NOAA's Office of Undersea Research Fiscal Year 1984 Report

Rockville, Md.
October 1985

U.S. DEPARTMENT OF COMMERCE
Malcolm Baldrige, Secretary

National Oceanic and Atmospheric Administration
Anthony J. Calio, Administrator

Office of Oceanic and Atmospheric Research
Joseph O. Fletcher, Assistant Administrator

Office of Undersea Research
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LIST OF ABBREVIATIONS AND ACRONYMS

ABS .....American Bureau of Shipping
BOSP .....Board on Ocean Science and Policy (formerly known as Ocean Science Board)
DAN .....Divers Alert Network, Duke University Medical Center
FAMOUS .....French American Mid-Ocean Undersea Study
FISSHH.....First International Saturation Study of Herring and Hydroacoustics
FLARE .....Florida Aquanaut Research Expedition
fsw .....feet of seawater
FY.....Fiscal Year
HBF.....Harbor Branch Foundation
IGUANA.....Intergovernmental Undersea Atomic Neutron Activation project
JACADS .....Johnston Atoll Chemical Agent Disposal System
JAMSTEC .....Japan Marine Science and Technology Center
LRT .....Launch, Retrieval and Transport Vehicle
MRECC.....Marine Resources and Engineering Coordination Committee (UJNR)
MUS&T.....Manned Undersea Science and Technology Program (NOAA)
NITROX .....Nitrogen-Oxygen Breathing Mixture
NMFS.....National Marine Fisheries Service (NOAA)
NOAA.....National Oceanic and Atmospheric Administration
NSF .....National Science Foundation
NUADC .....National Underwater Accident Data Center (University of Rhode Island)
NURP.....National Undersea Research Program (NOAA)
OAR.....Office of Oceanic and Atmospheric Research (NOAA)
ONR .....Office of Naval Research
OSB .....Ocean Science Board (now known as Board on Ocean Science and Policy)
OUR .....Office of Undersea Research
PTC .....Personnel Transfer Capsule
ROV.....Remotely Operated Vehicle
R/V .....Research Vessel
SCORE .....Scientific Cooperation Operational Research Expedition
SCUBA .....Self Contained Underwater Breathing Apparatus
SECURE.....Southeastern Consortium for Undersea Research Efforts
UCAP .....University of Connecticut at Avery Point
UJNR .....United States-Japan Cooperative Program in Natural Resources
UMS.....Undersea Medical Society
UNC-W .....University of North Carolina at Wilmington
UNOLS.....University National Oceanographic Laboratory System
USC .....University of Southern California

CONTENTS

FIGURES

TABLES

PREFACE

The primary responsibility of the Office of Undersea Research (OUR) is to support NOAA's legislated ocean-related mission by providing an ensemble of undersea equipment, facilities, and capabilities to extend the ability of marine researchers beyond the limits imposed by traditional laboratory and ship-based modes of research. To meet this responsibility, OUR has developed a national undersea research program of facilities, submersibles, and research on diving and diver safety to facilitate the accomplishment of NOAA's research goals and objectives in four major areas of the agency's responsibility: marine pollution, fisheries, ocean services, and seafloor properties and processes.

The purpose of this report is to highlight the achievements of OUR in helping NOAA to carry out its Congressionally mandated responsibilities in these four areas. The report summarizes program activities initiated, continued, or completed in the period October 1, 1983, through September 30, 1984. During this period, OUR activities include the provision of facilities and financial support for undersea research activities that involve habitats and submersibles, the conduct of research related to diving research and development, and the encouragement of joint international and interagency underwater research projects—all of which are conducted in a way that ensures that NOAA's undersea research needs are met in the most responsive and cost-effective manner. These program activities also include support of cooperative international projects with France, Kuwait, and Japan, and the establishment of an annual symposium series devoted to the presentation of scientific papers describing sponsored research projects.

DIRECTOR'S FOREWORD

The year 1984 marked a time of new initiatives, expanded programs, and increased activity for NOAA's Office of Undersea Research (OUR).

The most recent addition to NOAA's National Undersea Research Program (NURP), the facility at the University of Connecticut, implemented a full program of research activities in this period; the other elements of the NURP network (Fairleigh Dickinson University, the University of Hawaii, the University of North Carolina, and the University of Southern California) all conducted exciting programs of undersea research that answered a number of important marine science questions.

A state-of-the-art undersea habitat is being built at OUR's direction; it will be christened the GEORGE F. BOND, after the late USN Captain who has often been called the "Father of Saturation Diving." When completed, the habitat will be used in the Caribbean and will play a major role in NOAA's support of President Reagan's Caribbean initiative.

In 1984, OUR supported a 30-day mission in the North Pacific involving the newly refurbished deep-water submersible ALVIN. Scientists onboard investigated the unique tectonic characteristics of this region, which include vigorous hydrothermal activity at several underwater "hot spots" and the existence of economically important mineral deposits. A major shallow-water submersible cruise involving scientists from NOAA, the U.S. Navy, the U.S. Geological Survey, the states of Texas and Massachusetts, and several academic institutions was conducted in waters from the Gulf of Maine to the Gulf of Mexico; these researchers investigated various fishery resource problems.

On the international front, OUR intensified NOAA's cooperative science endeavors with Japan by supporting a series of experimental dives to depths equivalent to 1,000 feet of seawater, formalizing plans for a joint program of research using the deep submersibles ALVIN (U.S.) and SHINKAI (Japan), and developing the program for the 1985 Washington meeting of the Panel on Diving Physiology and Technology of the United States-Japan Cooperative Program in Natural Resources.

This report describes OUR's achievements for fiscal year 1984 (October 1, 1983-September 30, 1984). It also describes the program's future plans in the areas of international and interagency projects, information transfer, and undersea research.

I am grateful for the expert assistance of the U.S. science community in helping the Office of Undersea Research and NOAA meet their mandated marine science responsibilities in the most efficient and effective manner possible.

Rockville, Maryland
October, 1985

Elliott Finkle,
Director

SECTION I
OVERVIEW OF RESEARCH CONDUCTED IN PRIOR YEARS

BACKGROUND

The National Oceanic and Atmospheric Administration (NOAA), created in 1970 by an Act of the United States Congress, has responsibility for the management and protection of marine resources and their habitats and the conduct and support of manned research on marine pollution, underwater sanctuaries, and ocean-related climate and weather phenomena.

To ensure the effective coordination and monitoring of NOAA's undersea research efforts, the Manned Undersea Science and Technology (MUS&T) office was established in 1971. MUS&T functioned in this capacity until 1980, at which time it was superseded by the newly organized Office of Undersea Research (OUR), under the aegis of the Office of Oceanic and Atmospheric Research (OAR).

The sections below present a brief account of the programs and activities of the MUS&T office and its successor, OUR, from the time of NOAA's inception through fiscal year 1983.

NOAA'S UNDERSEA RESEARCH PROGRAM, 1971-1980

Manned Undersea Activity

From the outset, NOAA's undersea research program has stressed the direct observation and testing of the underwater environment by marine scientists using the most sophisticated equipment and methods advanced by post-World War II marine technology. Underwater habitats, submersibles, remotely operated vehicles, and saturation diving techniques have provided the means by which NOAA, acting independently or in partnership with other agencies, institutions, or governments, has progressed to the accomplishment of its stated mission: to observe, explore, manipulate, and comprehend the world beneath the sea.

During the first decade of NOAA's operations, the MUS&T office was involved in substantive research using operational seafloor habitats, such as EDALHAB, HYDROLAB, LA CHALUPA, and HELGOLAND, and both shallow- and deep-water submersibles, e.g., JOHNSON SEA-LINK; ALVIN; NEKTON ALPHA, BETA, AND GAMMA; DEEP DIVER; DEEPSTAR 2000; DEEP QUEST; PC-8; DIAPHUS; and BEAVER MARK IV.

Among the notable marine research programs conducted by NOAA during these early years were projects such as the Bahama Banks Research Program, the international HELGOLAND program (fig. 1), the IGUANA (Intergovernmental Undersea Atomic Neutron Activation) program, and the FAMOUS (French-American Mid-Ocean Undersea Study) cooperative oceanographic effort. The results of these undertakings elicited a considerable amount of public enthusiasm and support and stimulated Congressional interest in funding continued and expanded programs in manned underwater research.

OCEANLAB

A report prepared by the MUS&T office in 1975 to satisfy a Congressional inquiry detailed the need for the development and utilization of a mobile underwater laboratory—OCEANLAB—capable of sustaining American offshore research at a depth of approximately 1,000 feet of seawater in disparate ocean temperatures and environments. One year later, Congress earmarked NOAA appropriations to 1) analyze the performance requirements and specific design technology related to construction of such a facility, 2) project future underwater research needs, and 3) conduct programs in diving training and physiology, marine science and technology, and cooperative experimentation to determine and ensure the safe and expert conduct of future OCEANLAB operations.

In compliance with this directive, the MUS&T office launched investigative research initiatives in each of the categories cited by Congress, and, in so doing, enlisted the support of members of the various scientific, academic, commercial, private, and governmental sectors that shared

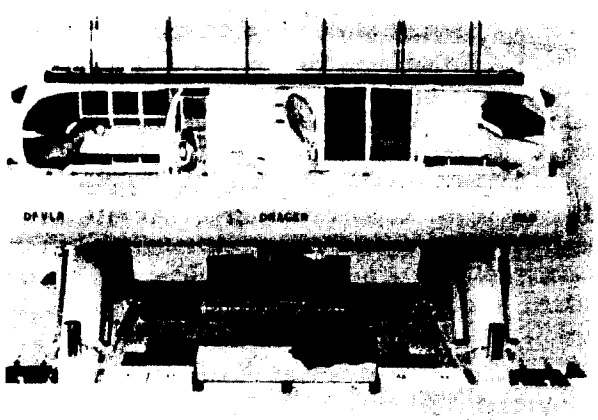


Figure 1.—Side view of HELGOLAND habitat.

an interest in or might be affected by the outcome of such research. By 1978, the OCEANLAB Concept Review, a thorough analysis and evaluation of the OCEANLAB program to date, was completed. As a result of this review, NOAA officials modified the original direction of the program to reflect concerns for increased cost-effectiveness and flexibility. The revised program called for better utilization of existing resources through a regional facilities approach.

To meet this challenge, a better notion of who, what, how, where, and when was necessary to determine and define the manned underwater research needs of the science community in terms of facilities, capabilities, methodologies, and expertise. Also needed was an exhaustive catalog of already available human and technological resources and their logistics. To this end, the Ocean Science Board (now known as the Board on Ocean Science and Policy) of the National Research Council undertook a phased course of action to provide answers to these questions and make policy and program recommendations for the future.

The Board's efforts confirmed the need for OCEANLAB capabilities in a number of research areas and also revealed the identities of a large group of scientists available to perform the necessary specialized tasks to move forward in these areas. Recommendations called for expansion of the existing undersea research program using available resources and techniques, such as submersibles and saturation diving, to the best possible advantage. In addition, the development of new underwater technology was cited as a pressing research need.

UNOLS Submersible Science Study

In 1977, NOAA collaborated with the National Science Foundation and the Office of Naval Research to sponsor a study to determine the immediate and long-range needs for research submersibles. The project was carried out between 1979-1982 by the Alvin Review Committee, a part of the University National Oceanographic Laboratory System (UNOLS), and was based at the Lamont-Doherty Geological Observatory.

A tripartite study team—comprised of a project office, a science assessment panel, and a facilities planning task force—was charged with the task of reviewing past and present technical requirements of manned and unmanned underwater research facilities and estimating the future demand for and technical requirements of such vehicles. The investigation focused primarily on the capabilities and usefulness of the deep-water submersible ALVIN and its support ship LULU (fig. 2). The study team's final report, *Submersible Science Study*, was published in 1982 and included short-term recommendations which called for modifications and improvements of the deep-submersible ALVIN and replacement of its support ship, the R/V LULU, by a larger vessel with greater capacity and capability. Other short-term recommendations included the need for submersible subsystems, robotic vehicles, and shallow-water manned submersibles for mid-water and under-ice missions.

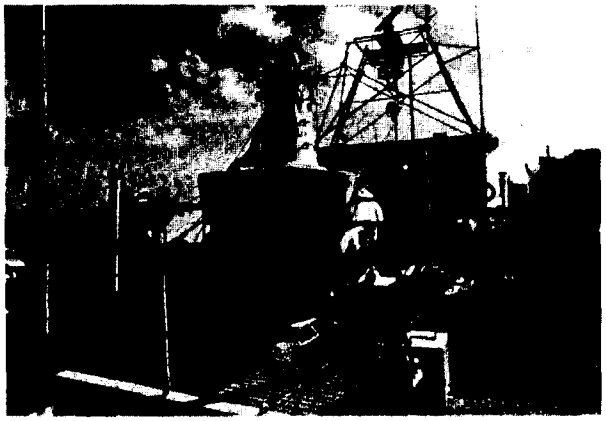


Figure 2.—ALVIN deep-water submersible onboard the LULU.

To ensure that submersibles are capable of meeting future needs, the study recommended ongoing development of sophisticated technology for submersibles, the availability of a submersible with a 6,000-meter depth limit, and continued funding for projects aimed at the design and construction of deep-ocean submersibles. Topics for long-term research identified in the report include: ocean crustal studies, abyssal sedimentation projects, continental margin erosion research, and mid-water and under-ice missions.

Information Transfer

Projects that support publications, data collection/dissemination, and workshops for the health and safety of divers have been an important element in NOAA's undersea research program since its inception. Notable examples of activities falling under this information transfer component of the overall program include the publication, in 1975 and 1979, of the first and second editions of the *NOAA Diving Manual* (fig. 3); sponsorship of workshops on subjects ranging from the pathophysiology of oxygen to safety procedures for excursions from saturation diving; and development of a national symposium series for underwater research, which provides a forum for scientific discussion and the presentation of important research papers.

International Activities

Another significant part of NOAA's undersea research program has been participation in cooperative international efforts to advance the aims of marine science.

One of the earliest of such joint projects is the United States-Japan Natural Resources (UJNR) program, established in 1964 to increase the efficiency of natural resource development and planning. A more recent example is the U.S.-France Cooperation in Oceanography program. To date, NOAA has sponsored joint undersea research projects with 10 countries.

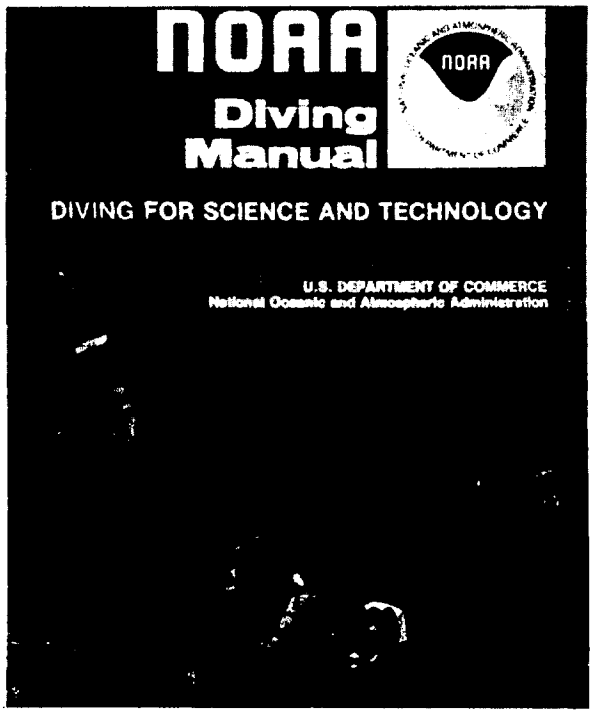


Figure 3.—Cover of NOAA Diving Manual (2nd edition).

Federal Interagency Programs

In addition to its involvement in joint international underwater research efforts, NOAA actively engages in cooperative marine research projects with other Federal agencies. One such program is the National Underwater Accident Data Center, co-sponsored by NOAA and the U.S. Coast Guard, which collects, analyzes, and disseminates information on underwater diving fatalities in this country. NOAA has collaborated in undertakings with many other Federal agencies, including the Environmental Protection Agency, the National Institutes of Health, the National Bureau of Standards, the U.S. Navy, and the Occupational Safety and Health Administration.

Diving Research and Safety

Diving technology and related research projects also have an important place in NOAA's undersea research program. Studies on various aspects of diving medicine and diving safety, as well as the development of sophisticated diving equipment, belong in this category.

RESEARCH PROGRAM OF THE OFFICE OF UNDERSEA RESEARCH, 1980-1983

In 1980, the Office of Undersea Research, newly named and directed as a result of the reorganization of the MUS&T program, announced its policy and program goals: to continue support for existing undersea research facilities, to continue support for the deep-water submersible ALVIN, to develop new cooperative regional undersea laboratories, and to support diving research and development.

Deep-Water Submersible Support

Over the years, NOAA, in conjunction with the Office of Naval Research (ONR) and the National Science Foundation (NSF), has sponsored a series of deep research dives involving the ALVIN/LULU system, operated by the Woods Hole Oceanographic Institution. This cooperative arrangement was extended in 1981 in a 3-year tri-agency agreement that governs the use of the ALVIN/LULU system. Four major research missions have been conducted since that time. In 1981, the ALVIN was used in the St. Croix Submersible Expedition and the Ecuador Rift-Inca Transform-Galapagos Rift Study. In 1982, ALVIN supported geological, geophysical, and geochemical studies of the Mid-Atlantic Ridge hydrothermal fields and, with its support ship LULU, continued biological and geological investigations in Oceanographer Canyon. Activities involving the ALVIN/LULU system were suspended during 1983 to permit its renovation.

Shallow-Water Submersible Support

The use of shallow-water submersibles to support underwater research has been a key in NOAA's program activities throughout its existence. During the period 1981-83, research activities involved the use of the submersible/support vessel systems JOHNSON SEA-LINK/JOHNSON, JOHNSON SEA-LINK/GLORIA MICHELLE, NEKTON GAMMA/GOLD N CLOUD, and the MERMAID/ALOHA to investigate natural processes and animal habitats in the nation's coastal zones. Under a series of cooperative agreements, NOAA and the Harbor Branch Foundation, which owns and operates the JOHNSON SEA-LINK (fig. 4), have shared costs and resources for a number of years in projects of mutual interest.

In 1983, OUR sponsored major shallow-water cruises on the Atlantic Continental Shelf and off the coast of Sitka, Alaska. The eastern cruise was conducted over a 10-week period in six separate legs, each of which had its discrete mission and scientific staff, supported by the vessel R/V JOHNSON and the JOHNSON SEA-LINK submersible. A brief description of the project's varied missions is presented below:

- to study the distribution of bioluminescence at different depths
- to monitor contamination levels in indicator species and general ecosystem response
- to determine the abundance, distribution, habitat, and behavior of several species of marine life, including the commercially important tilefish
- to explore archeological evidence of the shipwrecked USS MONITOR and survey the marine sanctuary where the MONITOR lies

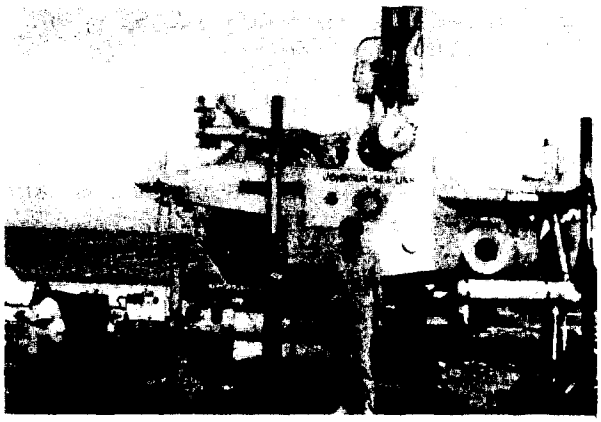


Figure 4.—JOHNSON SEA-LINK submersible preparing for launch.

- to determine the biomass of fish populations in the Onslow Bay area
- to assess the physical and biological factors influencing the effectiveness of various types of passive fishing gear

The Alaska mission, of more limited scope and duration, was a follow-up study of the 1982 SEA SUB expedition. Findings from the 52 submersible dives involved in the 1983 project corroborated earlier results showing that halibut preferred herring over other types of bait and that both halibut and rockfish could be more easily caught when circle hooks were employed by fishermen.

National Undersea Research Program

An important impetus for restructuring the NOAA program in 1980 was the perceived need for the development of a network of undersea research support facilities. A successful model was already in existence in the Caribbean Undersea Research Program, a 1978 initiative involving the use of the seafloor habitat HYDROLAB under a cooperative agreement between NOAA and the West Indies Laboratory of Fairleigh Dickinson University.

Building on the Caribbean model, NOAA entered into similar agreements, in 1980, with the University of Hawaii, the University of Southern California, and the University of North Carolina at Wilmington. In 1983, a fifth program was instituted with the University of Connecticut at Avery Point. Plans for the future include further expansion of this national undersea research facilities network. Section II contains a detailed description of these programs.

SECTION II
NOAA'S NATIONAL UNDERSEA RESEARCH PROGRAM

HISTORY

As part of the Congressional mandate that established NOAA in 1970, the new agency was given responsibility for developing programs for the assessment, protection, development, and utilization of the coastal zone resources of the United States. To fulfill this responsibility, NOAA began its National Undersea Research Program in 1977. The program was charged with providing manned underwater facilities and other research support for scientific investigations of coastal marine environments and for research into underwater biological, geological, and ecological programs.

NOAA's first manned regional underwater research facility was established in 1977 in St. Croix, Virgin Islands, and its programs revolved around the newly refurbished saturation diving habitat HYDROLAB (fig. 5). The success of the Caribbean program, coupled with the scientific community's expressed desire for expanded facilities, prompted NOAA to broaden its program to include several national underwater laboratories at scientifically significant sites. An expanded national approach to learning more about the country's various coastal zone areas would advance the state of undersea research by taking advantage of existing local personnel and research resources in an efficient and cost-effective manner.

NOAA advised more than 400 academic institutions of its intention to establish and maintain a national network of underwater research facilities and invited letters of interest. Fifteen institutions responded and, of these, nine were asked to submit detailed feasibility studies. After careful review and analysis by a panel of marine scientists and engineers, three respondents were selected to submit formal program proposals: the University of Hawaii, the University of Southern California, and the University of North Carolina at Wilmington. This process resulted in the signing of formal cooperative agreements between NOAA and each of these institutions in 1980. A fifth national facility program located at the University of Connecticut at Avery Point was established and brought into the network in 1982-83. Figure 6 shows the locations of NOAA's existing and future national undersea research facilities.

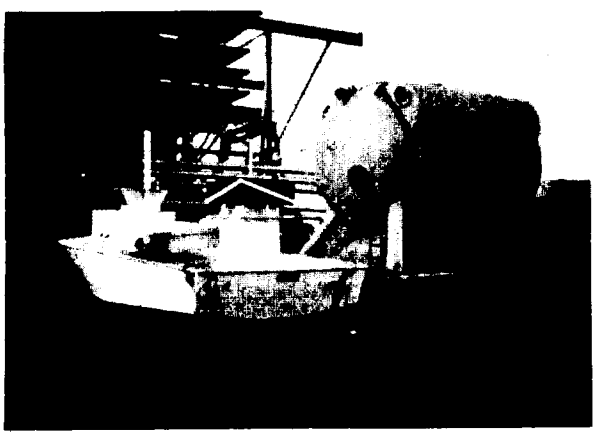


Figure 5.—Habitat HYDROLAB and its life support buoy.

NOAA'S NATIONAL UNDERSEA RESEARCH PROGRAM AT FAIRLEIGH DICKINSON UNIVERSITY (ST. CROIX)

The oldest and most active element of NOAA's national laboratory program is located in the U.S. Virgin Islands and operated by the West Indies Laboratory of Fairleigh Dickinson University. Established in 1977, the Caribbean National Undersea Research Program relies on the undersea saturation diving habitat HYDROLAB, in place on the seafloor in the Salt River Canyon off the north-central

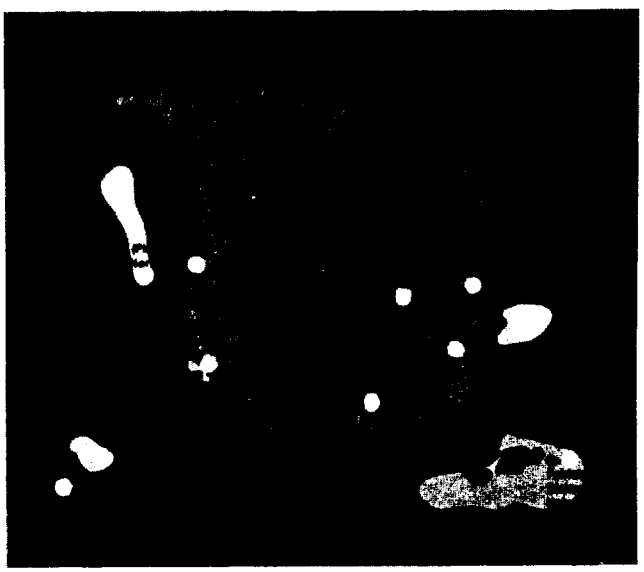


Figure 6.—Map showing locations of OUR's present and planned undersea research facilities.

Table II-1.—FY 1984 NOAA's National Undersea Research Program Missions at Fairleigh Dickinson University (St. Croix)

Participating Institutions	Date of Mission and Purpose	Principal Investigator(s)
Texas A&M University; National Marine Fisheries Service, NOAA; NOAA Ship FERREL	1/30/84—2/9/84 Evaluation of Multilevel Artificial Structures in the Attraction of Deep Reef Fishes	Andre M. Landry, Jr.
National Marine Fisheries Service, NOAA; Texas A&M University; NOAA Ship FERREL	1/30/84—2/9/84 Evaluation of the Potential of Using Fish-Attracting Devices to Attract Harvestable Concentrations of Coastal Pelagic Fishes Into Shallow Caribbean Waters	Ian K. Workman
U.S. Virgin Islands, Department of Conservation and Cultural Affairs	2/20/84—3/3/84 Working Divers' Tasks	Marcia Gilnack
University of Puerto Rico; Auburn University	3/12/84—3/24/84 Early Life History and Host Relationships of *Anilocra chromis*	Ernest H. Williams, Jr.
West Indies Laboratory, Fairleigh Dickinson University; North Dakota Geological Survey; University of Chicago; Northern Illinois University	3/24/84—4/5/84 Geological Development of Salt River Submarine Canyon	Dennis K. Hubbard
American Museum of Natural History	4/23/84—5/3/84 Diversity and Relative Abundance of Fish Larval Stages	C. Lavett Smith; James C. Tyler
Universite Antilles-Guyane, French West Indies	4/23/84—5/3/84 Irradiance Measurements, Correlation Bathymetric Distribution of Scleractinian Corals in Salt River Canyon, St. Croix	Claude Bouchon
University of Miami; U.S. Virgin Islands, Division of Fish and Wildlife; University of Puerto Rico; Philadelphia Academy of Sciences	5/11/84—5/28/84 Nutrient Regeneration in Coral Reef Sediments	Alina Szmant-Froelich
Harvard University; Yale University	6/7/84—6/14/84 Effect of Water Flow on Coral Respiration and Productivity	Kenneth P. Sebens
West Indies Laboratory, Fairleigh Dickinson University; State University of New York at Stony Brook	7/2/84—7/12/84 Diurnal Growth Patterns in *Halophila* and *Caulerpa*	Susan Lynn Williams
San Francisco State University; National Marine Fisheries Service, NOAA	7/26/84—8/2/84 Ecological Function and Fishery Resources of *Halophila* in the Caribbean	Ralph J. Larson
Skidaway Institute of Oceanography; University of Georgia; Monroe County Department of Planning, Key West, Florida; West Indies Laboratory, Fairleigh Dickinson University	8/13/84—8/25/84 Chemical Ecology of Space Competition Between Sponges and Corals	Nancy McKeever Targett
Goucher College; Stanford University; University of Utah; Associacion de Biologos Ambulantes	9/24/84—10/4/84 Role of Cleaning Stations in Overall Fish Community Organization Along a Depth Gradient at Salt River Canyon, St. Croix	William S. Johnson

coast of St. Croix, to carry out its program of manned underwater research.

Since its inception, the Caribbean program has supported more than 83 science missions involving scientists/aquanauts from institutions and governments around the world. In 1984, the program logged 14 missions representing 9,132 saturation hours and 1,951 excursion man-hours. Throughout its operational existence, the HYDROLAB-based program has maintained an exemplary record of underwater safety, a fact which speaks to the rigorous training and certification procedures required of all participants involved in NOAA-sponsored science missions.

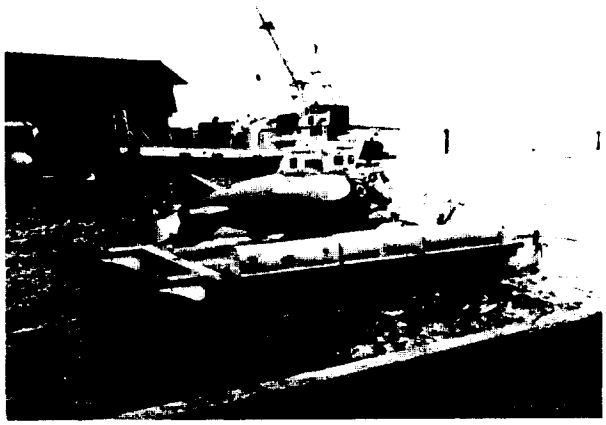


Figure 7.—The MAKALI'I, star of the Hawaiian undersea research program.

During FY 1984, research projects conducted from the HYDROLAB covered a wide range of scientific inquiry, as summarized in table II-1. The West Indies Laboratory accepts proposals in all of the technical areas of NOAA's research priorities: primary productivity and nutrient cycling, fisheries, marine pollution, seafloor properties and processes, and ocean services.

NOAA'S NATIONAL UNDERSEA RESEARCH PROGRAM AT THE UNIVERSITY OF HAWAII

With headquarters at the Makai Research Pier at Makapuu Point on the island of Oahu, the National Undersea Research Program (NURP) in Hawaii, developed by the University of Hawaii as the second component of NOAA's network, serves the Pacific area's community of marine scientists. The two-man research submersible MAKALI'I and the Launch, Recovery, and Transport (LRT) vehicle HIILAWE together form the mainstay vessels of the Hawaiian program and support research in the key areas of fisheries, pollution, seafloor properties and processes, and ocean technology and services.

The MAKALI'I (fig. 7) is a single-atmosphere submersible with a depth capability of 380 meters and an operating speed of 1 to 3 knots. The submersible can accommodate a pilot, an observer scientist, and a payload of approximately 200 pounds. After total refurbishing, the MAKALI'I was certified as an A-1 submersible by the American Bureau of Shipping (ABS) in 1981.

The LRT HIILAWE was designed to transport and deploy the MAKALI'I. It can be controlled by scuba divers as it is towed, carrying the MAKALI'I, to the launch site by a surface support vessel. At the launch site, the LRT submerges to permit the submersible to be launched and retrieved in the more serene waters that lie beneath the high-energy surface waters.

In addition to the submersible MAKALI'I and the LRT HIILAWE, a recompression chamber, refurbished to meet the NOAA Diving Safety Board's standards, is available as an on-site hyperbaric treatment center for scientists and crew members involved in the Hawaiian program's activities. The program also operates SNOOPY, a small remotely operated vehicle (ROV) equipped with a black-and-white video camera or a super 8-mm movie camera to photograph undersea research subjects in waters up to 1,200 fsw in depth.

In 1984, the Hawaiian program sponsored two major projects: the Johnston Atoll Research Project, designed to use the MAKALI'I in a series of dives to investigate the environmental feasibility of disposing of scrubber brine waste generated by the proposed Johnston Atoll Chemical Agent Disposal System (JACADS); and the Leeward Islands Mission, an interagency submersible science study to explore the mineral resource potential and environmental properties associated with cobalt-enriched manganese crusts. Table II-2 summarizes the details of the Hawaiian program's activities for FY 1984.

Johnston Atoll Research Project

The U.S. Army Corps of Engineers joined with NOAA to fund a 2-month research effort that collected baseline information required by the Environmental Protection Agency on two slopes of Johnston Atoll, the testing sites for the proposed disposal system. The JACADS process uses incineration to destroy the chemical agents and other combustible materials used in the munitions. Gases generated through the incineration process are put through scrubbers to reduce air emissions. The brine that accumulates from the scrubber process, consisting of ionic compounds commonly found in seawater and unknown quantities of several heavy metals, was studied for potential suitability for ocean disposal. Because heavy metals generally are thought to be toxic, other studies involved with the JACADS environmental program will investigate the brine's potentially toxic effects on the marine environment.

The total project consisted of four separate studies dealing with environmental monitoring, fisheries assessment, island processes, and biogeography. A total of 35 dives to depths of 400 meters were conducted around the Atoll.

During the baseline studies phase of the project, scientists used the MAKALI'I to investigate the geological, physical, chemical, and biological features of the two proposed sites. Preliminary results indicate that the area studied is low in faunal and floral diversity and abundance, probably because of the steep, smooth limestone-and-sediment-covered slopes. Considerable amounts of previously disposed of metallic material and other debris were observed in the study area. The scientific team's physical oceanographic studies showed circular and variable current patterns off the leeward side of the Atoll—an indication that further investigations might be better conducted at a greater distance offshore. The submersible was used to monitor a disposal of 500 gallons of salt, water, and dye of the same density as the proposed JACADS brine. This "mock" brine descended to a depth of 25 meters and spread

Table II-2.—FY 1984 NOAA's National Undersea Research Program Missions at University of Hawaii

Participating Institutions	Date of Mission and Purpose	Principal Investigator(s)
U.S. Army Corps of Engineers; Environmental Protection Agency; National Marine Fisheries Service, NOAA; U.S. Fish and Wildlife Service; Harvard University; University of Hawaii; University of Guam; Bishop Museum	35 missions between 9/3/83 and 10/24/83 Environmental and Ecological Investigations at Johnston Atoll	James E. Maragos; Richard Shomura; Phillip Lobel; Stephen Ralston; Reginald M. Gooding; Gerald Ludwig; Barbara Keating; Catherine Agegian; Edith Chave; Lucius Eldridge; John E. Randall
University of Hawaii; National Marine Fisheries Service, NOAA; Department Geology, Institut Francais de Recherche Scientifique pour le Developpement en Cooperation, New Caledonia	1/14/84; 1/17/84; 1/20/84 Orientation, Public Relations and Exploratory Dives	Edith Chave; Alan Hulbert; Patrick Maillet; Michael Sullivan
University of Hawaii	1/16/84 Biological and Geological Investigations of Deep Overhangs	Edith Chave
University of Hawaii	1/19/84 Coral Bioluminescence/Precious Corals	Richard Grigg
University of Hawaii; Hawaii Institute of Marine Biology	2/2/84 Equipment Testing and Exporation Dive for Pink Coral Recolonization Project	Edith Chave; Richard Grigg
National Marine Fisheries Service, NOAA; Hawaiian Shrimp Company	2/5/84—2/14/84 Observations of Deep Water Shrimp *Heterocarpus ensifer* Distribution Relative to Bottom Type and Trap Design	Reginald M. Gooding
University of Hawaii; NOAA Sea Grant; State of Hawaii	3/3/84—3/30/84 Hydrology, Chemistry and Biology of Geothermal Systems on Submarine Rift Zones in Hawaii	Gary McMurtry; David Epp; David Karl
University of Hawaii; Environmental Protection Agency; City and County of Honolulu	5/14/84—6/29/84 Impact of Deep Ocean Sewage Outfalls or Sediment Processes in the Hawaiian Islands; Microbial Metabolism and Nutrient Cycling	S. J. Dollar
University of Hawaii; National Marine Fisheries Service, NOAA; Minerals Management Services, U.S. Department of Interior	9/10/84—9/26/84 Investigation of Manganese Crusts and Fisheries in the North Western Hawaiian Islands	S. J. Dollar; Stephen Ralston; Charles Morgan; Richard Grigg; Fred MacKenzie; Jane Schoonmaker

out. Results of this test will be extremely valuable in making accurate predictions of the fate of the brine dumped at a selected disposal site in advance of any actual decision to dump.

A second phase of the project dealt with investigations of deep benthic fishes (mainly snappers, groupers, and jacks) in 10 localities around Johnston Atoll. These different locations contained varying quantities of the fishes, and the NOAA research vessel, TOWNSEND CROMWELL, is following up the submersible investigations with additional studies in the same locations to correlate the observed abundance of the fishes with the catch of these fishes at each station.

The third component of the project employed the submersible in three additional sites around Johnston Atoll to study its geological evolution. Limestone caves with stalactites and stalagmites—indicators of dissolution above sea level—were discovered at 400 meters below the Atoll's surface, pointing to the conclusion that the Atoll has submerged at least the equivalent of that depth over time. Additional dives involving a deeper submersible are proposed at Johnston Atoll to study its volcanic history.

The final element of the JACADS project consisted of two dives on the south slopes of the Atoll to determine deep-water algal diversity and abundance. The overall algal diversity was found to be low in comparison to that typical of Hawaii, although above 75 meters and in localized areas, algal abundance was extremely high.

Leeward Islands Mission at French Frigate Shoals

A month-long investigation of the mineral resource potential and environmental properties associated with

cobalt-enriched manganese crusts, supported cooperatively by NOAA's Undersea Research Program office, NOAA's Office of Ocean and Coastal Resource Management, and the Department of Interior's Minerals Management Service, was conducted on the submerged slopes of islands and seamounts in the exclusive economic zone that surrounds the northwestern Hawaiian Islands. The testing site was the shallow area in the vicinity of French Frigate Shoals.

The support vessel R/V KILA was used to transport the submersible MAKALI'I and the LRT HIILAWE to the French Frigate Shoals site in early September 1984. Once there, scientist/aquanauts used the MAKALI'I to assess the benthic communities present on the seafloor, to collect measurements on and samples of the water column, and to investigate the geology of the seafloor, with particular emphasis on the distribution of the ferromanganese crusts and their associated biota. This information is essential in determining the potential environmental effects from future mining of these recently discovered crustal deposits.

NOAA'S NATIONAL UNDERSEA RESEARCH PROGRAM AT THE UNIVERSITY OF SOUTHERN CALIFORNIA

The third link of the NURP chain of national facilities is located 25 miles off the coast of Los Angeles, on Santa Catalina Island, and is administered by the University of Southern California. The setting provides an ideal base for marine research in temperate waters using saturation diving techniques.

In May 1982, plans for the design of a saturation habitat system were completed, and construction was begun with a targeted operational date sometime in 1986. The basic habitat will consist of a double-lock chamber capable of both bottom and surface decompression. It will be towable through the use of submersible-type ballast tanks and a haul-down system for routine submergence and recovery. Hauling-down and recovering the habitat can be accomplished by implanting a movable and negatively buoyant base-plate on the seafloor of the research site. Designed to be operated without dependence on external controls, the habitat will be able to accommodate and support 6 aquanauts on missions of 7 to 10 days' duration. The physical working range of aquanauts will be extended by the use of diver way-stations (fig. 8), which are open diving bells equipped with communications, breathing gas supplies, and electrical power supplied by an umbilical from the main habitat.

During the 1983-84 period, program activities emphasized the construction and testing of the way-station, devising and testing of way-station and other diving procedures, and soliciting proposals from scientists for use of the systems. After completion and testing of the way-station and NOAA acceptance of the operational protocols, the program was ready, in August 1984, to begin its calendar year 1984 mission schedule. Those missions begun in the period

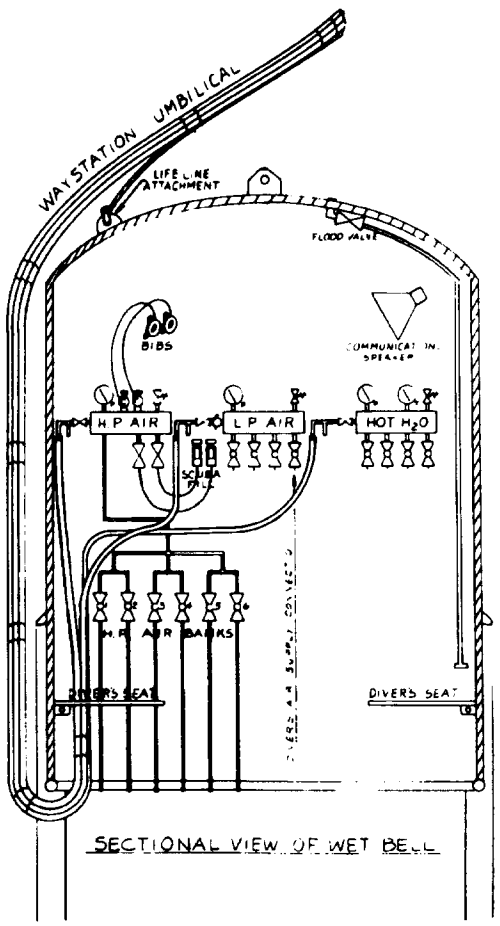


Figure 8.—Schematic of diver way-station used in University of Southern California's undersea research program.

covered by this report—October 1, 1983, through September 30, 1984—are summarized below and in table II-3.

Importation by Fishes of Nutrients into Deep Rocky Reefs

Building on previous studies conducted to determine the role that fishes and macroinvertebrates play in providing nutrients to macroalgae living in temperate rocky reefs, the NURP/USC studies permitted scientists to dive to greater depths for longer periods to conduct *in situ* nutrient research. The results obtained from the initial missions in this ongoing project are the development of new and more efficient incubation chambers and refined underwater sampling techniques. In addition, ammonium and phosphate excretion experiments were completed on 10 species of fish and invertebrates, and over 350 samples were collected and analyzed.

Evaluation of Underwater Video Systems in Scientific Research

Using the NOAA tethered diving system, with its capability for diver-to-diver communication and extended bottom

Table II-3.—FY 1984 NOAA's National Undersea Research Program Missions at University of Southern California

Participating Institutions	Date of Mission and Purpose	Principal Investigator(s)
California State University	8/10/85—8/12/84 Importation of Nutrients by the Blacksmith (*Chromis punctipinnus*) into Deep Rocky Reefs	Richard Bray; Alan Miller
Saddleback College; University of Southern California	8/14/84—8/18/84 Evaluation of Underwater Self-Contained Video Systems as a Documentation Medium	Joseph Valencic; Robert Given
San Francisco State University	8/19/84—8/26/84 Benthic Drift Algae on Deep Sand Bottoms	Michael Josselyn
University of California	8/28/84—9/1/84; 9/17/84—9/20/84 Olfactory Attractants and Foraging Behavior of Demersal Zooplankton	William Hamner

times, aquanauts were able to evaluate the ability of a self-contained high-technology underwater video system to record scientific observations and research accurately. The use of the way-station provided a safe and comfortable haven for decompression and additionally offered a place where scientists could discuss their results. Preliminary results of this project include the development of methods for calibrating camera systems for optimum use in both long- and short-range video documentation; the development of methods for computerizing video images to conduct fish counts and record behavior; and the production of video-taped documentation of large areas of the seafloor that showed the loss of biota caused by the 1982-83 oceanographic phenomenon known as *El Nino*.

Ecology of Drift Algae Within Kelp Beds

As part of the present interest in the dynamics of nutrient cycling through ecosystems, this exploratory mission investigated the applicability of tether diving to studying the formation and movement of drift algae and sought to devise methods for studying the effects of such formations and movement on soft-bottom communities. Transects were surveyed to determine the extent and abundance of drift algae in prime Catalina study sites and, by using plastic domes and analyzing net oxygen production, to measure the community metabolism of drift algal clumps. Although the amounts of drift algae were subnormal (an effect of *El Nino*), preliminary findings indicate that the potential for conducting a multifaceted study exists.

Olfactory Attractants and Foraging Behavior of Demersal Zooplankton

The use of tether diving for research on the behavior and natural history of the organisms that comprise the midwater biota was thoroughly tested and evaluated. It was found that the communications capability offered by tether diving and the safety and range offered by the way-station combined to provide a system that is versatile and well suited to conduct the very delicate experiments necessary to study the foraging behavior of various midwater organisms. Complex baited traps were devised and used to collect organisms, and behavior was observed using fluorescein dye. Results of the actual captures are being analyzed at the present time.

Proposals submitted for future funding include several recommending continuation of projects initiated during the 1984 mission schedule, as well as many for new projects. In addition, the NURP/USC program will continue to add new capabilities, such as hot water and video documentation, as they become available.

NOAA'S NATIONAL UNDERSEA RESEARCH PROGRAM AT THE UNIVERSITY OF NORTH CAROLINA-WILMINGTON

The fourth component of NOAA's national underwater research program was initiated in 1980 through a cooperative agreement between NOAA, the University of North Carolina at Wilmington (UNC-W), and the Southeastern Consortium for Undersea Research Efforts (SECURE). Major research interests of this program include marine fisheries, seafloor processes, petroleum pollution, ocean dumping, dredge spoil disposal, and diving medicine and safety. Scientific investigations related to these topics are conducted in the waters over the Continental Shelf.

Facilities

The program's principal activity during its infancy was to transform the shrimp trawler LADY ELLEN into the state-of-the-art Research Vessel (R/V) SEAHAWK. Equipped with sophisticated electronics, a deck decompression chamber, a refrigerated specimen storage area, an ample and modern laboratory, and an 82-foot dive platform, the R/V SEAHAWK can accommodate 12 persons on 3-5 day missions and is capable of supporting divers operating in

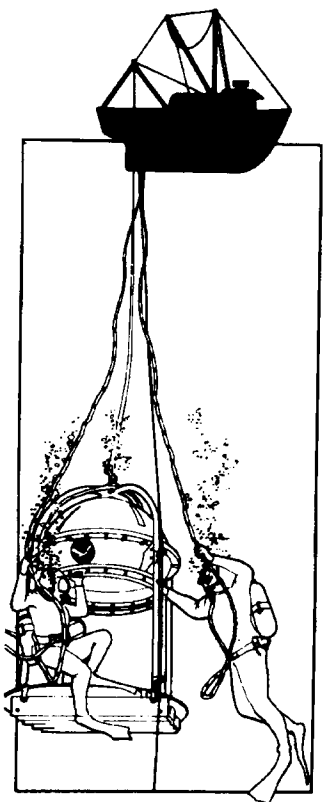
the scuba, surface-supplied air, or mixed gas diving modes. Divers can conduct research at depths as great as 300 fsw, and their safety is enhanced by using the available open diving bell (fig. 9).

Research

During 1984, 18 scientists from 8 institutions and government agencies participated in various research activities using the SEAHAWK. Table II-4 provides summary information on UNC-W activities in FY 1984. Projects were undertaken to evaluate seafloor processes in the Chesapeake Bay, assess the growth and development of the ocean quahog, and investigate deep algal mats. These studies are described below.

Seafloor Processes in the Chesapeake Bay

The studies conducted by the SEAHAWK have laid the foundation for a large multidisciplinary study by biologists and geologists of the physical and biological parameters affecting the productivity of the benthic boundary layer. Current plans are to expand this project beyond the Chesapeake, using instruments to monitor the activity of benthic flora and fauna.



The R/V Seahawk *supplies air, communications, and a tether from the surface for scientists working out of the wet bell on the sea floor.*

Figure 9.—Schematic of R/V SEAHAWK's wet bell system.

New Jersey Fisheries

Experiments using the SEAHAWK were conducted to corroborate the findings of laboratory results involving the growth and development of *Arctica islandica*, the ocean quahog, which is an important fishery resource species of the area. Laboratory results show significantly rapid growth rates for this species. Verified field results can have an important impact on the management of this resource.

Productivity and Respiration of Deep Algal Mats

These studies are among the first in the world to investigate these deep algal communities, and results indicate that established scientific concepts probably require re-analysis. During the project, significant amounts of fresh water, laced with contaminants, were discovered seeping into the coral reefs from subterranean aquifers off Key Largo, Florida. This discovery of a new source of contaminants potentially hazardous to the Coral Reef National Sanctuary may be critically important to aiding reef preservation throughout the Caribbean Basin and could directly impact the fishing industry, which is affected by contaminants because of runoff.

During 1985 the SEAHAWK will be used to conduct a study designed to discover pharmaceuticals in Bermuda invertebrates and algae; the study will involve the extensive collection of marine plants and animals for research use. The project's ultimate objective is to explore the potential for new biomedical drug development. In addition, the SEAHAWK will be used in a collaborative project with the Bermuda Biological Station to observe new species of deep water algae, some of which may be harvestable and profitable.

NOAA'S NATIONAL UNDERSEA RESEARCH PROGRAM AT THE UNIVERSITY OF CONNECTICUT

The fifth and most recently developed facility in NURP's national network is located at the University of Connecticut at Avery Point (UCAP). This facility is designed to meet the underwater research needs of scientists in the northeastern section of the United States. Since its establishment in late 1983, three subcommittees of the program's Advisory Board were created to focus on 1) Priorities/Planning; 2) Technology Evaluation/Development, and 3) Proposal Review. In addition, introductory seminars were held in the Maine, New Hampshire, and Rhode Island regions to acquaint the scientific community with the purposes, goals, and planned activities of the Northeast Undersea Research Program.

The program sponsored two significant and successful research endeavors during Fiscal Year 1984. On May 22-24, NURP-UCAP hosted the NOAA Office of Undersea Research annual symposium, which attracted some 200 attendees. The conference, entitled "Undersea Research and Technology—Scientific Applications and Future

Table II-4.—FY 1984 NOAA's National Undersea Research Program Missions at University of North Carolina-Wilmington

Participating Institutions	Date of Mission and Purpose	Principal Investigator(s)
University of North Carolina	10/10/83—11/19/83 Assessment of Fish Abundance, Spatial Patterns for Herbivory, and Importance of Chemical Composition in Determining Susceptibility of Macroalgae to Grazing by Fishes	Mark Hay
Virginia Polytechnic Institute and State University	11/19/83—12/9/83 and 4/5/84—4/20/84 Importance of Ground Water Influx to the Productivity and Perturbation of Coral Reef Ecosystems	George M. Simmons
University of North Carolina	4/20/84; 7/26/84-7/27/84; 8/15/84-8/16/84; 9/26/84 Biomass and Productivity of Benthic Microalgae and Demersal Zooplankton in Onslow Bay	Lawrence Cahoon; Anne B. McCrary
Virginia Institute of Marine Science	7/20/84—7/23/84 Benthic Boundary Layer Processes on the Inner Continental Shelf From the Mouth of Chesapeake Bay to Duell, NC	Robert J. Byrne; L. D. Wright
Rutgers University; Virginia Institute of Marine Science	7/26/84—7/31/84 *In Situ* Studies of Ocean Quahog Growth in Natural Populations	Richard Lutz; Michael Castagna
University of North Carolina	8/15/84—8/16/84 Recruitment and Substrate Preferences in Demersal Zooplankton and Invertebrate Larvae	Anne B. McCrary
Duke University; Salve-Regina—The Newport College	8/22/84—8/26/84 Primary Productivity Measurements of Continental Shelf Seaweeds off Cape Fear	Joseph Ramus; Paulette Peckol

Needs," provided a forum for assessing the research requirements of the region's marine scientists to ensure that the ongoing design of the University of Connecticut's science program is responsive and effective. The symposium's proceedings, which included 23 scientific papers, is scheduled for publication in 1985.

The second major component of the NURP-UCAP program took place during the period from July 23 to August 8, 1984. A three-phased cruise in the Gulf of Maine, using the submersible MERMAID II, the ROV RECON IV, and the support ship ALOHA (fig. 10), undertook the accomplishment of three separate objectives. Leg I (July 23-28) had as its purpose the study of dredge disposal sites, two of which were active (offshore from Boston and Portland) and one, a discontinued site off Cape Arundel, Maine, which is being reconsidered for active use. During this phase, a sophisticated precision navigation system was employed to map the extent of dredge piles accurately, and data were collected on disposed material, natural substrate, and marine community conditions and interactions. Leg II (July 30-August 3) focused on the ecology of soft-bottom substrate in the Gulf of Maine, and Leg III (August 4-8) concentrated on hard-bottom areas. Operations on the latter two legs frequently took place in areas which, in the past, had been sampled intensively from surface vessels but which scientists had never viewed *in situ*. Each of the cruise's three legs provided many scientists with their first opportunity to use advanced undersea systems and to compare the operational capabilities of manned (MERMAID II) and unmanned (RECON IV) underwater facilities.

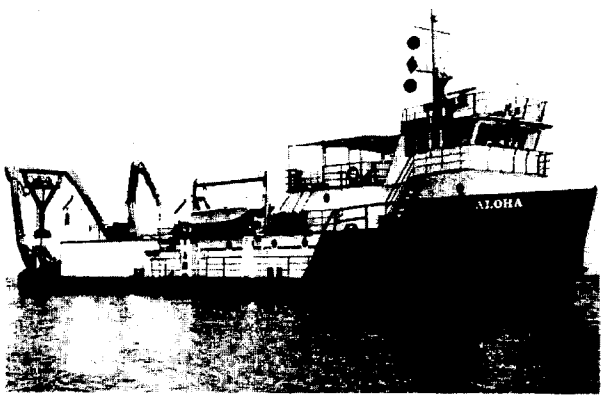


Figure 10.—The ALOHA, support vessel for undersea research projects.

The UCAP proposal submission/review processes and criteria have been refined during this first operational year, with an eye toward an expanded program of activities in FY 1985.

SECTION III
SUBMERSIBLE SUPPORT PROGRAMS

BACKGROUND

Both deep- and shallow-water submersibles have been used extensively in NOAA's underwater research program since the early 1970's. The value of submersibles to the diver/scientist lies in their maneuverability, their mobility, and their ability to provide shelter for long periods at depth. For *in-situ* underwater observation and data-gathering activities, such as rough bottom topography studies, ocean dumping studies, and investigations of time-related or dynamic functions, submersibles have ideal capabilities.

After careful peer review of proposals submitted by marine scientists, NOAA selects winning proposals and funds the submersible portion of the proposed research. The submersible vehicles/support ships utilized in these various projects are owned and operated by private companies, academic and scientific institutions, and the U.S. Navy.

DEEP-WATER SUBMERSIBLE PROGRAMS

The most widely used deep-water submersible in NOAA-sponsored research has been the ALVIN, a Navy-owned vehicle which, along with its support ship ATLANTIS II (fig. 11), is operated by the Woods Hole Oceanographic Institution under a cooperative support agreement between NOAA, the Office of Naval Research, and the National Science Foundation. ALVIN, which has a depth capability of 4,000 meters, has supported NOAA diver/scientists in numerous missions, including biological exploration of the Galapagos rift vents, studies of the benthic resedimentation associated with deep mining in the Pacific Ocean, and biological and geological research in the submarine canyons of the New England Continental Shelf.

Gorda and Juan de Fuca Ridges Study

In the summer of 1984 the newly refurbished ALVIN submersible research system was employed on a 30-day mission in the Northwest Pacific region to study rift morphology and the geology of potential hydrothermal deposits on the Gorda and Juan de Fuca Ridges. A major focus of the 2-year program is a comparison of findings from this study with those from a parallel study conducted in 1980-81 in the eastern Galapagos Rift-Inca Fracture Zone-Ecuador Rift area.

The two geographical areas share a number of similarities:

1. medium spreading rates (6-7 cm/yr);
2. occurrence of hot spots at or near the area being studied;
3. propagation of rifts away from the hot spots;
4. high amplitude magnetic (HAM) zones associated with propagation; and
5. sulfide mineralization zones.

The five dive sites, which were areas of relatively recent submarine volcanic activity that had been selected for their unique tectonic settings, are described below.

Cobb Propagator (10 dives)

Bathymetric evidence of rifting into older crust was observed in a large seamount, which formed the locus of a large negative magnetic anomaly that was bisected by a thin, normally magnetized rift valley. Scientist/divers hypothesized that this area is characterized by particularly metal-rich hydrothermal activity because the most recent rifting may tap off-axis cooling and partially differentiated magma chambers.

Juan de Fuca Hot Spot (10 dives)

A bathymetric high dominating the complex topography of the "hot spot" on the Juan de Fuca Ridge was postulated to be the probable location of vigorous hydrothermal activity because of its much higher-than-normal sustained rate of magma production.

Southern Juan de Fuca Ridge-Blanco Fracture Zone Intersection (10 dives)

Scientists studied the tectonics of this ridge-fracture zone intersection and the genesis of these sulfide deposits for

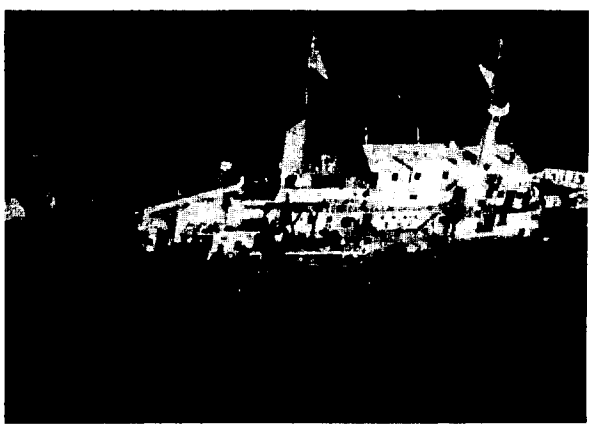


Figure 11.—The ATLANTIS, support ship for the deep-water submersible ALVIN.

comparison with the Galapagos-Inca Transform-Ecuador Rift system.

Northernmost Gorda Rift-Blanco Fracture Intersection (10 dives)

Divers explored the axial ridge and volcanoes, the boundary faults, and the intersection of the northernmost rift valley and the Blanco Fracture Zone. The narrowing of the rift valley to the southeast suggests that, at least for the episodes of spreading that built this rift segment, the spreading rate decreases as a function of distance southeast from the Blanco Fracture Zone.

The Gorda Fracture Zone and the Gorda Rift "Bend" (10 dives)

The objectives of the dive series in the Gorda Fracture Zone and Bend areas were to delineate the tectonic manifestations of a recent fracture zone and the transition from fast to slow spreading regions over a small distance and to evaluate the hydrothermal region and mineralization potential of the area.

The major participants in these dives were scientists from NOAA's National Ocean Service and Atlantic Oceanographic and Meteorological Laboratory, the State University of New York at Albany, the Hawaii Institute of Geophysics, and the Scripps Institution of Oceanography.

SHALLOW-WATER SUBMERSIBLE PROGRAMS

The emphasis in NOAA's shallow-water submersible research program has been on geological and biological marine explorations conducted in the nation's coastal zones. For the last several years, NOAA and the Harbor Branch Foundation (HBF) have jointly sponsored underwater research of mutual interest involving the use of the HBF-owned and operated submersible, the JOHNSON SEA-LINK, and its support ship, the R/V JOHNSON.

The major shallow-water submersible project carried out in FY 1984 was a six-part summer cruise in which the SEA-LINK supported research in waters ranging from the Gulf of Maine to the Gulf of Mexico. The separate portions of this mission are summarized below.

Leg I—Jeffries Ledge in the Gulf of Maine

During the initial phase, or "leg" of the eastern cruise, diver/scientists from cooperating institutions (the National Marine Fisheries Service, the Massachusetts Division of Marine Fisheries, the University of Connecticut at Avery Point, and Southeastern Massachusetts University) undertook a two-part mission to 1) investigate the waters over the Jeffries Ledge area in the Gulf of Maine for evidence of ghost gill nets (i.e., gill nets lost at sea and still fishing) and 2) study the efficacy of gill nets as fishing gear and monitor their effects on various species of fish and crustaceans.

In a series of 23 dives conducted in June 1984, the scientific team carried out the following specific tasks:

1) Direct and photographic monitoring of a series of commercially set gill nets to study the:
   - catch-efficiency of the net over the time of the set;
   - behavior of the net in response to the ocean's physical forces and of the fish and crustaceans that become trapped in the net;
   - behavior of fish and crustaceans in the vicinity of the net and their responses to fish caught in the net.
2) Determining the magnitude of the ghost gill net problem by
   - conducting direct bottom surveys of sites reported to have ghost gill nets; and
   - assessing the ability of ghost gill nets to continue to catch fish.

Leg II—Georges Bank and Submarine Canyons

The second leg of the cruise was designed to meet the following five objectives:

1) To revisit the eight site-specific monitoring stations set up at Lydonia, Oceanographer, and Veatch submarine canyons and on the southern flank of Georges Bank to study gas and oil drilling operations;
2) To conduct transect surveys to define qualitatively and quantitatively the megafauna of the seafloor and their habitats;
3) To collect formal substrate samples to test for contaminants (hydrocarbons, trace metals, and PCB's);
4) To conduct geological studies relating surficial, geological, and sedimentary features to animal abundance and distribution;
5) To revisit the deep water monitoring station on the slope east of Oceanographer Canyon.

The investigation was conducted by scientists from the National Marine Fisheries Service, the U.S. Geological Survey, Michigan State University, and the University of Connecticut. During the period July 3-13, 1984, the team was involved in a total of 19 dives.

Leg III—Gulf of Maine

Dives during this phase of the cruise, from mid-to-late July 1984, were conducted for the purpose of determining the abundance of lobsters and lobster shelters in selected areas of the northwest region of the Gulf of Maine along the transects originating in commercially productive areas inshore (Boothbay Harbor and Stonington, Maine) and ranging offshore to Cashes Ledge and Jordan Basin, respectively. Since the central Gulf of Maine lobster population is the only major lobster stock remaining that has not been exploited heavily, there is a critical need to examine the potential role of central Gulf lobsters as a primary broodstock source of larval lobster recruitment in peripheral coastal areas. The dives also documented: 1) the kinds and relative abundance of associated fauna; 2) habitat definitions, including the density and distribution of both occupied and unoccupied lobster shelters; 3) substrate samples; and 4) physical parameters of the bottom water. Divers were able to describe and record the geolo-

Figure 12.—Member of the commercially valuable tilefish species.

gical and sedimentary features of the seafloor at all dive locations throughout the programmed transect and to collect sediment samples for grain size-analysis and qualitative infaunal samples. This phase of the cruise was conducted by scientists from NOAA/NMFS, the Maine Department of Marine Resources, and the U.S. Geological Survey.

Leg IV—Mid-Atlantic Bight, Outer Continental Shelf

Dives during this phase (July 27-August 6, 1984) were made to test the hypothesis that the rough bottom topography around Hudson Canyon was formed as a result of bioerosion by the tilefish community. An additional goal was the development of the use of sidescan sonar and subbottom profiling techniques as important new fishery assessment tools for tilefish and other species. This project, a cooperative effort between Rutgers University, the Harbor Branch Foundation, and the U.S. Geological Survey, represents a continuation of a long-term investigation of the distribution, abundance, habitat, community structure, and behavior of the commercially important tilefish. Figure 12 shows a tilefish swimming in the vicinity of Hudson Canyon.

Leg V—Gulf of Maine and Georges Bank

The fifth leg of the eastern cruise consisted of water column ecology investigations, with specific mission objectives as follows:

1) To observe, photograph, and collect gelatinous zooplankton, particularly siphonophores that prey on fish larvae;
2) To quantify by observation, photography, and collection the abundance of leiphansiids, principally *Meganyctiphanes norvegica*, within 10 m of the bottom; and
3) To quantify by visual sightings and *in situ* collection the morphology, density, and distribution (both horizontal and vertical) of marine snow aggregates and the soft-bodied zooplankton that produce these particles. Shipboard experiments were conducted with the aggregates using vital staining and radioisotopic techniques to estimate growth rates of the microbial communities that enrich these aggregates.

A total of 45 dives were made between August 8-19, 1984, by scientists/divers representing the National Marine Fisheries Service, the Harbor Branch Foundation, and the U.S. Navy's Naval Ocean Systems Center.

Leg VI—Northwestern Gulf of Mexico

The final phase of the cruise consisted of a mission to assess deep-water reef fish stocks and habitats and to calibrate passive reef fish assessment gear on two offshore reef areas in the northwestern Gulf of Mexico. During the period September 9-27, 1984, collaborating scientists from the National Marine Fisheries Service, the Harbor Branch Foundation, and the Texas Parks and Wildlife Department conducted investigations at the two study sites to meet the following primary and secondary objectives.

Primary Objectives

1) To determine species and size selectivities of passive fishing gear (on- and off-bottom longlines) for assessment of deep-water reef fish stocks
2) To compare stock assessments of groupers and tilefish based on assessments made during submersible operations, captures by passive gear, and mark-recapture methods, and to evaluate the effectiveness of each method in estimating the abundance of these deep-water commercial species
3) To evaluate the physical characteristics of rocky and smooth bottom deep-water habitats and determine associated faunal components
4) To evaluate the physical and biological factors that impact the effectiveness of passive fishing gear
5) To compare stock densities, faunal components, and biological characteristics of rocky and smooth deep-reef habitats in similar depths off the south Atlantic coast and in the northwestern Gulf of Mexico
6) To provide the necessary data to determine the potential impact of expanding commercial fisheries on deep-water grouper and tilefish stocks.

Secondary Objectives

1) To continue efforts to develop effective means of marking deep-reef fishes for movement and population studies
2) To continue evaluation of varying bottom longline configurations to improve sampling efficiency and reduce gear losses
3) To provide biological materials for life history studies of northwestern Gulf of Mexico deep-reef species
4) To document juvenile/adult/burrow utilization ratios of golden tilefish to determine the rate of recruitment and adult depletion under commercial fishing pressure.

The Leg VI phase of the cruise was conducted in company with the R/V OREGON II, a National Marine Fisheries Service research vessel.

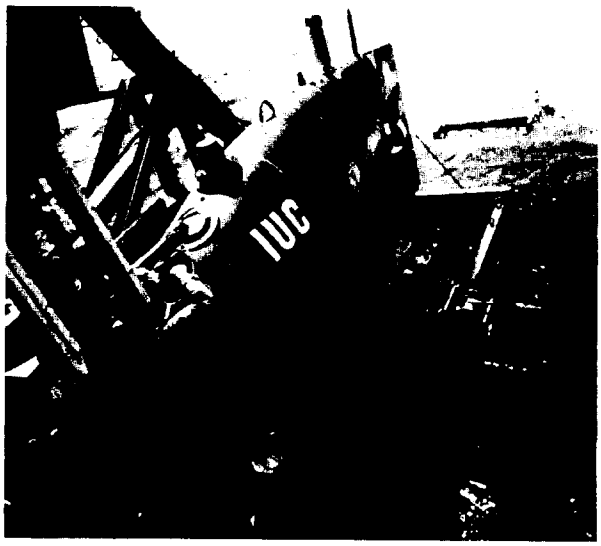


Figure 13.—The ROV EPAULARD on deck before launch.

REMOTELY OPERATED VEHICLES

The use of remotely operated vehicles (ROV's) in underwater research permits the marine science community to carry out its objectives with greater flexibility, selectivity, and productivity. NOAA has encouraged experimental investigations involving these vehicles that compare and contrast their capabilities with those of submersibles, and, in addition, has sponsored activities in which both types of vehicle are employed in complementary tasks. Results of such research have shown that ROV's can be used to advantage in the systematic inspection of biological/physical impact zones by providing quantified field of view, close-focus resolution, low species avoidance effects, extended observation time, and precise surface navigation control.

Examples of NOAA-supported projects involving ROV's include: the Hawaiian Undersea Research Laboratory's observational studies using the small remotely manned vehicle SNOOPY; the NOAA/HBF functional comparison experiments involving the R/V JOHNSON/JOHNSON SEA-LINK submersible system and the R/V SEA DIVER/CORD ROV system; and NOAA's exploration of the seafloor topography and bottom fauna of Gorda Ridge using the R/V ALOHA and the remotely operated deep sea search and recovery vehicle EPAULARD (fig. 13). In 1984, ocean disposal site investigations in the Gulf of Maine, described below, were conducted. These ROV missions represent the first use of the combined ROV/submersible research strategy to monitor dredged material disposal sites in the Northeast.

1984 Ocean Disposal Site Investigations—Gulf of Maine

Biological and substrate conditions were assessed at three New England dredged material disposal sites during July 1984, utilizing the ROV RECON IV and the manned submersible MERMAID II (fig. 14). Three deep (30-100 m)

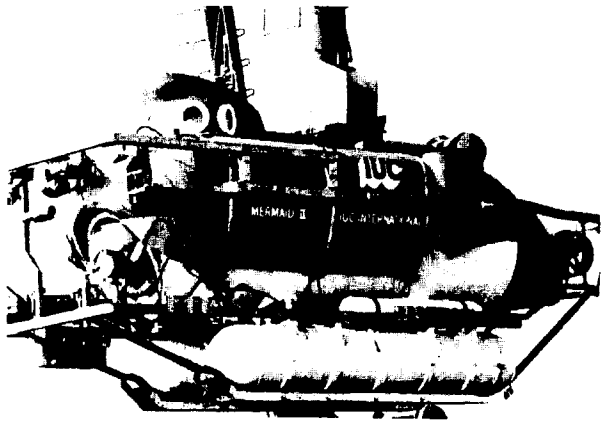


Figure 14.—The MERMAID II, used in the Gulf of Maine research cruise.

coastal sites within the Gulf of Maine—Boston Foul Ground, Cape Arundel Disposal Site, and Portland Disposal Site—were surveyed to determine sediment micro-scale topography, peripheral limits of dredged material mounds, faunal recolonization patterns, and predominant macrofauna associated with mound features in the near field vicinity. Linear ROV photodocumentation (video/35 mm) transects provided quantified data on:

1) Benthic habitat existing at pre-designated disposal locations and active disposal sites;
2) Abundance and distribution of motile epibenthic species; and
3) Important behavioral observations of commercial fishery resources.

NOAA's National Undersea Research Program (NURP) at the University of Connecticut chartered a ROV/submersible/ship system for the ecological *in-situ* studies off the northeast coast. The ROV was the RECON IV, and the ALOHA served as support ship. The first phase of the mission, lasting 6 days, was devoted to partial project support of the New England Division-Army Corps of Engineers dredged material management program.

The RECON IV has a 2,300-foot (701-m) operating depth and, like the MERMAID II submersible, can be flown over the bottom or propelled on a sled while conducting surveys. The RECON IV is equipped with a Harco silver-silver chloride cathodic protection probe and color video, which enhances the quality of documentation for all types of inspections. It is one of the few ROV's designed with all its electronic components in the control console on the surface, which eliminates the risk of water infiltration—a major factor in vehicle downtime. Forward, lateral, and horizontal thrust is provided by four 1-HP motors with specially designed shrouds and propellers to produce up to 80 pounds of thrust, which allows the vehicle to move at 3 knots. The vertical thrust can be controlled manually or automatically to provide constant depth hover control. The RECON IV's tether management system acts as an umbilical depressor, allowing the vehicle to be de-coupled from the ship's motion during live boating operations.

SECTION IV

INTERNATIONAL AND INTERAGENCY PROGRAMS AND INFORMATION TRANSFER ACTIVITIES

BACKGROUND

Medical and technological aspects of diving research and development have been a major part of NOAA's undersea research program from the outset. To carry out this task, NOAA collaborates with marine scientists from various institutions and agencies within the United States and throughout the world to support projects that provide information, technical and medical assistance, and training in the areas of diver health and safety.

INTERNATIONAL PROGRAMS

Japan

Toward the goal of increasing and enhancing the bonds of friendship between Japan and the United States through scientific and technological relationships, the Cabinet-level U.S.-Japan Committee on Trade and Economic Affairs decided in 1964 to create the United States-Japan Cooperative Program in Natural Resources (UJNR). The general objectives of the UJNR program are 1) to promote development and conservation of natural resources through cooperative activities and 2) to share information and results so a better environment can be developed for the benefit of present and future generations.

To conduct its affairs, UJNR has formed 17 panels, seven of which deal with marine science and are coordinated by NOAA under the Marine Resources and Engineering Coordination Committee (MRECC), established in 1970. The MRECC meets every 2 years, either in Japan or the United States, and individual panels may meet more frequently.

At the end of FY 84, the sixth in a series of cooperative dives was begun at JAMSTEC (the Japan Marine Science and Technology Center) as an integral part of the U.S.-Japan Cooperative Diving Research Program, which was initiated in 1972 under the aegis of the UJNR Panel on Diving Physiology and Technology. Scientists from both countries participated in this study to investigate man's response to a 7-day continuous exposure to a dry helium-oxygen environment at 31 ATA (300 msw or 1,000 fsw equivalent). Results of this study, which measured the following parameters, will be documented in NOAA's FY 85 Annual Report:

1. Circulation changes in renal-endocrine functions, including a comprehensive characterization of nocturia;
2. Cardiovascular-endocrine responses to a 90° body tilt, including an assessment of sympathetic nervous system activity;
3. Erythrocyte functions, including intracellular organic phosphates and the Donnar ratio for chloride; and
4. Blood enzyme profiles.

Additional UJNR activities initiated in 1984 include the formalization of plans for a joint program of undersea research in the Pacific Ocean using the deep water submersibles ALVIN and Japan's SHINKAI (fig. 15). The two-phased project will feature the exchange of scientists from both countries as participants in two ALVIN dives—at Gorda Ridge and at the Galapagos Islands—as well as in a number of SHINKAI dives at as yet unspecified locations.

In 1985, the U.S. contingent of the UJNR Panel on Diving Physiology and Technology will host the 8th biennial meeting of the panel in Washington, D.C., and in Hawaii. Office of Undersea Research personnel will chair and coordinate these sessions, and the office will also publish the proceedings of these sessions.

INTERAGENCY PROGRAMS

U.S. Underwater Diving Fatality Statistics

The National Underwater Accident Data Center (NUADC), based at the University of Rhode Island, was established in 1969 with support from several Federal agencies. Since 1972 NOAA has administered this grant, with additional funding from the U.S. Coast Guard's Office of Merchant Marine Safety. The stated task of the NUADC is the acquisition, investigation, and statistical analysis of

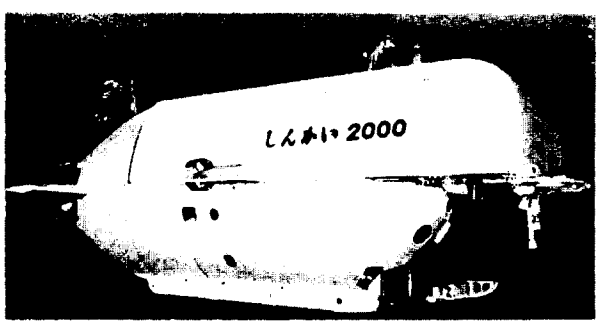


Figure 15.—The deep-water Japanese submersible SHINKAI.

all United States underwater diving fatalities, including those involving American citizens diving in other parts of the world.

To implement this charge, NUADC collects accident information from such varied sources as Federal and State government agencies, diver training organizations, law enforcement agencies, the Divers Alert Network, autopsy reports, and media clipping services. These raw data are then analyzed, compiled, and published for use by interested parties, including representatives of the sport and commercial diving industries, the government, and the general public. The latest publication in this series is *U.S. Underwater Diving Fatality Statistics, 1970-1982.*

Inventory of Manned Submersibles

In May 1984, in conjunction with the U.S. Navy and the U.S. Coast Guard, NOAA published the *Manual of Manned Submersibles* as a result of an interagency agreement, the National Search and Rescue (SAR) Plan. The objectives of this manual are 1) to obtain a complete description of presently operating submersibles in terms of dimensions, life support capabilities, and emergency instrumentation; 2) to outline the methods used to support, deploy, and navigate the various vehicles; and 3) to tabulate and describe international unmanned search/retrieval systems available in the event of an emergency.

Under the SAR agreement, the Coast Guard, which has responsibility for the search and rescue of civilian submersibles, may request assistance from the U.S. Navy in a submersible emergency situation. Recognizing the vehicle-to-vehicle variation in design, instrumentation, and capabilities, the three agencies supporting this publication sought to define the specific nature of the potential rescuees so that the necessary data would be available if an actual rescue situation occurred. Information gathered for the manual was obtained by written correspondence and, for vehicles constructed during the period January 1981 through January 1984, by personal inspection, where feasible.

Two ground rules governed the scope of the manual:

1. Only active submersibles and those under construction with operating depths greater than 182 m (600 ft) were included; and
2. No government-classified or company-proprietary data were solicited.

National Divers Alert Network

Recent studies estimate that nearly 400 diving accidents occur each year in the United States, two-thirds of which involve serious and debilitating illnesses such as paralysis and quadriplegia. To address the need for prompt and correct treatment of these diving-related injuries, NOAA, in cooperation with the U.S. Department of Energy and the National Institute for Occupational Safety and Health (NIOSH), instituted support for the Divers Alert Network, formerly the Diving Accident Network or DAN, in September 1980. DAN is based at the Duke University Medical Center. DAN physicians represent a wide range of clinical disciplines in addition to those of the seven medical specialists regularly on call to advise diving accident victims through the Network's 24-hour emergency telephone consultation service (phone number: 919/648-8111). In 1984, DAN logged nearly 2,000 calls for information, advice, and guidance; about 300 of these calls involved diving emergencies. In addition to the Duke facility, the network consists of six regional institutions, each with its own trained medical director. DAN headquarters maintains close liaison with the regional centers.

Other services provided by DAN include the distribution of posters bearing a brief summary of diving accident symptoms and signs for display in all U.S. emergency rooms. Smaller posters in layman's language are made available for use on dive boats and ambulances. Both signs leave space for DAN's main and regional phone numbers and any local emergency phone numbers to be added. In 1983, DAN inaugurated a membership association, which now has 8,000 members. Members receive the DAN *Underwater Accident Manual*, a membership card, a DAN decal for their scuba tanks, and a subscription to *Alert Diver*, the DAN newsletter. In the past year, DAN has also distributed more than 75,000 informational brochures and 10,000 DAN posters (fig. 16).

DAN has established and maintains a listing of suitable U.S. recompression chambers for use by the Network, including accurate location, availability, emergency telephone contacts, and available medical support. In addition, the Network maintains accurate information on air ambulance capabilities nationwide to ensure ready availability of medically staffed pressurized aircraft to transport divers quickly from any location to an adequate chamber.

Institute for Environmental Medicine, Diving Data System

Since 1982, NOAA and the U.S. Navy have jointly sponsored the Diving Research Data System (DRDS), which was developed and is administered by the Institute for Environmental Medicine at the University of Pennsylvania. DRDS maintains a data base of validated diving accident therapy information and systematized methods of observing and recording diving-related information. The system used is capable of storing records, analyzing models, and generating diving decompression and treatment schedules. Access to this critical technical information in the areas of diving physiology and safety is provided to American civilian and military facilities and research institutions in several foreign countries.

INFORMATION TRANSFER

Symposium Series for Undersea Research

The second annual symposium sponsored by NOAA's Office of Undersea Research was held on May 22-24, 1984,

at the University of Connecticut at Avery Point. The topic of the symposium for 1984 was Undersea Research and Technology: Scientific Applications and Future Needs. NOAA developed its symposium series to provide a national forum for the exchange of information by scientists participating in OUR-sponsored projects; the symposium encourages researchers to discuss major findings and to describe future research plans. The Proceedings of the symposium will be published in 1985.

Remotely Operated Vehicle Handbook

In June 1984, OUR published *The Remotely Operated Vehicle Handbook*, compiled by Frank Busby, world-famous expert on remotely operated vehicles, to serve as a quick reference for obtaining data on the characteristics, location, prices, manufacturers, and operators of remotely operated vehicles (ROV's) in the United States and Canada. The ROV's described in the manual are of the tethered, free-swimming variety; no attempt was made to include towed or untethered (autonomous) vehicles. Copies of this publication are available from OUR headquarters.

Undersea Medical Society

For several years a contractual agreement between NOAA and the Undersea Medical Society (UMS) has resulted in the development of numerous publications

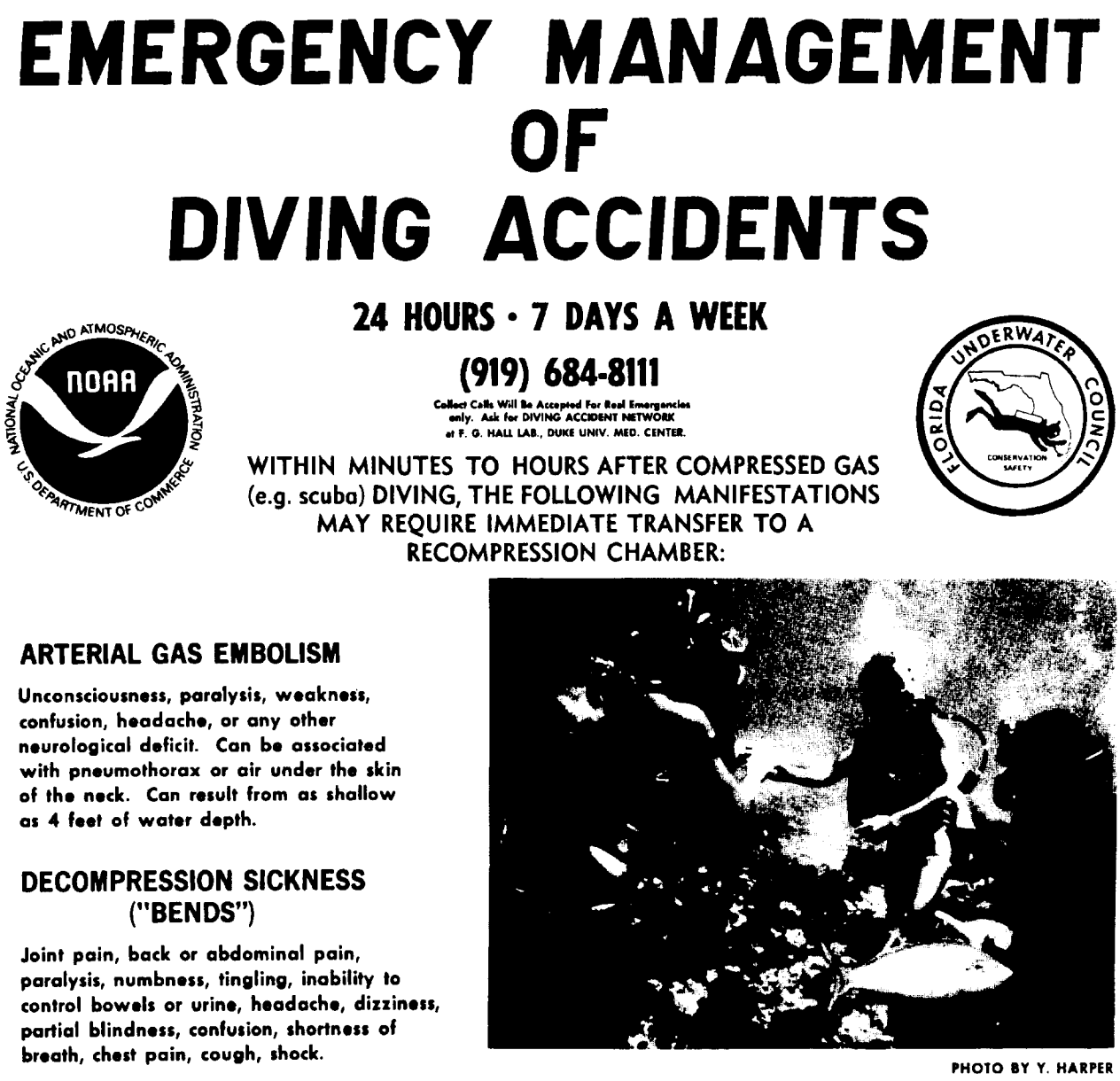


Figure 16.—Poster of the National Divers Alert Network (NDAN).

Figure 17.—Photograph of NOAA-supported Undersea Medical Society publications.

(fig. 17) and technical workshops dealing with different aspects of diver safety. UMS is a professional association located in Bethesda, Maryland, whose more than 2,000 individual members are drawn from the fields of diving medicine, physiology, and related scientific areas. The UMS is perfectly geared to undertake a range of information transfer and educational activities in keeping with its own mission and that of the Office of Undersea Research.

Workshop on "The Rehabilitation of the Paralyzed Diver"

On March 8-9, 1984, the UMS arranged a workshop in conjunction with OUR and the University of South Alabama's College of Medicine and Department of Anesthesiology. The workshop, entitled "The Rehabilitation of the Paralyzed Diver," had as its objectives the following:

1. Assessment of the incidence and magnitude of the problem, that is, number of patients with significant residual neurological deficits caused by diving accidents and warranting extensive rehabilitation efforts.
2. Discussion of the pathophysiology and neuropathology of diving accidents.
3. Discussion of current acute care management concepts, from the first aid stage through recurrent hyperbaric oxygen therapy.
4. Discussion of a coordinated therapeutic regimen, including acute treatment, being implemented in Singapore.
5. Discussion of how diving accident patients differ from other rehabilitation patients.
6. Development of guidelines for appropriate rehabilitation from early management of cases through referral of patients for rehabilitation in their home localities.

UMS expects the report of this workshop to be available from the society in 1985.

Workshop on "Nitrogen Narcosis"

UMS conducted a workshop on nitrogen narcosis, funded by NOAA and hosted by the Santa Barbara Medical Foundation Clinic, on December 15, 1983. The goals of the workshop were to 1) review the pathophysiology and epidemiology of nitrogen narcosis; 2) describe the effects of nitrogen narcosis and the methods of assessing them; 3) delineate how nitrogen narcosis differs in nitrox and air environments; 4) determine what can be done to prevent or ameliorate the effects of nitrogen narcosis; and 5) identify priority areas of research related to nitrogen narcosis.

A bibliographic study containing informative abstracts was prepared for the workshop by the UMS staff. In addition, UMS will issue a detailed report on the workshop proceedings in FY 85.

Proceedings of Workshop on "Oxygen: An In-Depth Study of Its Pathophysiology"

In 1984 UMS published 22 papers prepared for the workshop held in Oak Ridge, Tennessee, the preceding year on the subject of "Oxygen: An In-Depth Study of Its Pathophysiology." The papers represent a summary of the current state of knowledge in each participant's field of expertise and integration of this knowledge with information from the broader areas of physiology, biochemistry, pharmacology, pathology, and clinical medicine. Special emphasis was placed on the underlying mechanisms of oxygen toxicity, and each participant pointed out promising and needed areas of research.

Other UMS Publications

Two major publications issued by UMS in FY 84 and sponsored by OUR are especially noteworthy: *Key Documents of the Biomedical Aspects of Deep-Sea Diving* and *Underwater Physiology VIII: Proceedings of the Eighth Symposium on Underwater Physiology.*

In the *Key Documents* volumes, articles, reports, and chapters of books selected from the world's diving literature from the period 1608-1982 have been compiled, arranged, and reprinted in five volumes. Experts in each of the many fields of diving medicine chose items for inclusion on the basis of their judgment that the material was important to the development and understanding of their particular field of specialization. Several documents in each of the following technical areas were selected for in-depth treatment:

- Caisson and Tunnel Work
- Chronic CO_2 Toxicity
- Cold Water Exposure and Thermal Balance
- Decompression Theory
- Diving Gases (Other Than Hydrogen)
- Diving Medicine: the High Pressure Neurologic Syndrome
- Drowning and Near-Drowning
- Dysbaric Osteonecrosis
- Gas Embolism

- Hydrogen-Oxygen Diving
- Hyperbaric Oxygen Therapy
- Inert Gas Narcosis
- Otology in Diving (the Ear in Diving)
- Oxygen Toxicity
- Pathophysiology and Treatment of Decompression Sickness
- Pulmonary Function
- Saturation Diving
- Underwater Performance
- Vision

Underwater Physiology VIII documents the papers presented at the Eighth Symposium on Underwater Physiology, which was sponsored by NOAA and the University of Pennsylvania, the U.S. Office of Naval Research, and the UMS. The Eighth Symposium was held in St. Jovite, Quebec, Canada, in 1983 and was the latest in a continuing series of symposia initiated 30 years ago. A total of 68 scientific papers is presented in this volume in the following eight subject areas:

- Oxygen Toxicity
- Inert Gas Exchange, Counterdiffusion, and Bubble Formation
- Decompression Sickness, Osteonecrosis, and Other Dive-Related Disorders
- Circulatory and Hematologic Effects of Hyperbaric Exposure
- Thermal Effects of the Hyperbaric Environment
- Interactions of Ventilatory Control, Hyperoxia, and Increased Gas Density at High Ambient Pressures
- Molecular and Cellular Effects of Pressure
- Behavioral and Neurological Effects of Hyperbaric Conditions

The *Proceedings* can be purchased from the Undersea Medical Society.

Abstract Alerting Services

The Undersea Medical Society maintains abstract alerting services in the areas of underwater physiology and underwater equipment and technology as part of its national information clearinghouse function. To provide these services, UMS staff review scientific and medical journals, books, symposium proceedings, workshop reports, government publications, industry newsletters, and a host of other pertinent published materials and summarize their contents for both the specialized and general reader.

On request, and for a nominal fee, UMS will perform literature searches on specific topics in the areas of biomedical research and diving technology.

Other OUR Publications

OUR's ongoing information program also includes the publication of scientific and technical documents in several formats:

- professional papers—important research results, descriptions of major techniques, and reports of special investigations
- contract and grant reports—reports prepared by contractors or grantees working under NOAA-OUR sponsorship
- presentation of analyzed data, generally in the form of maps showing distribution of rainfall, chemical and physical conditions of oceans and atmosphere, distribution of fishes and marine mammals, and ionospheric conditions
- technical memoranda—reports of preliminary, partial, or negative research findings or technology results, interim instructions, and so forth.

A notable example among FY 84's offerings is a technical memorandum on "The Influence of Fish Predators on the Distribution and Abundance of *Diadema antillarum*" (a long-spined sea urchin), which is available from OUR headquarters.

SECTION V
FUTURE PLANS

INTERNATIONAL PROGRAMS

United States-Japan

Building on the support established by working together over the years on the U.S.-Japan Cooperative Program in Natural Resources (UJNR) Panel on Diving Physiology and Technology, the two countries are actively planning an exciting deep-water submersible exchange program. The Japanese submersible SHINKAI and the U.S. deep-water submersible ALVIN will participate in the exchanges, which will permit scientists from the two nations to study such undersea phenomena as polymetallic sulfide deposits, thermal vents, and manganese crusts.

The first exchange dives are planned for the area north of the Mariana Islands, and later plans call for the Japanese submersible to participate in research dives using the Hawaiian Islands as a base.

The Japanese are also sponsoring other research dives in the SEADRAGON VI series of experimental dives to evaluate the effects of pressure on physiological functioning in humans. To date, these dives have achieved pressures equivalent to those at 1,000 feet of seawater, and future dives are scheduled to go to 1,500 fsw.

U.S.-French Program

OUR personnel are currently exploring the possibilities of performing deep-water research using the French submersible CYANA (fig. 18) and the ROV NUTEL. The NUTEL has a depth capability of 20,000 feet, and plans call for joint U.S.-French missions to map areas of the Mid-Atlantic Ridge.

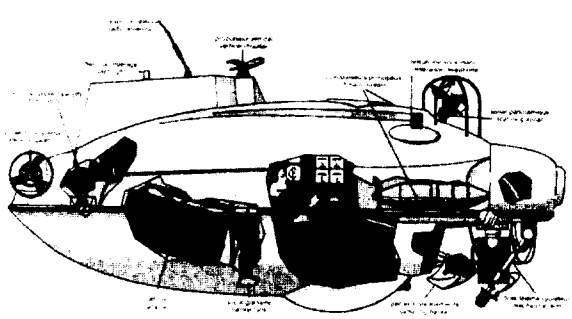


Figure 18.—The French research submersible CYANA.

The Office of Undersea Research is planning initiatives in each of the program areas within its purview: national undersea research; submersible research; international and interagency programs; and technology transfer projects. In addition, the office plans to continue funding several on-going projects begun in earlier years. Each of these projects is described in the following paragraphs, which also stress how the project implements NOAA's overall goals.

NATIONAL UNDERSEA RESEARCH PROGRAM

New Initiatives

Great Lakes

A Great Lakes component will soon join OUR's existing network of facilities (with headquarters at St. Croix, U.S. Virgin Islands; Wilmington, North Carolina; Catalina Island, California; Makapuu Point, Hawaii; and Avery Point, Connecticut). The Great Lakes program will initially rely on the Connecticut program for personnel and equipment resources, but plans call for an independent program in the future, fully supported by the Great Lakes states, including Michigan, Minnesota, and Wisconsin.

NOAA is presently operating a multiperson recompression chamber (fig. 19) in Alpena, Michigan, which is designed to provide hyperbaric treatment for Great Lakes divers.

The major ecological problems in the Great Lakes are marine pollution and the depletion of commercially valu-

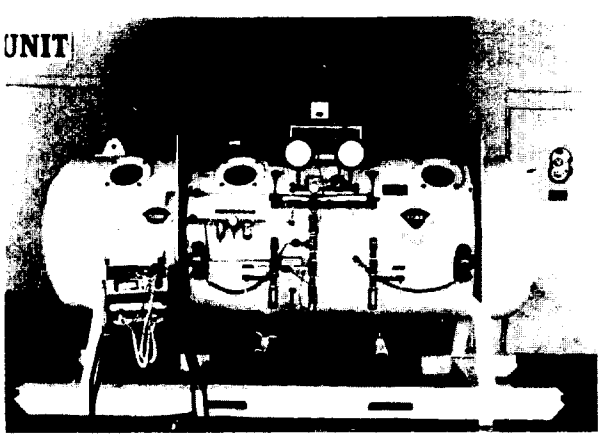


Figure 19.—NOAA's recompression chamber in Alpena, Michigan.

able fishery stocks. Both acid rain and industrial runoff have contributed to this area's water pollution problem, and heavy commercial fishing and a major infestation of sea lampreys have devastated the population of native fish, especially lake trout.

In the 1985-86 period, OUR will support several research missions designed to investigate various phases of this problem. The objectives of these projects range from the identification of the spawning grounds used in the past by lake trout to an evaluation of the number of lake trout unintentionally caught in lost or abandoned gill nets intended to catch whitefish. Investigators from several universities, state wildlife agencies, and Canadian fisheries management agencies will participate in these projects. The R/V SEWARD JOHNSON and the submersible JOHNSON SEA-LINK will provide researchers with direct access to the underwater world of the Great Lakes. Although the initial missions will focus on Lake Superior, future plans call for similar investigations in Lakes Huron, Michigan, and Ontario.

Northeastern United States

The University of Connecticut component of the National Undersea Research Program will be conducting a multifaceted undersea research program in the 1985-86 period; the R/V SEWARD JOHNSON and the shallow-water submersible JOHNSON SEA-LINK will again provide advanced technological support for the marine scientists.

The various "legs" or phases of the submersible cruise will have separate objectives and will involve personnel from different agencies and academic institutions. The cruise will focus attention on a variety of problems existing in the Gulf of Maine ecosystem, including the impact of ghost gill nets on native fish stocks, the depletion of the lobster population in peripheral coastal areas, and the predation of fish larvae by gelatinous zooplankton. Cruise participants include scientists from the Harbor Branch Foundation, NOAA's National Marine Fisheries Service, and the Maine Department of Marine Resources.

Northwestern United States

The Northwestern coastal zone offers unique opportunities to investigate several research areas of particular interest to NOAA and the Office of Undersea Research. The Gulf of Alaska provides an ideal environment to assess the impact on marine fisheries of oil and gas well drilling in the offshore areas. NOAA's recent success in increasing the catch-efficiency of longline fishing gear used in catching halibut in northwestern waters has increased research interest in the link between technology design and fisheries productivity. NOAA also plans to investigate the use of biodegradable materials in the manufacture of crab pots and nets. Use of such materials would ensure the disintegration of lost or "ghost" pots and nets, thus preventing them from continuing to catch fish and crustaceans in their untended state.

Gulf of Mexico

Although OUR has no firm plans at this time to establish a program in the Gulf of Mexico region, the office plans to provide support to existing marine science projects being conducted by Gulf academic institutions, such as the Florida Institute of Technology and Texas A&M University. The principal problems in this region are water pollution caused by offshore oil and gas well drilling and fresh-water intrusion in the Texas Garden Reefs area.

Expansion of Existing National Undersea Research Programs

Pacific Basin

Beginning in 1986, NOAA's Office of Undersea Research will support a submersible-based research program throughout the Pacific Basin. Undersea investigations will focus on two of NOAA's primary mission responsibilities—fisheries and seafloor properties and processes (particularly within the exclusive economic zone of the United States and its territories). With respect to fisheries, the principal research goal will be to assess the abundance, distribution, and population dynamics of important fishery resources associated with seamount ecosystems, rocky bottoms of the Pacific Northwest and Alaska, and underutilized stocks in outer continental shelf areas off the Northwest coast of the United States. For seafloor properties and processes, the goals will be to determine the role of hydrothermal and continental margin vent systems on global ocean processes and to assess mineral resources (including ferromanganese crusts and hydrothermal deposits) associated with seamounts. Research also will address the physical oceanographic effects of seamounts and seamount geology and geomorphology, precious coral resources, and the early diagenesis of shallow-water carbonate particles.

Caribbean Basin

OUR's expanded program in the Caribbean reflects the Nation's recent Caribbean Basin initiative, which seeks to strengthen ties between the United States and countries bordering the Caribbean. The Caribbean has been recognized for many years for its strategic and economic importance to the United States. To facilitate the development of the Caribbean nations, the Department of Commerce, of which NOAA is a part, has developed an integrated trade, investment, and financial aid program—the Caribbean Basin Initiative—designed to encourage long-term economic progress. One aspect of the economy that has not so far been addressed by this program is the development of the region's marine resources.

The Office of Undersea Research is planning to help scientists and technical personnel from the Caribbean countries develop the expertise necessary to conserve and protect their marine resources, which are vital to the economic well-being of the Caribbean Basin countries. The deep-

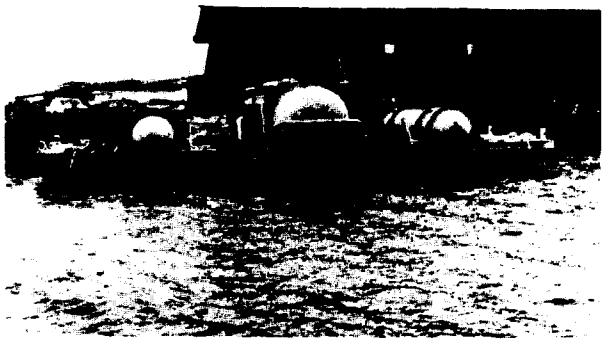


Figure 20.—The habitat AEGIR, to be used in the Caribbean Basin program.

diving saturation system AEGIR (fig. 20), which has been towed to the St. Croix National Undersea Research Program site for refurbishment, will provide the principal means for answering vital questions about the Caribbean area's marine ecosystems to depths of 200 feet of seawater. The AEGIR will give Caribbean scientists the opportunity to learn state-of-the-art research techniques and to explore the causes and effects of many marine problems, such as pesticide pollution, depletion of fishery stocks, and loss of beaches and coastline areas.

NOAA DIVING MANUAL, THIRD EDITION

In the interval since the second edition of the *NOAA Diving Manual* was published, many advances have been made in the fields of diving-related science and technology. To bring the *Diving Manual* (the government's all-time bestseller) up to date, OUR is revising and expanding the material from the second edition. The third edition will be published in 1986 and will include new chapters on: Women and Diving; Diving in Polluted Water; History of Diving; and Diver Certification, Diving Standards, and Regulations. More than 50 experts from the fields of hyperbaric medicine, physiology, psychology, engineering, diver training, oceanography, biology, physics, geology, and diving equipment are volunteering their time to write and review various sections of the manual. Copies will be available in 1986 from the Government Printing Office, Washington, D.C.