHA (butylated hydroxyanisole), pure body oil treated with seawater, and pure body oil treated with seawater plus BHA.

Natural oil slicks proved difficult to sample and no correlations were derived between body oil and marine oil film composition.

BIOLUMINESCENCE

In situ bioluminescence results from the mechanical stimulation of certain planktonic organisms, mainly dinoflagellates, causing them to emit flashes of light. Schooling fishes can cause bioluminescence and often enough light is emitted to illuminate the bodies of individual fish. Fishermen for centuries have used this phenomenon to catch fish at night. More recently commercial spotter pilots off the west coast of the U.S. detect fish schools from aircraft at night. Spotters have observed fish with the naked eye at depths of more than 10 fathoms.

Observations made off Louisiana, Mississippi, and Florida in the Gulf and from New Jersey to Georgia on the east coast, showed bioluminescence occurred throughout that area. Luminescing organisms apparently occur deeper with increasing distance from shore as tests showed subsurface agitation in deep water induced brilliant flashes visible to a depth of 8 to 10 meters, while in shallow water moderately intense flashes were observed down to two meters but not three.

During Fiscal Year 1970 a prototype low-light-level television system was tested from a NASA aircraft and the crow's nest of the RV *George M. Bowers* to evaluate the application of bioluminescence detectors in fishery research. The objective was to obtain visual observation, photographs, and low-light-level imagery of fish schools along a given flight track. Unfortunately insufficient data were obtained due to inclement weather and instrument problems; however, the study did demonstrate that a low-light-level television system could aid in the detection of schools at night and could also be effectively utilized in night fishing operations.

PLADS

During the year program personnel assisted the Naval Oceanographic Office in tests conducted with a pulsed-light airborne depth-sounding system (PLADS) developed by the Raytheon Company. The laser system was developed as a depth sounding and submerged target detection device for use in conjunction with amphibious and oceanographic operations.

Its objectives are: determination of altitude within an accuracy of $\pm$ 1 foot from 200 to 1,000 feet; depth determination within an accuracy of $\pm$ 1.5 feet under water clarity conditions $\alpha = 0.1$ to 1.0 per meter and bottom reflectivity from non-reflective (0) to 30 percent. Depth penetration of 3 attenuation lengths minimum was required.

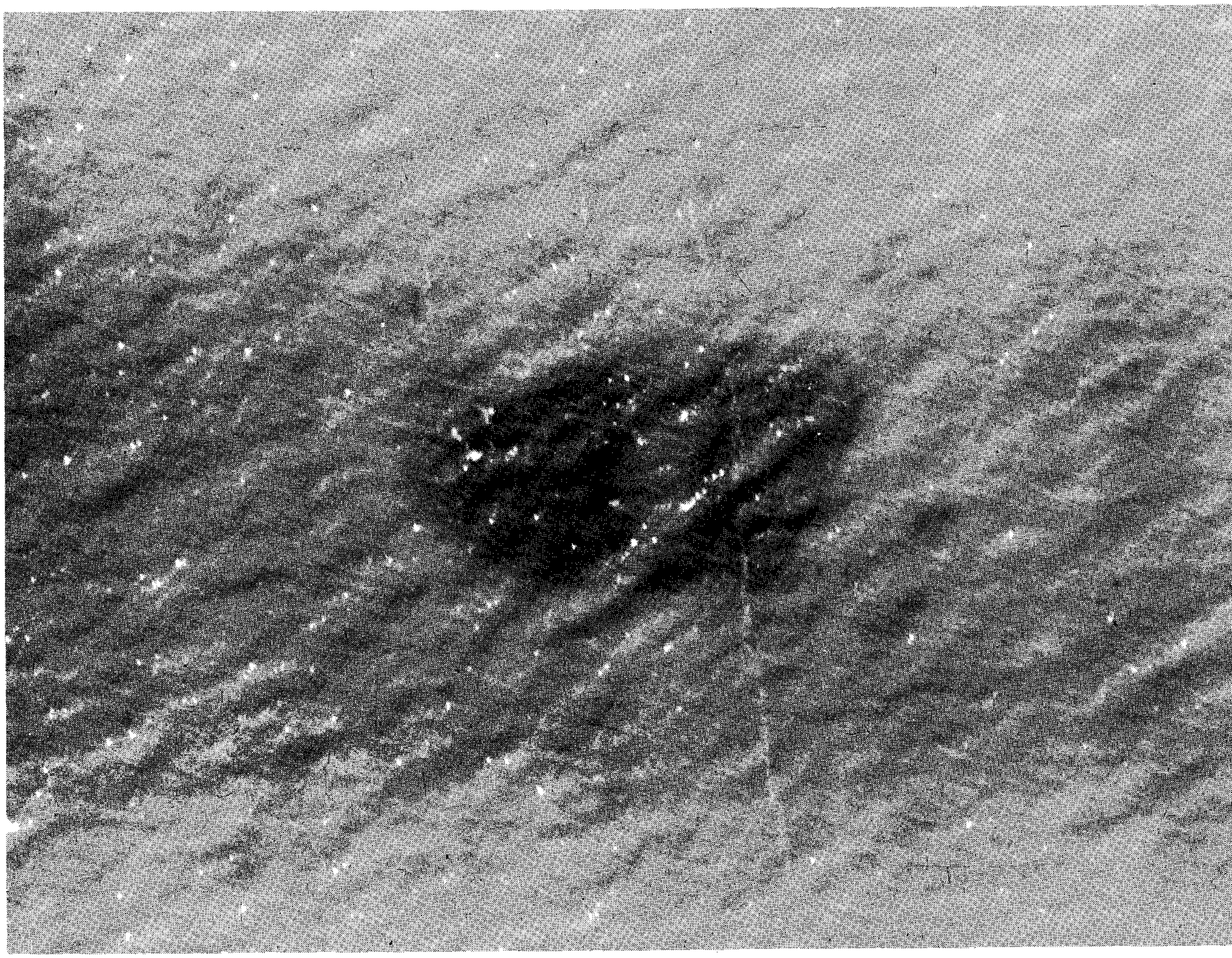

Figure 1. Fish school photographed at 1,500 feet using Ektachrome film.

The system was designed to operate under a wide range of altitude, surface wind, and sea conditions.

Tests were conducted on the stationary platform (U.S. Navy Ship Research and Development Laboratory, Stage 2 platform) off Panama City, Fla. in June 1970 to determine depth penetrability of the system and explore its possibilities as a fish school detector.

Tests showed that detection of the bottom to at least 60 feet was possible and that fish schools could be detected and indications of school depth and density provided. However, difficulties with the system prevented further testing.

AERIAL PHOTOGRAPHY

Aerial photographs taken during remote sensing studies indicated aerial photography may play a major role in detecting pelagic surface fish schools (Fig. 1). As a result of these flights many of the parameters for obtaining optimum photography of fish schools were determined. Exposures four to six times greater than in terrestrial photography were found necessary for maximum water penetration and school detection. Sun angles greater than 50° (using 6-inch focal length camera and 9-inch by 9-inch format) were found detrimental.

These studies also determined the spatial resolution/altitude requirements for aerial photography and other remote sensors used to detect fish schools in the northeastern Gulf of Mexico. At 7,000 feet schools as small as 20 feet in diameter were easily distinguished.

Attempts were made to correlate film characteristics with quantity and species of fishes, including a densitometric analysis by McDonnell-Douglas Corporation. These proved inconclusive. New techniques such as multispectral photography will be required for species identification.

An aerial survey of the northern Gulf of Mexico was conducted between Chandeleur and Horn Islands off Mississippi in June 1971 to evaluate the reliability of using aerial photographs to estimate the standing crop of schooling fishes within a selected area. Eight aerial transects were flown twice daily to provide the statistical reliability of standing crop estimates made from aerial surveys. Presently the film taken during the survey is under analysis and findings will be published when available.

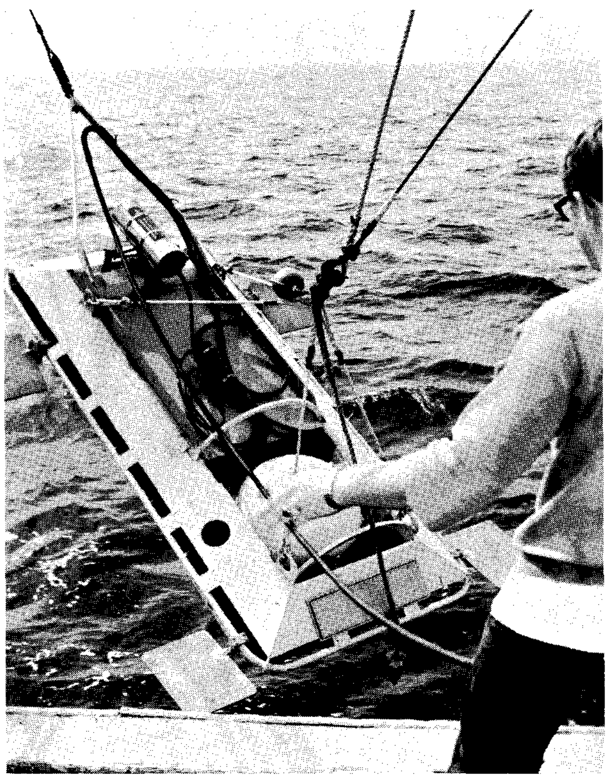

Figure 2. Remote Underwater Fishery Assessment System (RUFAS).

RUFAS

A significant advancement in remote sensing was accomplished with the development of a remote controlled underwater assessment system (RUFAS) for the assessment of calico scallops (Fig. 2). Construction of the underwater vehicle was completed in June 1969 and it was used for the first time in July 1969. This unmanned vehicle can visually assess living marine animals undisturbed in their natural habitat, in contrast with traditional trawling or dredging methods in which the nature of the resource must be interpreted from the catch. Additionally, vast areas of ocean bottom can be examined in a short time.

The towed vehicle is vane-controlled, similar to an airplane. Roll, pitch, vane angle, and height above bottom are monitored on a control console to allow the operator aboard the towing vessel to "fly" the sled at any desired altitude above the seabed (usually limited to a minimum height of 5 feet). A 35-mm data camera and an underwater TV camera with video tape recorder is used to produce rapid and accurate estimates of calico scallop concentrations. A 400-watt dysprosium iodide and a 400-watt high-pressure sodium arc light provide illumination. Results of the RUFAS surveys are discussed in the next section.

Resource Assessment

SHELF EXPLORATIONS

Calico Scallops

Field activities were concerned with the development and use of new and improved methods of calico scallop detection and stock assessment. The program is conducted in close cooperation with industry interests requiring nearly full-time counseling and extension-type services. Three different submersibles and three surface vessels were used. Cooperative effort was maintained to assist the new calico scallop biology program of the Tropical Atlantic Biological Laboratory (now the Southeast Fisheries Center, Miami Laboratory). Of four factory-type automated scallop processing vessels, two entered into bankruptcy proceedings and two continued operation on an expanded basis. Three new shore-based scallop processing facilities were constructed and there was a resurgence of the fishery in North Carolina.

One 10-day survey cruise in September 1970, with the chartered submarine "Perry Cubmarine" and her support vessel RV *Undersea Hunter* was conducted to gather scallop population data and to provide *in situ* observations for fishing captains. Thirteen dives totaling seventeen hours fourteen minutes of bottom time were made. Scallops were photographed in six areas between Ponce De Leon Inlet and Bethel Shoal (Fig. 3).

Laboratory observers participated in a cruise aboard the Grumman submersible *Ben Franklin*

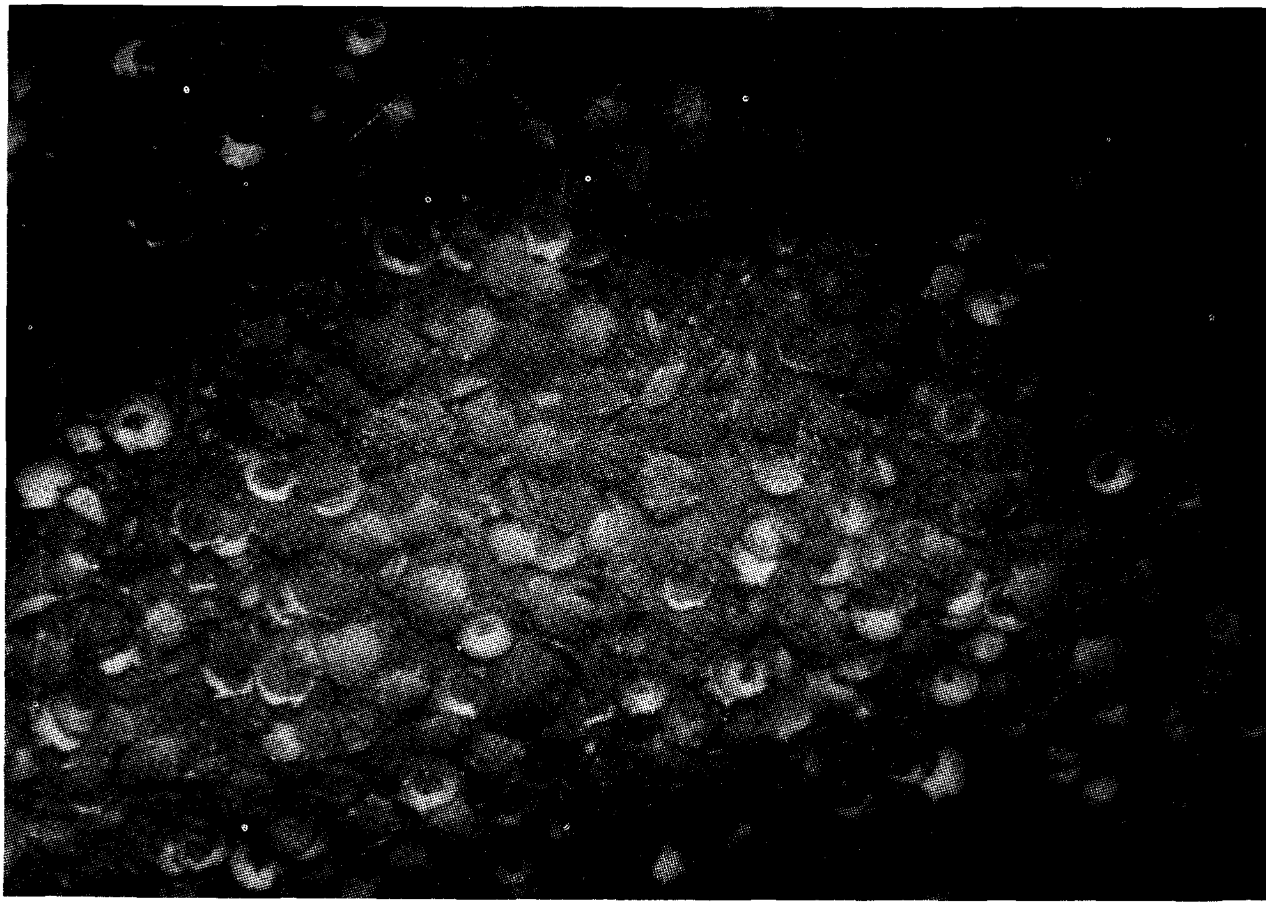

Figure 3. Scallop shells photographed from Perry Cubmarine.

and support vessel MV *Pioneer* to determine the feasibility of their use in calico scallop research and fishery. Rough seas and poor visibility on the ocean floor limited observations to one 24-hour period. Some of the observations were recorded on video tape. Capabilities of the vessel were impressive; however, good visibility is an absolute necessity due to the off-bottom height of the observation ports.

Our major breakthrough in calico scallop assessment has been accomplished with the remote controlled underwater vehicle, RUFAS. The RUFAS was first used in conjunction with the *George M. Bowers* in 1969. That late summer survey completed seven transects and produced 4,000 feet of exposed 16-mm color film. Scallop density distributions and predicted catch rates were compiled into a fishing log for distribution to fishing captains for the fall fishery.

Later that summer RUFAS was extensively damaged by Hurricane Camille and repairs and modifications to the system were necessary prior to the spring survey. Taking advantage of this situation, we increased the camera format to 35 mm, added dysprosium-iodide lights, and improved the closed-circuit television monitoring system. Control vanes with a greater surface area were added to provide far more effective maneuverability at slower towing speeds.

In the spring and summers of 1970 and 1971 RUFAS was used to conduct seabed surveys for calico scallops along the southeast coast and in the Gulf of Mexico. Eight surveys were completed, a total of 26,450 feet of film exposed, and a linear distance of some 821 miles of seabed observed. From these surveys two summary logs of fishing areas with predicted catch rates were prepared and released to the industry. Analytical techniques and computer programs are being developed and used for detailed evaluation from the survey photographs.

In late 1970 RUFAS was taken to the NASA Mississippi Test Facility to have accurate engineering drawings made of the system. These drawings, together with written descriptions of the components and subsystems, were compiled into a specification manual. The document was prepared in sufficient detail to allow duplication of RUFAS. An operations manual, including setup and installation, check, and flight-handling procedures, was also written.

A benthic survey of the Georgia/South Carolina coasts was carried out with RUFAS during the spring of 1971. Early in the cruise the vehicle collided with an uncharted 6-fathom reef and was slightly damaged. Unfortunately this caused an early cruise termination. However, RUFAS was to have been used in the summer of 1971 to survey the northeastern Gulf of Mexico shelf from 10 to 50 fathoms.

SLOPE INVESTIGATIONS

Past investigations on the Continental Slopes of the Gulf of Mexico, southwestern North Atlantic, and Caribbean Sea have delineated a few latent resources that appeared available to bottom trawling. One, the royal-red shrimp *(Hymenopenaeus robustus)*, is exploited on a limited basis. Others such as the scarlet prawn and silver hake were known only from fragmented explorations. Therefore a strong emphasis was placed on a systematical investigation of the slope using large bottom trawls (130- to 204-foot headrope length).

Most significant in Gulf resource assessment trawling was the discovery of large concentrations of silver hake in 200-500 fathoms in the De Soto Canyon (Fig. 4). Commercial feasibility cruises assessed the magnitude of this hake stock in August 1970 and 1971. Continued assessment of the slope in 200-1,000 fathoms from the De Soto Canyon to west of the Campeche Bank produced several new records of fishes from Campeche Slope on the Gulf and indicated reduction in fish concentrations below 500 fathoms. While concentrations of scarlet prawns found in August 1970 were not in commercial quantities, a mixing of finfish and crustacean faunas, similar to that in the northeastern Caribbean, was noted on the Campeche Slope during *Oregon II* Cruises 18 and 19 (Fig. 5).

Exploratory trawling on the Caribbean Slope was unproductive during *Oregon II* Cruise 22 in October-November 1970. However, one unusually high concentration of slope crustaceans was found to be associated with a natural asphalt deposit north of Aruba in 250-350 fathoms.

Production fishing with large nets (130- to 204-foot headrope length) during *Oregon II* Cruise 13 yielded two tons of scarlet prawns in November. During this cruise, trawling on the upper Continental Slope of the northeast Caribbean and Anegada Passage produced no commercial catches but revealed an unusual mixture of lower-shelf and upper-slope faunas. Finfish catches were light and scarlet

Figure 4. Catch of silver hake, *Merluccius* sp., taken by RV *Oregon II* in De Soto Canyon.

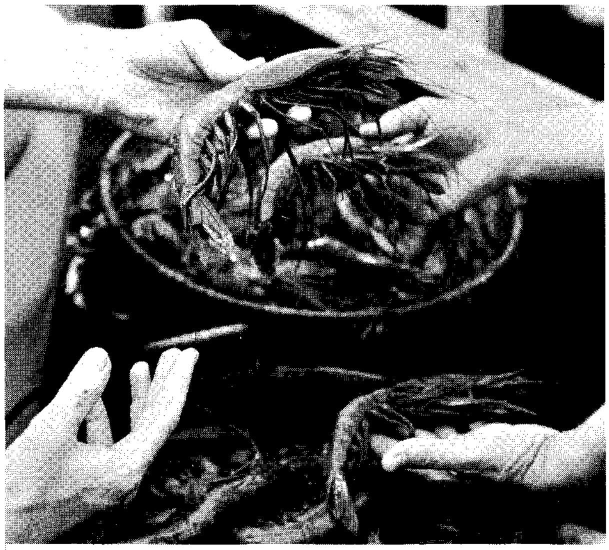

Figure 5. The scarlet prawn, *Plesiopenaeus edwardsianus*.

Figure 6. The deep sea red crab, *Geryon quinquedens*.

prawns were mixed with gamba prawns (*Aristaeomorpha foliacea*), megalops shrimp (*Penaeopsis megalops*), royal-red shrimp, and several species of deepwater lobsterettes (*Nephropsis*), and deepwater pink lobster (*Neophoberus caecus*).

Our slope explorations with bottom trawls have been extremely interesting and in some cases such as hake most productive. An important product of these investigations has been the discovery of shellfish resources other than shrimps and prawns which seemingly lend themselves to trapping. These are led by the deepsea red crab (Fig. 6). In Fiscal Year 1972 we shall engage in a deepwater trap study to determine the feasibility of using this type of gear on the Continental Slope of our area. If successful, we hope the study will also provide estimates of abundance and availability of those species not readily trawled.

HIGH-SEAS PELAGICS

The most important accomplishment and yet bitterest disappointment was the development and subsequent demise of a successful swordfish (*Xiphias gladius*) fishery in the northern Gulf during the winter and spring of 1970. Trawl, longline, and larval catches strongly suggested the area off the Mississippi Delta as a likely spot for swordfish concentrations. Catch rates up to 3.8 per 100 hooks were made off the Delta and fish were caught off Brownsville, Texas in De Soto Canyon and off Campeche Bank. Six months of commercial fishing indicated yearly production in the Gulf could reach three million pounds.

The Maine swordfish longliner *Gulf Stream* and the Biloxi, Miss. converted shrimper *Alvera C.* opened the fishery in January 1970 and between February and July they, plus three other vessels, had completed 20 trips and landed 2,479 swordfish weighing over 240,000 pounds valued at $200,000. The *Gulf Stream* alone grossed $45,000 on its fourth trip, a record single-trip swordfish catch for the U.S. (Fig. 7).

The average size of the fish increased from 75 pounds in February to 140 pounds in late May. By July, it had decreased to 96 pounds. The price also dropped from $1.00 per pound in mid-June to $0.55 in July. Price decreases were attributed to New England landings by the subsidized Canadian halibut fleet which converts to swordfish longlining during summer. In winter, the Canadian fleet reverts to halibut fishing due to the unavailability of North Atlantic swordfish. However, winter is the peak season of availability in the Gulf and, therefore, prices are highest. This situation creates a year-round American swordfishery.

The success of the *Gulf Stream* and *Alvera C.* resulted in many inquiries from snapper and shrimp fishermen about conversion to swordfish longlining,

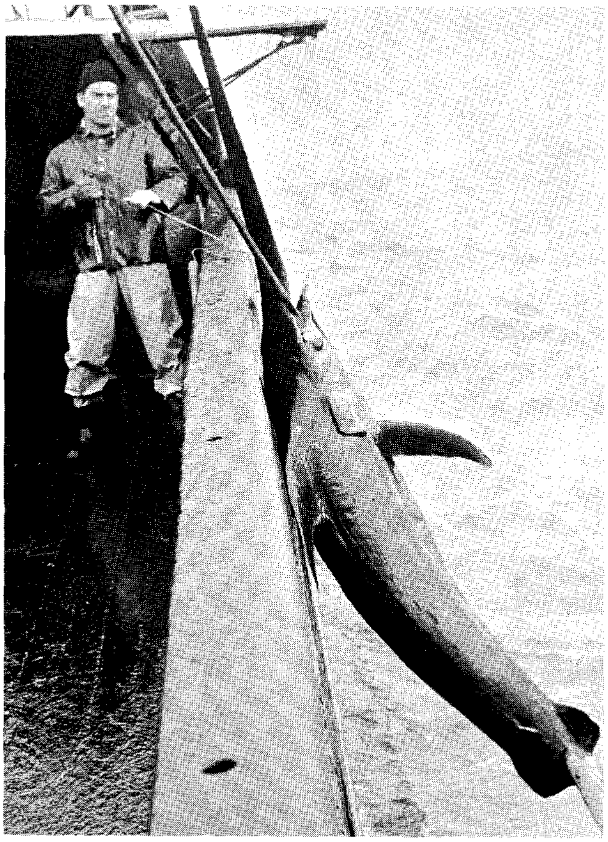

Figure 7. Part of swordfish catch landed in Pascagoula, Miss., by longliner *Gulf Stream*.

but the anticipated development of a viable fishery during the winter of 1970 with 10 to 20 boats never materialized with the discovery of abnormally high concentrations of mercury in swordfish from the Gulf. Due to the FDA recommendation that the swordfish be taken off the U.S. market, vessels outfitted for swordfish longlining have converted to other types of fishing. The fishery is now defunct.

COASTAL PELAGICS

The Stock Assessment System (SAS)

Pelagic fishes are difficult to assess because of their rapid mobility and wide-ranging distribution. These characteristics have led to the consideration of hydroacoustical techniques for pelagic fish assessment. The Pascagoula Laboratory, in conjunction with GE, has developed a stock assessment system consisting of a Ross echo sounder (105 kHz), a GE PAC-30 computer, signal conditioning circuitry, and a teletype (Fig. 8). This system was initially programmed to acoustically sample the water column at ½-foot increments to a maximum depth of 50 fathoms. It has since been modified to accept a 30 kHz signal and to sample in 1-foot increments to a depth of 100 fathoms.

A magnetic tape recorder set was purchased as an adjunct to the SAS-I computer system installed on the RV *Oregon II*. The recorder set is a portable system that can be used in conjunction with a fathometer aboard another vessel and obtain data recordings which can be later played back into SAS-I for reduction and printout.

Evaluation tests for the tape recorder were conducted at Stage 2, Panama City, Fla. before shipboard utilization. A 100 kHz sound source was used to ensonify known targets (live fish and 8-inch aluminum balls) set at various depths. Difficulties with the system were minor, but heavy seas prevented completion of the study.

Our initial attempt to calibrate the SAS with the tape recorder at sea, using targets of known signal strength, were disastrous. Ship movement, wind and water currents, and interfering fish effectively negated our *in situ* study. Tests were therefore carried out in a freshwater lake using -28 db acoustic targets. Difficulties were experienced in producing compatible signal processing between

Figure 8. The stock assessment system (SAS) used to quantify schooling fishes.

Figure 9. Large catch of rough scad, *Trachurus lathami*, taken by RV *Oregon II* in the southwestern Gulf.

the original recording and the taped recording. Modifications to the tape system hardware eliminated this problem and we elected to conduct further testing at sea using both the acoustic targets and caged fish.

These tests were highly successful despite the interference from wild fish attracted to the suspended cage. The software time variable gain (TVG) operated superbly and matched the 40 log R TVG integrated into the tape system hardware. Signal strength versus density plots from increasing densities of caged fish provided a near straight line relationship to indicate SAS could be effectively used to quantify fish schools.

Presently we have begun correlating SAS printouts with midwater trawl sets made on the indicated targets. A short survey (*Oregon II* Cruise 25, Phase 2) on the east coast for groundtruth information on pelagic fish schools detected by SAS was conducted in May 1971. Few pelagic schools were encountered, however, with only twelve midwater trawling stations made on low-intensity fish targets. Catches were light and mixed, consisting mostly of round herring (*Etrumeus teres*), Spanish sardine (*Sardinella anchovia*), and round scad (*Decapterus punctatus*).

This type of data must now be amassed and treated statistically before SAS becomes fully operational in a sampling mode. Training of Laboratory personnel in SAS operations has been completed and our operational manual for SAS operators written.

DISTRIBUTION AND ABUNDANCE

During *Oregon II* Cruise 18 several fathometer transects were run between 70 and 100 fathoms in off-bottom schools proved to be rough scad *(Trachurus lathami)* and round herring when sampled with high-opening bottom trawls. One hour-and-a-half tow produced 1,760 pounds of rough scad (Fig.).

We have frequently seen on the fathometer heavy concentrations of targets in 100 fathoms in the northeastern, east central, and south central Gulf. Recently we have used high-opening fish trawls to successfully sample these targets. The majority of these catches have produced large quantities of deepwater butterfish *(Ariomma bondi)* mixed with lesser amounts of bigeye scad *(Selar crumenopthalmus)* and wenchmen *(Pristipomoides aquilonaris)*. These catches indicate a latent midwater pelagic fish resource may lie just on the outer shelf edge.

The Brunswick station (now Southeast Fisheries Center, Brunswick Laboratory) carried out two acoustic assessment surveys on the east coast in cooperation with the NMFS Exploratory Fishing and Gear Research Base in Woods Hole and the State of North Carolina. Three research vessels, the *Oregon II*, *Delaware II*, and *Dan Moore*, conducted transects between 5 and 50 fathoms from Cape May to Cape Kennedy to provide knowledge on the unutilized off-bottom and midwater fish stocks. Both the *Dan Moore* and the *Delaware II* made midwater trawl sets on acoustic targets detected by the *Oregon II*. These sets were dominated by Atlantic herring *(Clupea harengus)*, blueback herring *(Alosa aestivalis)*, and spiny dogfish *(Squalus acanthus)*. Targets were generally scarce throughout the area.

Development of Fishing Strategy

The Gear Technology Program conducts behavior studies to determine how to control and lead fish and designs and develops the mechanical and electrical equipment to economically sample or harvest the resource.

A mobile automated fishing platform is being developed to efficiently harvest the dispersed but large resource of coastal pelagic fishes along the Gulf coast and southeastern Atlantic (Fig. 10). Conceptually, the system consists of several peripheral submerged rafts to concentrate fish, lights to lead the fish from the rafts into an electrical field adjacent to a platform, and electricity coupled with a fish pump to bring the fish aboard for processing.

BEHAVIORAL STUDIES

An effective netless harvesting system for coastal pelagic schooling fishes requires a method for concentrating the desired species in selected areas for capture. That pelagic fishes associate with drifting and fixed objects is a factor long exploited by commercial fishermen around the world. Capitalizing on this behavior could provide a means for concentrating fish for harvest with conventional gear or with netless systems deployed from the NMFS proposed automated fishing platform.

The feasibility of concentrating coastal pelagic fishes in selected areas for harvest has now been established.

A 3-week field study off Shell Island, Panama City, Fla. in July 1969 established the feasibility of using artificial structures for concentrating coastal pelagic fishes (Fig. 11). A series of tent-shaped structures, positioned at ¼- to ½-mile intervals, in 6-7 fathoms attracted large quantities of coastal pelagic fishes (primarily round scad and Spanish sardine (Fig. 12)). On one occasion scuba divers estimated that 25 metric tons of fish were attracted to a single structure. On six other occasions at least 5 metric tons were estimated around individual structures. This study also revealed that simple rather than complex structures attracted the largest concentrations of bait fish and jacks because structures positioned in midwater attracted large quantities of bait fish while surface structures attracted large numbers of jacks.

Studies on artificial structures were continued during July and August 1970 off Panama City, Fla. Eight artificial structures were evaluated daily by scuba divers who made visual estimates of the quantity and species of fish attracted to each experimental structure. Immediately following each dive the chartered bait seiner, *Gulf Ranger*, made purse seine sets around the structures according to a predetermined experimental design. Diver estimates and purse seine catches agreed closely as to the total number of fish present at each structure. Although divers could estimate the species composition accurately, they had difficulty in estimating the percent species composition. Daily purse seine sets averaged approximately 1,000 pounds of mixed round scad and Spanish sardine per structure. Night sets during a new moon produced few fish, indicating fish leave the structures some time after sunset. Recruitment must, therefore, occur daily.

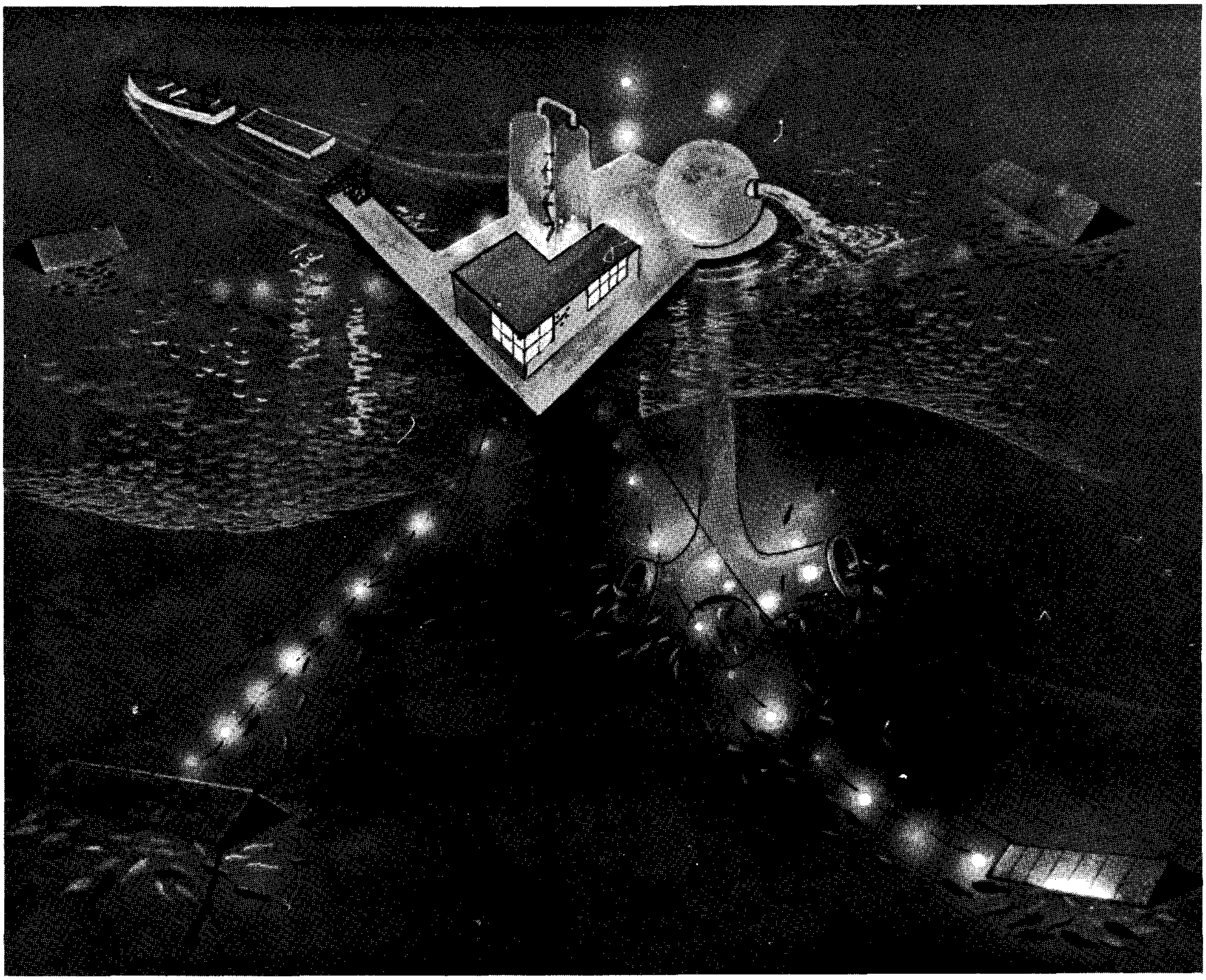

Figure 10. Conceptual view of proposed automated fishing platform.

The per-set production was not significantly increased by lengthening the number of days between sets. Large structures were found to attract more fish than small ones. Preliminary tests with variously colored structures were inconclusive.

A method for leading fish from artificial structures is through the deployment of a light attraction system. Artificial light has been used for some time in conventional net fisheries for sardines and related fishes in various areas throughout the world. Field experiments in the southeast region indicate light systems can be used successfully to attract and lead fish for a netless harvesting system.

Light attraction techniques for concentrating commercial aggregations of coastal pelagic fishes were investigated with the *Gulf Ranger*, a chartered purse seiner, during the new and full moon of August 1969 and new moon of September 1969 off Port St. Joe, Fla. Purse seine sets were made at predetermined intervals around a 16-foot skiff from which a 1,000-watt underwater mercury vapor lamp was deployed. Nightly total catches from this light source ranged from 500 pounds to over 6,000 pounds with a 2,500-pound nightly average. Three species, Spanish sardine (*Sardinella anchovia*), Atlantic thread herring (*Opisthonema oglinum*), and scaled sardine (*Harengula pensacolae*), estimated as the greatest potential among coastal pelagics, contributed 50 percent or more of the total weight in 71 percent of the sets. These experiments also revealed that fish were attracted continually throughout the night and that the

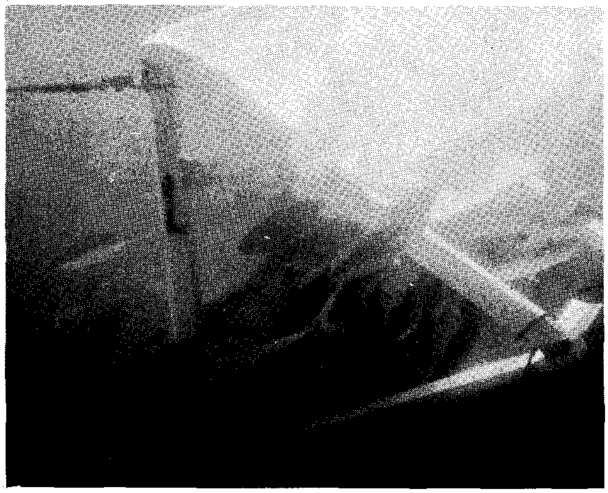

Figure 11. Fish concentrated around submerged artificial structure.

average catches were larger during the new moon.

Preliminary experiments were conducted during the *George M. Bowers* cruise off northwest Florida in October 1969 to evaluate the feasibility of leading fish aggregations with both a moving light and along sequentially deployed underwater lights. Rough seas prevented completion of experiments but it was established that aggregations of coastal pelagic fish could be led short distances with both moving and sequentially deployed lights.

Further light leading experiments were conducted during September and October 1970 off Panama City, Fla. Experiments using sequentially opeated lamps revealed that in clear water coastal pelagic fish could be led between lamps spaced up to 20 meters apart; however, in turbid waters fish could only be transferred between lamps spaced less than 10 meters apart. Fish attracted to artificial structures during the day were held with light after dark and led more than 0.5 mile away with a moving lamp. On one occasion over 10,000 pounds of Spanish sardine were held after dark at Stage 2, then led clear of the structure with a moving lamp and captured with a purse seine. Plans are in progress to evaluate the application of the artificial structure/light leading technique to harvest the large aggregations of coastal pelagic fish found around petroleum drilling platforms in the northern Gulf of Mexico.

Prototype light-attraction hardware was designed and constructed during calendar year 1970. Two

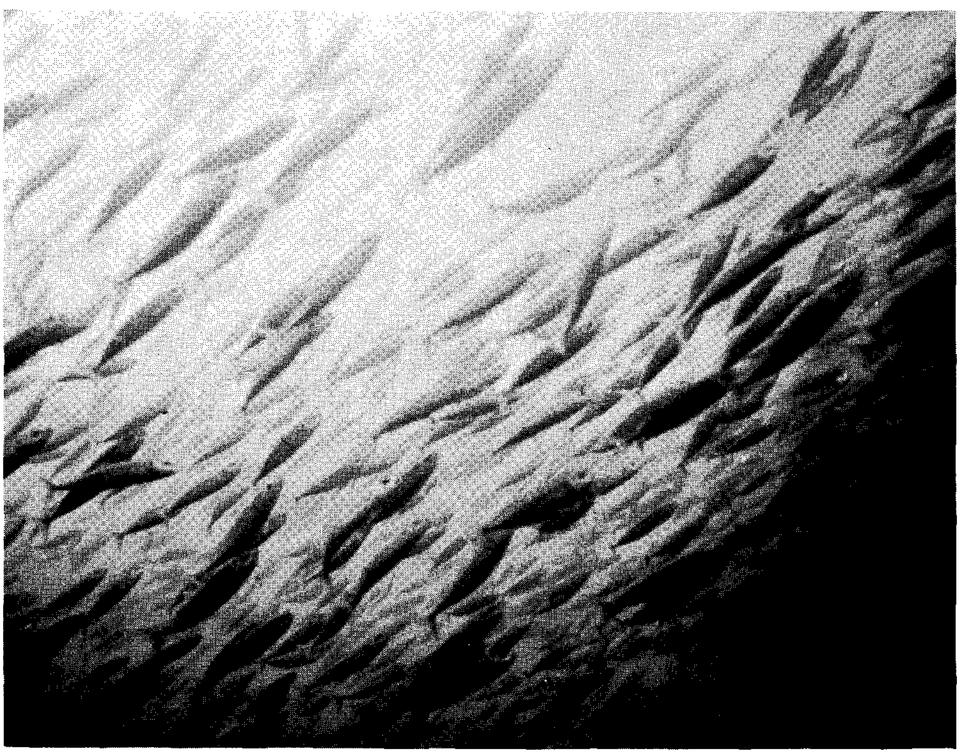

Figure 12. Large school of round scad, *Decapterus punctatus*, attracted by artificial structures.

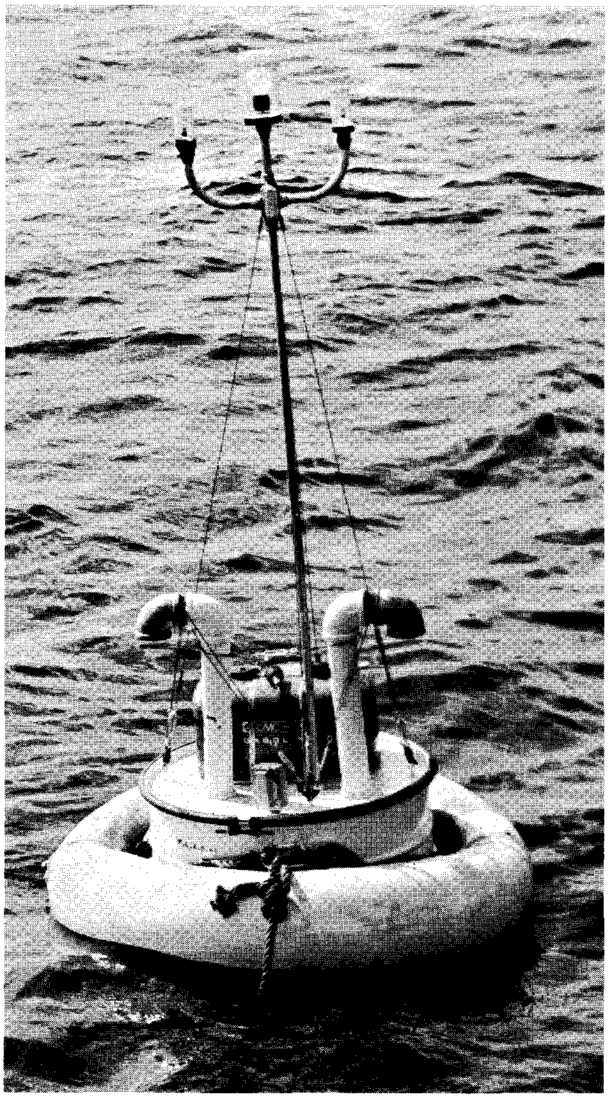

Figure 13. The fish light-attraction buoy (FLAB) developed at the NMFS Southeast Fisheries Center, Pascagoula Laboratory.

self-contained systems, the fish light-attraction buoy (FLAB I) (Fig. 13) and the fish light-attraction catamaran (FLAC I), were developed for application with both the netless harvesting system and with conventional fishing gear. The FLAB system is a stationary light buoy intended for use as a component in the sequential light leading array envisioned for the netless harvesting system. FLAC I was designed for use with conventional purse seines as its underwater lamp can be raised out of the water for either towing or to facilitate pasage over purse seine cork lines. Both systems performed successfully in field tests.

ELECTRICAL STUDIES

Fishes, within a suitable electrical field, show forced directional swimming (electrotaxis) toward the anode. Construction of the anode as an electrode array around the nozzle of a conventional fish pump could direct fish toward the pump for netless extraction.

Electrical fishing is widely used in fresh water, but effective electric fields are difficult to generate in salt water because of high conductivity and high power requirements. Therefore considerable research was required to determine the optimum electrical parameters necessary to lead selected coastal pelagic fishes. Once established, these parameters could be used to design and field test pulse generators and electrode arrays in conjunction with a fish pump.

Laboratory studies to determine the best combination of pulse rate, pulse width, and voltage to control and lead coastal pelagic fishes were conducted at Pascagoula on 13 species of coastal pelagic fishes. Individual fish were placed in an insulated tank and subjected to preselected electrical stimuli. Capacitor/discharge type pulses were used since the rapid increase in amplitude and slow rate of decay are best suited for fish control in salt water. The response and reaction times required for fish to swim from the cathode to the anode and the total swimming distance were measured and recorded.

Optimal combinations of voltage and pulse rate to induce electrotaxis were determined for 12 of the 13 species studied. No combination of voltage and pulse rate tested was suitable for controlling croaker *(Micropogon undulatus)*, the last species. All other species were effectively induced into electrotaxis, controlled, and led several laps in the experimental tank.

Fish length was found important in determining the combination of the best parameters for inducing electrotaxis. Fish less than 100 mm long could not be controlled with the same combination as larger fish.

Threshold voltages, determined for five selected species, were found to be greater for fish facing the anode than for fish facing the cathode.

In July 1970 a 12 kva pulse generator was constructed for application in electrical fish-leading studies under actual field conditions. This pulse generator system was designed only as a test model and not for actual harvesting since the required

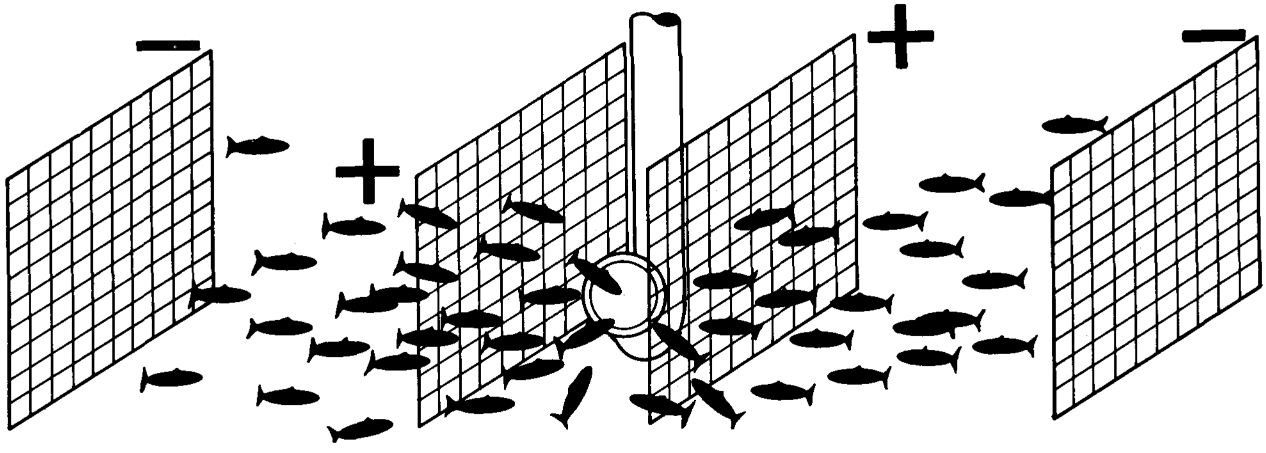

Figure 14. Diagram of pulse generator electric field leading fish to the anode adjacent to pump nozzle.

low load resistances will allow only a relatively small array with the 12 kva generator. The design logic suggested first acquiring a relatively inexpensive pulse generator to investigate wild fish responses in the field, validate laboratory response data, and provide a sound basis for designing specifics for a full-scale harvesting system. Once these parameters were obtained the full-scale system could be constructed and tested with a minimization of errors and expense.

During August and September 1970 experiments were conducted in the Panama City, Fla. area using an electrode array 2 × 2 × 4 meters in size. Each 2 × 2 meter electrode was constructed of sheet copper arranged in a grid with 18-inch square openings. The sides, bottom, and top were open.

Observations were first made on fish which had been captured by light-attraction techniques the previous night and held in live tanks. These were placed singly into the electrode array, power applied, and their reaction observed. Various combinations of pulse rate, pulse width, and field strength were studied until the optimum combination was found which would cause the fish to swim to and through the anode. A total of five species was observed in this manner.

Once the proper field characteristics had been established, the experimental system was set up at night and tested on wild, untouched fish of the same five species attracted with lights into the electrode array. Fish were allowed to freely congregate in the array with the power off. Periodically, power was turned on and the response of the fish in the array observed. At the optimum electrical settings, established in the laboratory and verified during the daylight experiments, virtually all of the fish within the dimensional volume of the electrode array, as well as in a fringe field area outside the array, were controlled and forced to swim through the anode.

These tests proved conclusively that wild, coastal pelagic fish can be controlled with an electrical field in such a manner that their capture be insured.

A system for harvesting coastal pelagic fishes in the Gulf of Mexico requires a pulse generator capable of providing an electrical field at least 10 meters long and 5 × 5 meters in cross section. Parallel plates or grids are the most effective electrodes to provide a uniform field and would be the most economical in terms of power (Fig. 14).

A 120 kva pulse generator has been designed and is presently under construction which is based on the test data and which meets the previously stated field requirements. Delivery of this equipment is expected in the fall of 1971.

GEAR DEVELOPMENT

The high percentage of fish, invertebrates, and miscellaneous material in shrimp trawl catches increases the amount of sorting time necessary to separate shrimp from the remaninder of the catch.

The National Marine Fisheries Service Laboratory in Seattle, Washington, has had considerable success in developing a separator trawl for the shrimp fishery of that region. Subsequently, a project was set up at the Pascagoula Base to design and test a similar trawl for the Gulf of Mexico shrimp fishery.

Various designs of separator trawls field tested aboard the *George M. Bowers* revealed that the west coast type was not effective for use in the Gulf of Mexico. Vertical panel separator trawls were not effective in sorting out fish from shrimp due to the small size of the fish which allows them to pass through the separator panel as easily as the shrimp.

The 70-foot western-type semiballoon shrimp trawls furnished by industry and converted to shrimp separator trawls by program personnel were tested during *Oregon II* Cruise 18. Results were unsatisfactory in that too large a percentage of shrimp continued to pass into the fish bag (trash chute). Fishing efficiency, however, was improved over earlier models.

These studies indicate separator trawls as presently configured will not function effectively in the penaeid shrimp fishery of the Gulf of Mexico because of the large number of fish that are as small or smaller than the shrimp. Therefore separator trawl studies have been discontinued for the present.

The electric shrimp trawl pulser and array was revamped for application with a 71-foot semiballoon shrimp trawl. Our older system had been originally designed for incorporation with 40-foot trawls which, at that time, were more or less standard in the industry. Since then shrimp trawls of larger sizes have been widely adapted, necessitating changes in the pulser and electrode array.

Field trials were conducted with the new system in early June in the north Gulf of Mexico. Catches during daylight hours with the electric trawl equaled nighttime catches with conventional trawls and night sets with the electric trawl equaled or exceeded night catches with conventional nets. Cable difficulties were experienced which forced a premature cancellation of the cruise. These difficulties are presently being overcome and more trials are expected in the fall.

Mississippi Test Facility Engineering Laboratory

The Remote Sensing Program had its origins in earlier efforts of the Exploratory Fishing and Gear Research Base at Pascagoula and the Biological Laboratory at Galveston, Texas. Pascagoula's work involved contracts with TRW Corporation to develop a marine resource spectrometer, with Baird-Atomic Corporation to develop a sensor for detecting fish oil slicks, with a U.S. Army low-light-level image intensifier to detect bioluminescence stimulated by fish schools at night, and with various kinds of aerial photography for detecting fish schools.

Galveston's involvement with remote sensing included a pioneering effort in space oceanography (the determination of a variety of oceanic physical and biological features by analysis of satellite photographs), subsequent contracts with Humboldt State College and the University of Southern California in the space oceanography area, a study of remote sensing of the pelagic fisheries environment off Oregon by contract with Oregon State University, and a contract with Seaonics International (Los Angeles) for the preparation of a 208-page annotated bibliography of ocean-surface features significant to fisheries.

In September 1970, many of the above projects were transferred to the Mississippi Test Facility (MTF) where they were reorganized as the Remote Sensing Program, a national program of NMFS. (This activity is now the NMFS Southeast Fisheries Center, Mississippi Test Facility Engineering Laboratory.) The Program's staff was gradually augmented so that by March of 1971 significant research and development projects had begun. The program's work is divided into four projects: remote sensing, engineering services, data management, and biological sample handling.

REMOTE SENSING

Field tests of a marine resource spectrometer were held on an offshore tower at Panama City, Fla. in October 1970. Environmental variables greatly affected the results so the instrument was next tested over an instrumented 27,000-gallon tank especially built at the Mississippi Test Facility (Fig. 15). Studies were made of various sized schools of bluegill sunfish, with significant spectral signatures only appearing for schools of 1,500 or more fish within 10 feet of the surface. Bull's eye targets in the tank may have biased the data. The spectrometer was also mounted on a leased helicopter for field tests over schools of menhaden and mullet. Data for these trials have not yet been analyzed. This summer's tests will be via fixed-wing aircraft off southern California.

It was also necessary to develop handling and holding techniques for the fish used in the tank tests. The basic problem has been fin rot for both

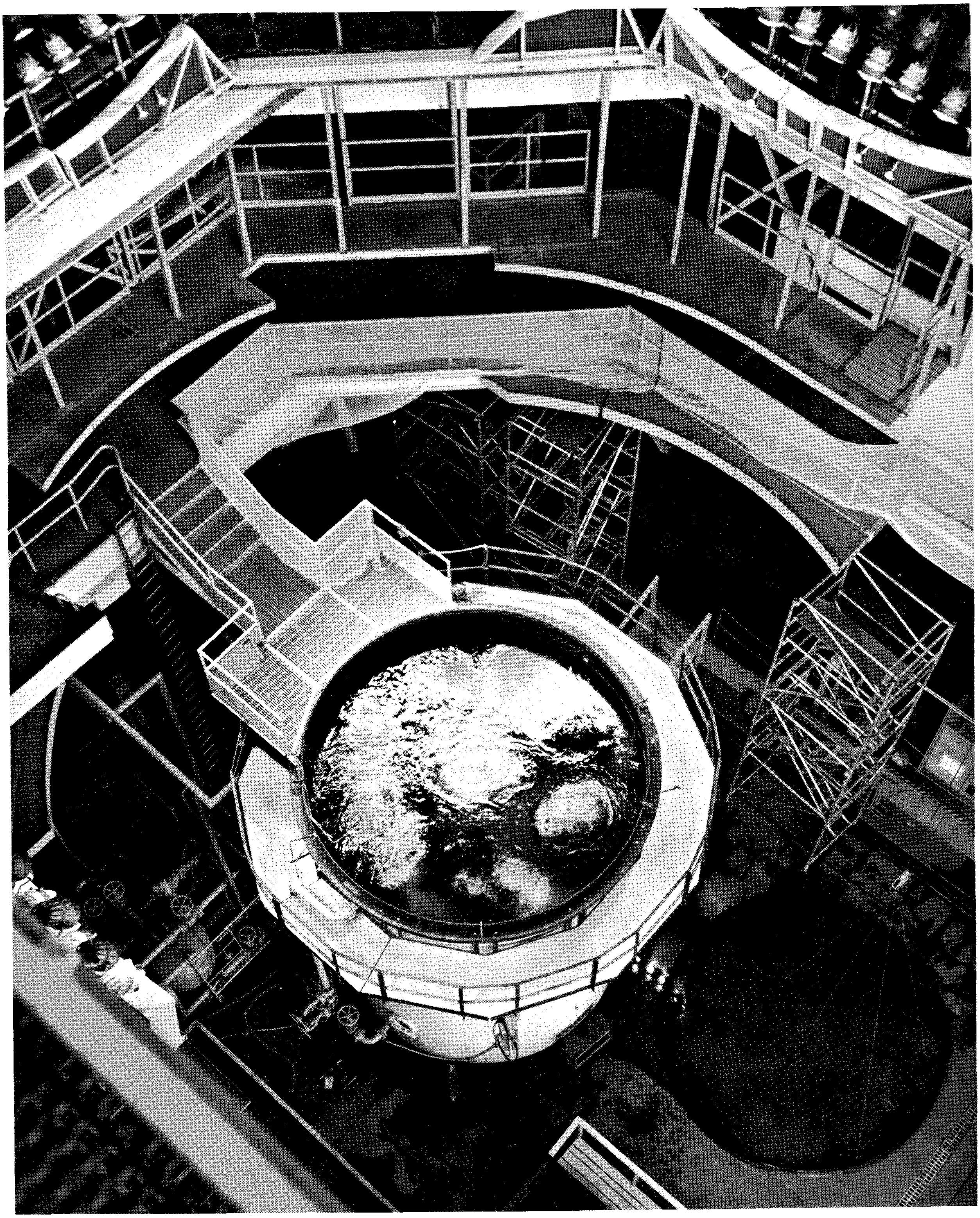

Figure 15. The 27,000-gallon fisn-sensor testing tank at the Mississippi Test Facility. The tank is 15 feet in diameter, 22 feet high, and is supplied with filtered oxygenated fresh water. A crane is used to transfer fish from nearby holding tanks. The device resembling an inverted parachute is one of the two screens used to restrict target fish to a particular depth level. Tungsten lamps at the top of the picture supply light at about 60 percent the intensity of sunlight.

bluegill and mullet, for which Terramycin is only semieffective. Experimental handling procedures are still under test.

A proposal to investigate the Mississippi River's effluent plume via ship, aircraft, and the satellites ERTS-A and B and SKYLAB was submitted to NASA. By correlating ship and aerospace data it is hoped to establish the relationship between the river's discharge and the adjacent fish stocks.

A hydroacoustic work review meeting was held at MTF in response to the Director's memorandum to identify ways of accelerating the development of acoustic assessment techniques. Representatives from the NMFS laboratories identified the technical basis and current status of projects involving acoustical resource assessment and a set of workshop recommendations was submitted to Washington.

A leased low-light-level image intensifier tube was installed in a helicopter for experimental detection of bioluminescence at night. Tests over a submerged artificial light source were followed by a coastal flight, where a U-shaped pattern of bioluminescence, undetectable by the human eye, was seen around a fish school from an altitude of 1,000 feet. Summer activities in 1971 were scheduled to include night flights in the Pacific Northwest.

Baird-Atomic's final report on fish oil films on the sea surface was received. Fluorescence/excitation methods were used to identify the emission signatures of oils extracted from several fish species. An investigation is now underway on the feasibility of the NASA biological and chemical support team conducting the research necessary to provide adequate natural fish oil slicks for further sensor testing.

Aerial photographs of fish schools (from Pascagoula) and underwater photographs of scallop beds (from Brunswick) were sent to a number of commercial firms to determine whether fish and scallop identification could be automated. There appears to be little possibility of success for fish schools, whereas the prospects are more favorable for scallops.

A contract was let between NMFS/MTF and the Sensory Systems Laboratory (Tucson, Ariz.) to provide five temperature-sensing acoustic tags and related equipment for the Eastern Gulf Sport Fisheries Marine Laboratory's sport fish tagging program. Tagging was to have commenced during the first quarter of Fiscal Year 1972.

BIOLOGICAL SAMPLE HANDLING

Areas of immediate interest include an automatic plankton sorter and an automatic fish scale reader. Higher-priority projects have diverted all but token efforts from both concepts. For the plankton sorter, taxonomic priorities have been established and some obvious physical/mechanical sorting procedures identified. For the scale reader a cursory study of the state-of-the-art was made and presented to the Washington Office with recommendations.

ENGINEERING SERVICES

At the request of the Woods Hole Exploratory Fishing and Gear Research Base, a prototype automatic data logger system was designed and field tested on the *Delaware II*. The components for a revised system, which will measure 25 to 30 parameters, have received an extensive system checkout and are being readied for installation on the *Albatross IV* for testing off New England in July 1971. Data requirements and hardware design and specifications have been defined as well.

The bongo plankton sampling system was studied to recommend improvement and develop purchase specifications. Tests of the system were conducted in June and July 1971 at the David Taylor Model Basin. A system mathematical model is being delayed pending the test results.

Pascagoula's RUFAS underwent an engineering evaluation, and in addition, specifications and drawings and an operation manual were also developed. Hardware improvements were made to make RUFAS more reliable in the field.

At the request of the Miami Laboratory, an XBT data recorder system was developed and subjected to successful field tests aboard the *Oregon II*. The data were processed at MTF to determine other changes required in the system, and another study was begun to obtain the most economical recorder for use as a standard recorder for the XBT system.

A freshwater electronic fish-herding device from the Kelso Exploratory Fishing and Gear Research Base was modified and repaired to increase its reliability and to meet operational requirements.

DATA MANAGEMENT

A software program was developed for Pascagoula to reduce acoustic sampling (SAS) magnetic tape data so as to make the data output compatible with computerized biological information.

A study was undertaken to determine improved methods of acquiring, processing, automatically analyzing and handling RUFAS data for the Brunswick Laboratory.

A data logger measurement program was finalized and the data requirements established with the Woods Hole Laboratory. Data processing programs for planned field tests are under development.

A feasibility study to develop the computer programs for processing acoustical data was completed for the Seattle Laboratory.

A bongo plankton system mathematical model continues under development and awaits additional data from system tests in the David Taylor Model Basin.

A measurement program and the data requirements for the NMFS freshwater impoundment system were developed and used to process data from the spectrometer under test at MTF. This program is also being used to evaluate field tests of this instrument.

The MARMAP Program office was provided with data management consulting services for use in the MARMAP Program Development Plan and in establishing the MARMAP Program office data functions.

The Exploratory Data Center

The volumes of biological, ecological, and environmental data collected by our exploratory fishing projects are assimilated into an extensive faunal data library maintained within the Exploratory Data Center. This data file contains over 200,000 punched cards holding some 900,000 data items on approximately 3,000 species of marine organisms. Over 250 exploratory fishing cruises have contributed to this vast library.

These faunal data are only part of the data inventory housed on Base. Various other projects have contributed information or use the data pro cessing facilities available within the Center to perform statistical and other mathematical analyses of their data.

Data processing facilities at the Center include a UNIVAC 9200 computer system having 12K core memory with an internal cycle time of 1.2 microseconds. Data input and output are through the 400 card per minute reader, 60 card per minute punch, and 250 line per minute printer.

Center personnel are actively engaged in projects related to the faunal library, particularly in reference to the biota of the Continental Slope of the Gulf of Mexico between 100 and 1,000 fathoms. These studies have resulted in several published manuscripts and the preparation of many more not yet completed.

The Center is responsible for the collection and transcription of data aboard the *Oregon II* and, in this respect, has developed a sampling procedure and data recording method for the catch processing conveyor system aboard the *Oregon II*. Samples of predetermined size are removed from the belt at specified intervals and all species in the sample are listed including the weight and numbers of each. A computer program converts the weight and number of each species in the sample to weight and numbers of that species in the total catch and punches this information on data cards. With this method a more accurate estimate of the total catch is obtained and processing of large catches is expedited.

Exploratory Data Center personnel advise and assist other program staff in using data processing facilities in their activities. In using these facilities, line staff realize a more effective utilization of data generated from their activities.

Staff

Exploratory Fishing Staff - Fiscal Years 1970-71

Pascagoula, Mississippi

Harvey R. Bullis, Jr., Base Director, Reassigned to Central Office 3/13/70
Edward F. Klima, Acting Base Director, 4/19/70
Richard B. Roe, Acting Assistant Base Director, 4/19/70
Wayne T. Adkison, Fishery Biologist, EOD 7/22/69, Terminated 8/27/70
Martin R. Bartlett, Fishery Methods & Equipment Specialist, Resigned 12/11/70
Joseph A. Benigno, Fishery Biologist
Johnny A. Butler, Supervisory Fishery Methods & Equipment Specialist
Jimmy B. Cagle, Engineering Technician
Francis J. Captiva, Supervisory Fishery Methods & Equipment Specialist, Detailed to Central Office 7/8/70, Termination of detail 8/23/70
Kirby L. Drennan, Supervisory Oceanographer, Reassigned to Remote Sensing Program, Mississippi Test Facility, Bay St. Louis, Miss. 9/21/70
Shelby B. Drummond, Fishery Biologist, Reassigned to Brunswick, Ga. Field Station 9/7/69
Hilton M. Floyd, Fishery Methods & Equipment Specialist, Reassigned to Brunswick, Ga. Field Station 7/1/69
Robert S. Ford, Jr., Fishery Biologist to Fishery Methods & Equipment Specialist 11/2/70
Elmer J. Gutherz, Supervisory Fishery Biologist
James E. Higgins, Fishery Biologist, Reassigned to Port Isabel, Texas 8/11/69
Frank J. Hightower, Jr., Fishery Methods & Equipment Specialist
Dorothy M. Latady, Administrative Assistant
Richard W. Lichtenheld, Fishery Biologist, Reassigned to Beaufort, N.C. 7/15/69
Jack C. Mallory, Fishery Biologist, Transferred to U.S. Corps of Engineers 10/25/70
Bobby Joe McDaniel, Administrative Officer, Resigned 11/1/69
Norman L. Pease, Fishery Biologist, Transferred to Central Office 4/18/71
Gladys B. Reese, Fishery Biologist

Luis R. Rivas, Fishery Biologist
Bennie A. Rohr, Fishery Biologist
Charles M. Roithmayr, Fishery Biologist, Reassigned to Remote Sensing Program, Mississippi Test Facility, Bay St. Louis, Miss. 9/21/70
Gary M. Russell, Fishery Biologist to Fishery Methods & Equipment Specialist 11/2/70
Wilber R. Seidel, Supervisory Mechanical Engineer
Anthony F. Serra, Fishery Methods & Equipment Specialist
Sven J. Svensson, Supervisory Fishery Methods and Equipment Specialist
John R. Thompson, Assistant Base Director, Resigned 8/23/69
John W. Watson, Biological Aid, Terminated 9/14/69, EOD Fishery Biologist 6/15/70
Donald A. Wickham, Supervisory Fishery Biologist

Brunswick, Georgia

Robert Cummins, Jr. Station Chief
Shelby B. Drummond, Assistant Station Chief, Reassigned from Pascagoula 9/7/69
Abraham J. Barrett, Reassigned from First Officer *OREGON II* to Fishery Methods & Equipment Specialist 2/1/70
Hilton M. Floyd, Fishery Methods & Equipment Specialist, Reassigned from Pascagoula 7/1/69
Harriette S. Hightower, Administrative Assistant
Raymond O. Maurer, Fishery Biologist
Leonard L. May, Fishery Biologist
Raymond D. Nelson, Fishery Biologist, Resigned 2/20/70
Joaquim B. Rivers, Fishery Methods & Equipment Specialist

Bay St. Louis, Mississippi

William H. Stevenson, Manager, Transferred from Washington Central Office 9/21/70
Donald W. Strasburg, Assistant Manager, EOD 10/18/70
Walter F. Gandy, Electronic Engineer (General), EOD 12/28/70
Edward J. Pastula, Oceanographer, Transferred from Naval Oceanic Office 6/13/71
Charles M. Roithmayr, Fishery Biologist (General), Transferred from Pascagoula 9/21/70
E. Allen Stevenson, General Engineer, EOD 1/24/71
Frank Wittmann, Electronic Engineer, EOD 12/28/70
E. Glade Woods, Chief, Operations Group, Transferred from NASA 11/29/70

Oregon II

Richard E. Adams, Master
Louis Guirola, Chief Engineer

George M. Bowers

J. B. Randall, Motor Vessel Captain

Publications

ANDERSON, WILLIAM W. and HARVEY R. BULLIS, JR.
1970. Searching the shrimp beds by sub. Sea Frontiers 16(2): 112-119.
BARTLETT, MARTIN R.
1970. Maine longliner taps Gulf swordfish bonanza. National Fisherman, May, pp. 16A-17A.
BENIGNO, JOSEPH A.
1970. Fish detection through aerial surveillance. Proc. of FAO Fishing Gear Congress, FII: FF/70/78, pp. 1-13.
BULLIS. HARVEY
1970. World Fishery Technology. Calif. Mar. Res. Comm., CalCOFI Rept., 14: 57-66.
BULLIS, HARVEY R. and FRANCIS J. CAPTIVA
1969. Fishing gear and methods. The Encyclopedia of Marine Resources. (Ed) Frank E. Firth, pp. 237-250.
BULLIS, HARVEY R., JR. and JOHN R. THOMPSON
1970. Bureau of Commercial Fisheries, Exploratory Fishing and Gear Research Base, Pascagoula, Miss., July 1, 1967 to June 30, 1969. U.S. Fish Wildl. Serv., Circ. 351, 29 pp.
CALDWELL, DAVID K. and HARVEY R. BULLIS, JR.
1971. An unusually large aggregation of prejuvenile bigeyes, *Priacanthus arenatus*, in the West Indies. Copeia No. 1: 176.
CAPTIVA, FRANCIS J.
1970. Changes in Gulf of Mexico shrimp trawler design. *In:* Papers Presented at Conf. on Canadian Shrimp Fishery, Saint John, New Brunswick, Oct. 27-29, 1970, 17 pp.
CUMMINS, ROBERT, JR. and JOAQUIM B. RIVERS
1970. Calico scallop fishery in southeastern U.S.: A photo review of latest developments. Commer. Fish. Rev. 32(3): 38-43.
DRENNAN, KIRBY L.
1969. Fishery oceanography from space. Proc. of Sixth Space Congress, Cocoa Beach, Fla., pp. 9-1 thru 9-6.
FLOYD, HILTON M.
1971. A lift net for catching bait fish attracted to light. Fish. Leafl. 638, 3 pp.
JUHL, ROLF, MARTIN R. BARTLETT, and BRUCE W. MAGHAN
1970. Exploratory fishing in the western tropical Atlantic by the tuna seiners Normandie and Queen Mary. Contribuciones Agropecuarias y Pesqueras 11(4): 1-16.
KLIMA, EDWARD F.
1970a. Development of an advanced high seas fishery and processing system. Marine Technology Society Journal 4(5): 80-87.
1970b. A comparison of flashed white and infrared illumination for photographic observation of nocturnal behavior of shrimp. Prog. Fish-Cult., 32(2): 110-112.
1970c. The automated fishing platform. Proc. of FAO Fishing Gear Congress, FII: FF/70/3: 1-9.
KLIMA, EDWARD F. and ROBERT S. FORD
1970. Gear and techniques employed in the Gulf of Mexico shrimp fishery. *In:* Papers Presented at Conf. on Canadian Fishery, Saint John, New Brunswick, Oct. 27-29, 26 pp.
KLIMA, EDWARD F. and DONALD A. WICKHAM
1971. Attraction of coastal pelagic fishes with artificial structures. Trans. Amer. Fish. Soc. 100(1): 86-99.
MALLORY, JACK C.
1971. [Review of] Arakie's fishery blue book (David H. Arakie). Trans. Amer. Fish. Soc. 100(1): 141.
PEASE, NORMAN L.
1970. The commercial shrimp potential in West Africa from Dakar to Douala, Commer. Fish. Rev. 32(8-9): 30-39.
RIVAS, LUIS R.
1969. A revision of the poeciliid fishes of the *Gambusia punctata* species group, with descriptions of two new species. Copeia (4): 778-795.
1970a. Snappers of the western Atlantic. Commer. Fish. Rev. 32(1): 41-44.
1970b. The red grouper of the Gulf of Mexico. Commer. Fish. Rev. 32(10): 24-30.
1971. A new subspecies of poeciliid fishes of the genus *Gambusia* from eastern Cuba. Publications of the Gulf Coast Research Laboratory Museum, Vol. 2, pp. 5-9.
RIVAS, LUIS R. and WILLIAM L. FINK
1970. A new species of poeciliid fish of the genus *Limia* from the island of Grand Cayman, B.W.I. Copeia (2): 270-274.
RIVAS, LUIS R. and CHARLES M. ROITHMAYR
1970. An unusually large Atlantic croaker (*Micropogon undulatus*) from the northern Gulf of Mexico. Copeia (4): 771-772.
ROE. RICHARD B.
1969. Distribution of royal-red shrimp *Hymenopenaeus robustus,* on three potential commercial grounds off the southeastern United States. U.S. Fish Wildl. Serv., Fish. Ind. Res. 5(4): 161-174.
ROE, RICHARD B., ROBERT CUMMINS, JR. and HARVEY R. BULLIS, JR.
1971. Calico scallop distribution, abundance, and yield off eastern Florida, 1967-1968. Fish. Bull. 69(2): 399-409.

ROHR, BENNIE A.
1968. Surface schooling of red drum. Underwater Naturalist 5(2): 21-23.
ROITHMAYR, CHARLES M.
1970. Airborne low-light sensor detects luminescing fish schools at night. Commer. Fish. Rev. 32(12): 42-51.
SEIDEL, WILBER R.
1970. Video scallop assessment system. Proc. of FAO Fishing Gear Congress, FII: FF/70/8: 1-7.
STEVENSON, WILLIAM H.
1971a. Remote sensing in the National Marine Fisheries Service. Proc. Symposium on Remote Sensing in Mar. Biol. and Fish. Res., Remote Sensing Center and Sea Grant Program Office, Texas A&M Univ., pp. 1-7.
1971b. Remote Sensing: Space-age techniques designed to aid commercial fishermen. National Fisherman Yearbook Issue 51(13): 91.
STEVENSON, WILLIAM H. and JAMES H. JOHNSON
1970. Application of airborne remote sensing to fishery research and development and to fishery operations. FAO Fisheries Division Issue Paper, 38 pp.
STRUHSAKER, PAUL
1969. Observations on the biology and distribution of the thorny stingray, *Dasyatis centroura* (Pices: Dasyatidae). Bull. Mar. Sci. 19(2): 456-481.
WICKHAM, DONALD A.
1970. Collecting coastal pelagic fishes with artificial light and 5-meter lift net. Commer. Fish. Rev. 32(12): 52-57.
1971. Harvesting coastal pelagic fishes with artificial light and purse seine in the northeastern Gulf of Mexico. Commer. Fish. Rev. 33(1): 30-38.
WICKHAM, DONALD A., JIMMY B. CAGLE, and FRANK J. HIGHTOWER, JR.
1971. Apparatus for controlling ambient light cycles in experimental environments. Trans. Amer. Fish. Soc. 100(1): 128-131.

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