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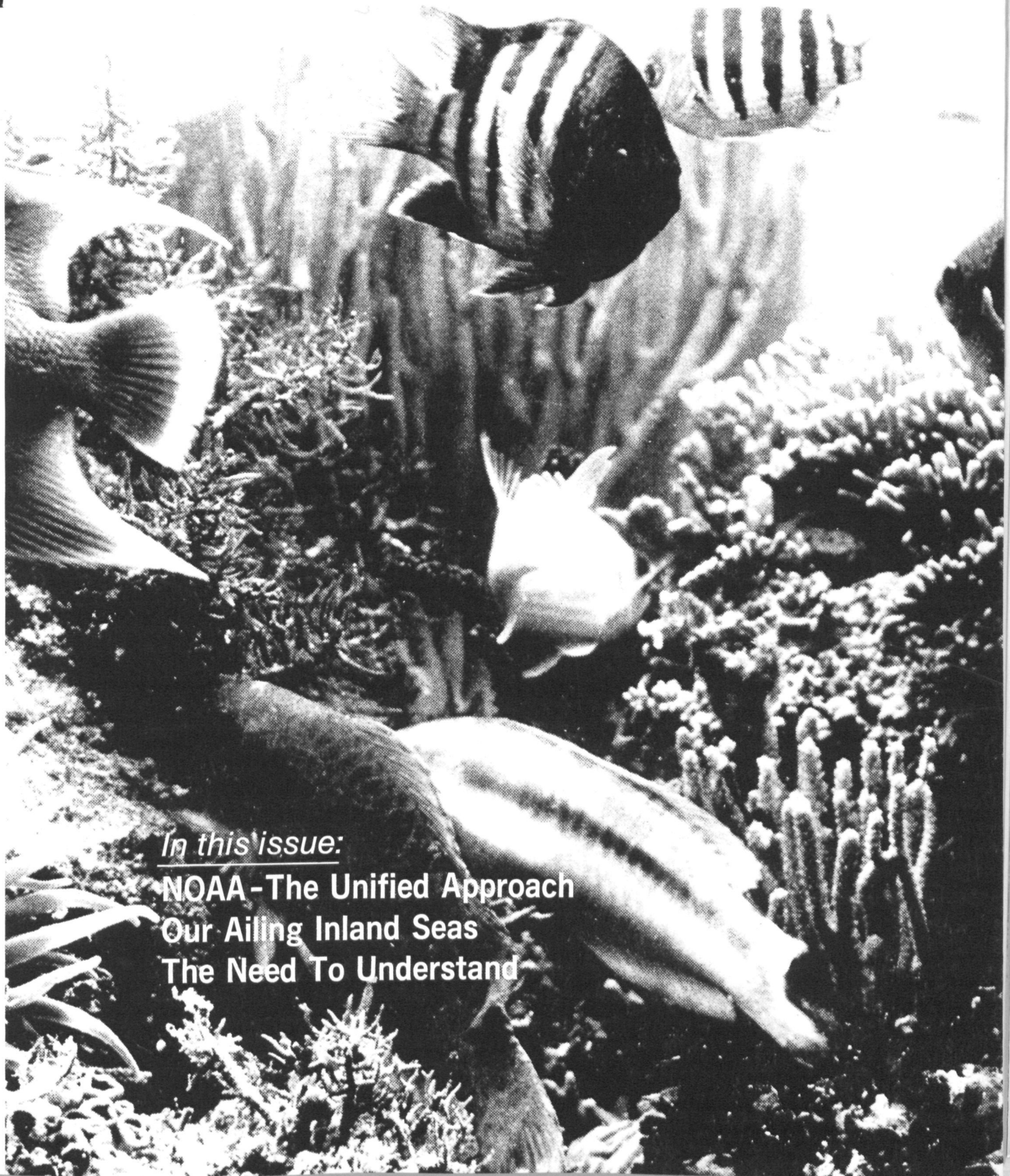
JANUARY 1971

NOAA

U.S. DEPARTMENT OF COMMERCE NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION



In this issue:

NOAA-The Unified Approach
Our Ailing Inland Seas
The Need To Understand

VOLUME 1
NUMBER 1

National Oceanic and Atmospheric Administration

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NOAA

U.S. DEPARTMENT OF COMMERCE
Maurice H. Stans, Secretary
Rocco C. Siciliano, Under Secretary

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
Dr. Robert M. White, Acting Administrator
Dr. John W. Townsend, Jr., Acting Associate Administrator

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VOLUME 1 NUMBER 1

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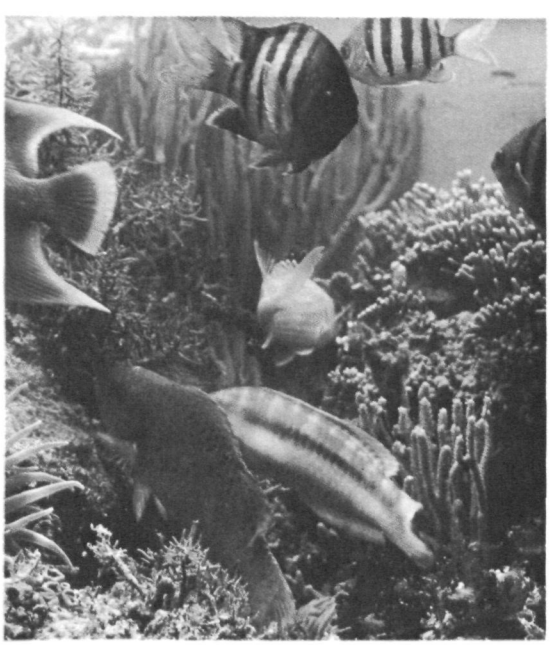

COVER
The underwater environment and its inhabitants symbolize NOAA's role in exploring, mapping, and charting the global oceans and their mineral and living resources.

STANLEY B. EAMES
Director, Public Information

ANN K. COOK
Associate Editor

MAX M. CHESY
Art Director

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A Message From the Secretary

MAURICE H. STANS

I am pleased to launch the first issue of *NOAA,* the National Oceanic and Atmospheric Administration's new employee magazine, with a message to the NOAA family.

Over many months, the Department has devoted intensive effort to carrying out the President's wishes in the creation of our new environmental organization. To me and to Under Secretary Siciliano, and to Dr. Robert M. White, your Acting Administrator, NOAA represents the fulfillment of a long period of planning toward an exciting and workable concept built on the Department's program of environmental science and service, now expanded to encompass the task of resource assessment, development, and conservation within the ocean environment.

Now NOAA is here. Our Department's environmental and oceanic service to the Nation is far from new, and it is my conviction that, through solid achievement over a period of years, we have earned the opportunity to operate this new Administration. NOAA's interest and responsibilities are extremely wide ranging, from the interior of the solid earth to outer space. The safety of American life and property in the face of environmental hazards, the extent of man's comprehension of his world, the success of the national effort to explore, assess, develop, and conserve the living and non-living resources of the global sea—these rest largely upon the success of our labors. Our mission is vast, but at least the organizational instrument for its accomplishment exists, in the form of a center of strength which will permit a unified attack upon the problems of the earth and atmosphere, of the global oceans, their rich reserves and fragile web of life.

Environmental protection, in the regulatory sense, will rest with another Federal entity, the Environmental Protection Agency. We have assured the Congress that NOAA's environmental efforts will be undertaken in a context of guarding against the thoughtless exploitation and despoilment of our air, lands and seas. We are environmentalists, and we are also conservationists.

And now we have set forth upon our task. I know you share my enthusiasm for the high opportunity and the high obligation which have been entrusted to us.

Let us go forward together in the service of our Nation.

Maurice H. Stans

A NEW BEGINNING

NOAA—

THE UNIFIED APPROACH

NATIONAL OCEAN SURVEY

NATIONAL WEATHER SERVICE

NATIONAL MARINE FISHERIES SERVICE

ENVIRONMENTAL DATA SERVICE

NATIONAL ENVIRONMENTAL SATELLITE SERVICE

ENVIRONMENTAL RESEARCH LABORATORIES

"Scattered through various Federal departments and agencies, we already have the scientific, technological and administrative resources to make an effective, unified approach possible. What we need is to bring them together. Establishment of NOAA would do so . . ."

PRESIDENT RICHARD NIXON

BUT HOW?

How to assimilate and shape the broad mission of the new agency, the efforts of its 13,000-plus employees, the varied and dispersed facilities, the collective centuries of tradition and expertise? How to achieve this "effective, unified approach" to the challenges and problems of the physical environment and oceanic life?

The early answers to this are suggested by NOAA's interim organization, which reflects certain major changes of name and mission for NOAA elements, and which signals the trends and reformations future years will bring.

In this interim structure, NOAA is guided by the Administrator, his Deputy, and an Associate Administrator, aided by such special staff offices as international affairs, aviation affairs, public information, and general counsel.

Line staff activities are dispersed among five major offices—those of the Assistant Administrators for Administration and Technical Services, Plans and Programs, and Environmental Systems, the Office of the Director of the NOAA Corps, and the Office of Sea Grant. Six major line components—the National Ocean Survey, National Weather Service, National Marine Fisheries Service, Environmental Data Service, National Environmental Satellite Service, and Environmental Research Laboratories—comprise the bulk of NOAA and provide the service, survey, and research activities which are the agency's reason for being.

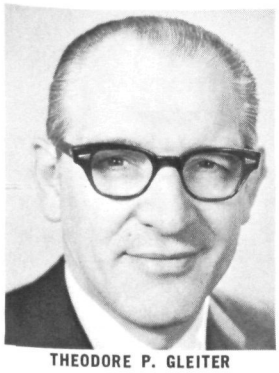
OFFICE OF THE ADMINISTRATOR

DR. ROBERT M. WHITE

NOAA's administrator is appointed by the President by and with the advice and consent of the Senate, formulates policies and programs for achieving the objectives of NOAA, and directs the execution of these programs. He reports to the Secretary of Commerce. The Deputy Administrator, also appointed by the President by and with the advice and consent of the Senate, performs such functions as the Administrator assigns, and acts as Administrator during his absence or disability, or in the event of a vacancy in that office. NOAA's Associate Administrator is the agency's number three man, acting as Administrator during the absence or disability of the Administrator and Deputy Administrator. On October 9, 1970, Dr. Robert M. White, former administrator of ESSA, was appointed by the President as interim Deputy Administrator of NOAA, and is serving as Acting Administrator of the new agency. Dr. John W. Townsend, formerly ESSA's Deputy Administrator, was named Interim Associate Administrator of NOAA.

Designated interim directors of special staff offices attached to the Office of the Administrator were Nels E. Johnson, Office of International Affairs, Stanley B. Eames, Office of Public Information, Newton A. Lieurance, Office of Aviation Affairs. William E. Murane was named Acting General Counsel.

ASSISTANT ADMINISTRATOR FOR ADMINISTRATION AND TECHNICAL SERVICES


THEODORE P. GLEITER

If NOAA were a giant animal, this office would constitute its cardiovascular and respiratory systems. To sustain something of NOAA's size and weight, money must be moved and monitored, facilities must be acquired and discontinued, employees must be hired and paid, office services must be provided, as must safety, security, and a continuing view to improving the dynamics of a dynamic organization.

Theodore P. Gleiter is the interim Assistant Administrator for Administration and Technical Services, a post he held in ESSA. Under his aegis come the divisions which keep NOAA organizationally alive: administrative operations, budget, finance, management systems, computer, scientific information and documentation, radio frequency management.

ASSISTANT ADMINISTRATOR FOR PLANS AND PROGRAMS

DONALD F. MOORE

As surely as an army travels on its stomach, a modern Federal agency travels on its plans and programs. So much is involved scientifically, technologically, and logistically in getting from point A in 1970 to point B in 1975, say, that someone must develop a set of maps and milestones for the journey.

Working closely with major line components and staff offices, this office is NOAA's focal point for planning and programming budget and objectives, and for evaluating products and services in terms of their users. Specialized units here are designated by environmental area—oceanic, solid earth, atmospheric, space. In addition, an Office of Special Studies provides long-range guidance on NOAA's major program areas, permitting technological and other forecasts to play a part in designing NOAA's role, and in seeing how well it is performed.

Donald F. Moore is interim Assistant Administrator for Plans and Programs, the post he held in ESSA.

ASSISTANT ADMINISTRATOR FOR ENVIRONMENTAL SYSTEMS

DR. RICHARD E. HALLGREN

The work of NOAA stands so close to so many thresholds that its objectives can only be achieved with the help of special initiatives in science and technology, interagency and intergovernmental cooperative activities—large jobs which constitute anomalies in day-to-day services, but which are essential to ensure the quality and continuity of services through advancing time and technology. Such international programs as the World Weather Watch, the Integrated Global Ocean Station Systems, the Global Atmospheric Research Program, and the International Field Year for the Great Lakes are being planned by this office and its divisions. This office also has responsibility for the coordination across the Government of the activities of all Federal agencies in the field of meteorological services and supporting research, ocean mapping and charting, and geodetic surveys.

New technical groups in the interim NOAA organization report to this office. These include the National Oceanographic Instrumentation Center (from the Navy), Marine Minerals Technology Center (from the Department of the Interior) at Tiburon, Calif., and the National Data Buoy Project Office (from the U.S. Coast Guard) are administered by this office in the interim NOAA organization.

Dr. Richard E. Hallgren is Assistant Administrator for Environmental Systems. Gilbert Jaffe continues as director of the instrumentation center, John W. Padan is acting director of the Marine Minerals Technology Center, and Capt. Virgil W. Rinehart is director of the National Data Buoy Project Office.

DIRECTOR OF THE NOAA CORPS

REAR ADMIRAL HARLEY D. NYGREN

On May 22, 1917, by act of Congress, a commissioned corps was created within the Coast and Geodetic Survey. Initially a response to the need for a technically trained cadre of leaders for ship and survey duty, this corps has since developed into a group of scientists and engineers capable of acting across a wide range of disciplines. When ESSA was formed in July 1965, the corps became part of that agency.

Now, in 1970, it has become the NOAA Corps. Still the Nation's smallest of seven uniformed services, the Corps faces its broadest range of opportunity and challenge. Rear Admiral Harley D. Nygren, formerly the Associate Administrator of ESSA, is Acting Director of the NOAA Corps.

THE OFFICE OF SEA GRANT

ROBERT B. ABEL

The National Sea Grant Colleges and Programs Act was signed into law in October 1966, just over a century after the 1862 passage of the first Morrill act, which provided land-grant and other support to colleges and universities for the advancement of agricultural and mechanical knowledge. No land changed hands with the advent of the sea-grant program, but much support has gone to institutions and individuals engaged in marine resources programs—programs aimed at assisting man in the intelligent use of the seas and Great Lakes. The program, formerly with the National Science Foundation, is now administered by NOAA's Office of Sea Grant, but still directed by Robert B. Abel.

THE NATIONAL MARINE FISHERIES SERVICE

DR. PHILIP M. ROEDEL

Combining elements of the Bureau of Commercial Fisheries and the Marine Game Fish Research Program (both from the Department of Interior), NOAA's National Marine Fisheries Service promotes the protection and rational use of living marine resources for their aesthetic, economic, and recreational value to America. The Fisheries Service administers programs to determine the consequences of the naturally varying environment and human activity on living marine

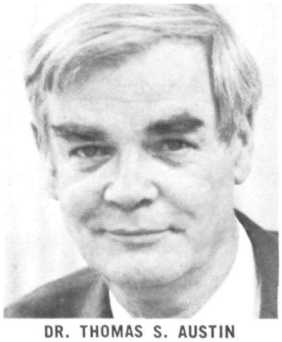
continued

resources, and to provide understanding and services aimed at ensuring their wise use and protection, domestically and internationally. Dr. Philip M. Roedel, former director of the Bureau of Commercial Fisheries, is interim director of the Fisheries Service.

As with other NOAA components, Fisheries Service activities are conducted mainly in the field, where the people and the need are. Four regional centers, at Seattle, Wash., St. Petersburg, Fla., Gloucester, Mass., Terminal Island, Calif., and Juneau, Alaska, provide focal points for operations at some 30 major laboratories and centers and more than 50 statistics and market news offices across the land. The regions also control the operations of the 25-vessel fleet, which mixes small fisheries research craft with such ships as the $3.3 million, 214-foot MILLER FREEMAN.

Marine sport fishery facilities, in the interim NOAA organization, are administered by the Office of the Director, and include: Sandy Hook Marine Laboratory, Sandy Hook, N.J.; Tiburon Marine Laboratory, Tiburon,Calif.; Narragansett Marine Gamefish Laboratory, Saunderstown, R. I.; Eastern Gulf Marine Laboratory, Panama City, Fla.; Aransas Pass Marine Laboratory, Aransas Pass, Tex.

ENVIRONMENTAL DATA SERVICE


DR. THOMAS S. AUSTIN

Data is information, and few regions of investigation produce—or require—as much as the environmental sciences. Composed of ESSA's Environmental Data Service and the National Oceanographic Data Center (formerly Navy-administered), the Environmental Data Service collects, processes, archives, publishes, disseminates, and recalls worldwide environmental data for use by commerce, industry, the scientific and engineering community, and the general public; guides research activities related to improvement of such services; and coordinates international activities in climatological and geophysical data problems with the world scientific organizations.

The Data Service is headquartered near Washington, D.C., and its oceanographic and geomagnetic data centers are located there. Asheville, N.C., is the site of the National Climatic Center and National Geophysical Data Center. An upper-atmosphere data center is located at Boulder, Colo. The Laboratory for Environmental Data Research, in Asheville, is developing new ways of using this information to improve man's view of the physical world. Dr. Thomas S. Austin, former director of the National Oceanographic Data Center, is interim Director of the Environmental Data Service.

THE NATIONAL WEATHER SERVICE

DR. GEORGE CRESSMAN

The 300-odd offices of the National Weather Service (formerly the ESSA Weather Bureau) give NOAA its greatest public exposure, for weather forecasts and warnings are the most pervasive of environmental science services. Charged with observing and reporting the weather of the United States and possessions, and with issuing forecasts and warnings of weather and flood conditions affecting national safety, welfare, and economy, the National Weather Service touches virtually every citizen's life, both through its public weather services and its specialized services to aviation, space operations, agriculture, maritime activities, and other weather-sensitive activities.

Dr. George Cressman, former director of the ESSA Weather Bureau, is interim Director of the National Weather Service. Aided and guided by key offices and facilities near Washington, D.C., the day-to-day work is accomplished mainly in the field. The National Meteorological Center is the keystone of the forecast organization, preparing much of the synoptic-scale guidance material and long-range forecasts used by local and regional Weather Service offices. It has been designated by the World Meteorological Organization as the analysis and forecast arm of the Washington World Meteorological Center, which has global responsibilities as part of the World Weather Watch.

The Office of Hydrology provides the water management services of the water management and hydrometeorological sides of National Weather Service operations, including river forecasts and flood warnings. Through a network of River Forecast Centers and River District Offices, this office keeps watch on the Nation's important watersheds and river basins, using satellite data, ground-station measurements, and computer modeling techniques to provide forecasts ranging from a few days to 30 days into the future. Six regions—Eastern, headquartered in New York City; Southern, Ft. Worth Tex.; Central, Kansas City, Mo.; Western, Salt Lake City, Utah; Pacific, Honolulu; Alaska, Anchorage—provide the critical link between the Weather Service and activities it serves.

ENVIRONMENTAL RESEARCH LABORATORIES

DR. WILMOT N. HESS

The success of much of the work of NOAA rests on advances in science and technology—advances which propel techniques from experimental to operational, which expand man's understanding of the physical world, which show where he can (and where he should not) intervene in natural processes. The Environmental Research Laboratories, formerly the ESSA Research Laboratories, conduct the fundamental investigations and experiments needed to achieve these advances. Dr. Wilmot N. Hess, who directed the ESSA Research Laboratories, is Director of the Environmental Research Laboratories in the interim NOAA organization.

The Atmospheric Physics and Chemistry Laboratory (Boulder, Colo.) is NOAA's major focus for developing methods of practical, beneficial weather modification.

The Air Resources Laboratories (Washington, D. C.) house NOAA's principal efforts to identify, detect, predict, and control atmospheric pollution.

The Geophysical Fluid Dynamics Laboratory (Princeton, N.J.) studies the dynamics and physics of geophysical fluid systems to develop predictive mathematical models of ocean and atmosphere.

The National Severe Storms Laboratory (Norman, Okla.) studies tornadoes, squall lines, and other severe local storms with an eye to improved detection and prediction methods.

The Atlantic Oceanographic and Meteorological Laboratories (Miami, Fla.) conduct research toward a fuller understanding of the global ocean and its interactions, study hurricanes and other tropical weather phenomena, and conduct experiments in hurricane modification.

The Pacific Oceanographic Laboratories (Seattle, Wash.) conduct research toward a more complete description of the global ocean and its interactions, including seismic sea waves.

The Earth Science Laboratories (Boulder, Colo.) conduct research in geomagnetism, seismology, geodesy, and related technologies.

The Aeronomy Laboratory (Boulder, Colo.) studies the physical and chemical processes of the ionosphere and exosphere of the earth and other planets.

The Space Disturbances Laboratory (Boulder, Colo.) monitors characteristics of the space environment related to early detection and reporting of important disturbances, and conducts related basic research.

The Research Flight Facility (Miami, Fla.) meets NOAA's requirements for environmental measurements from specially instrumented aircraft. The Facility currently maintains a fleet of five aircraft.

THE NATIONAL OCEAN SURVEY

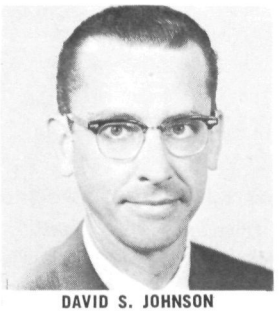
REAR ADMIRAL DON A. JONES

President Nixon, in his message transmitting the NOAA Reorganization Plan to the Congress, said that "by employing a unified approach to the problems of the ocean and the atmosphere we can expand our opportunities not only in those areas but in the third major component of our environment, the solid earth, as well." Although the solid earth is not spelled out in NOAA's name, it is implicit in its mission.

The National Ocean Survey, which combines the functions of the ESSA Coast and Geodetic Survey and elements of the U.S. Lake Survey, provides much of the "solid earth" part of NOAA's work. The Survey monitors the earth's geophysical fields and seismic activity, issues tsunami warnings to Pacific Ocean residents, conducts precise geodetic and other geophysical surveys, and generally provides NOAA's major involvement in solid earth activities. A worldwide system of geodetic control, developed through the use of satellites and photogrammetric techniques, is nearing completion that, for the first time, provides precise links between the geodetic nets of distant continents. The Survey is also strengthening the national geodetic control network, determining earthquake effects, and evaluating seismic risk on local and regional bases.

Rear Admiral Don A. Jones, former Director of ESSA's Coast and Geodetic Survey, is Acting Director of the National Ocean Survey. Through technically specialized headquarters offices—geodesy and photogrammetry, seismology and geomagnetism, hydrography and oceanography, aeronautical charting and cartography, systems development—the Survey's Rockville headquarters plans and guides what is largely a field activity. The oceanographic operations of the Survey are run from centers on both coasts and the Great Lakes. The Atlantic Marine Center, in Norfolk, Va., handles operation of ocean-going survey ships and maintains ship bases at Norfolk and Miami, Fla. The Pacific Marine Center, in Seattle, Wash., conducts survey operations in the Pacific Ocean area. The Lake Survey Center, in Detroit, Mich., conducts surveys and prepares the various cartographic and other products derived from its work in the Great Lakes and their outflow rivers, Lake Champlain, New York State Barge Canal, and the Minnesota-Ontario Border Lakes. A Mid-Continent Field Office directs geodetic and other field parties.

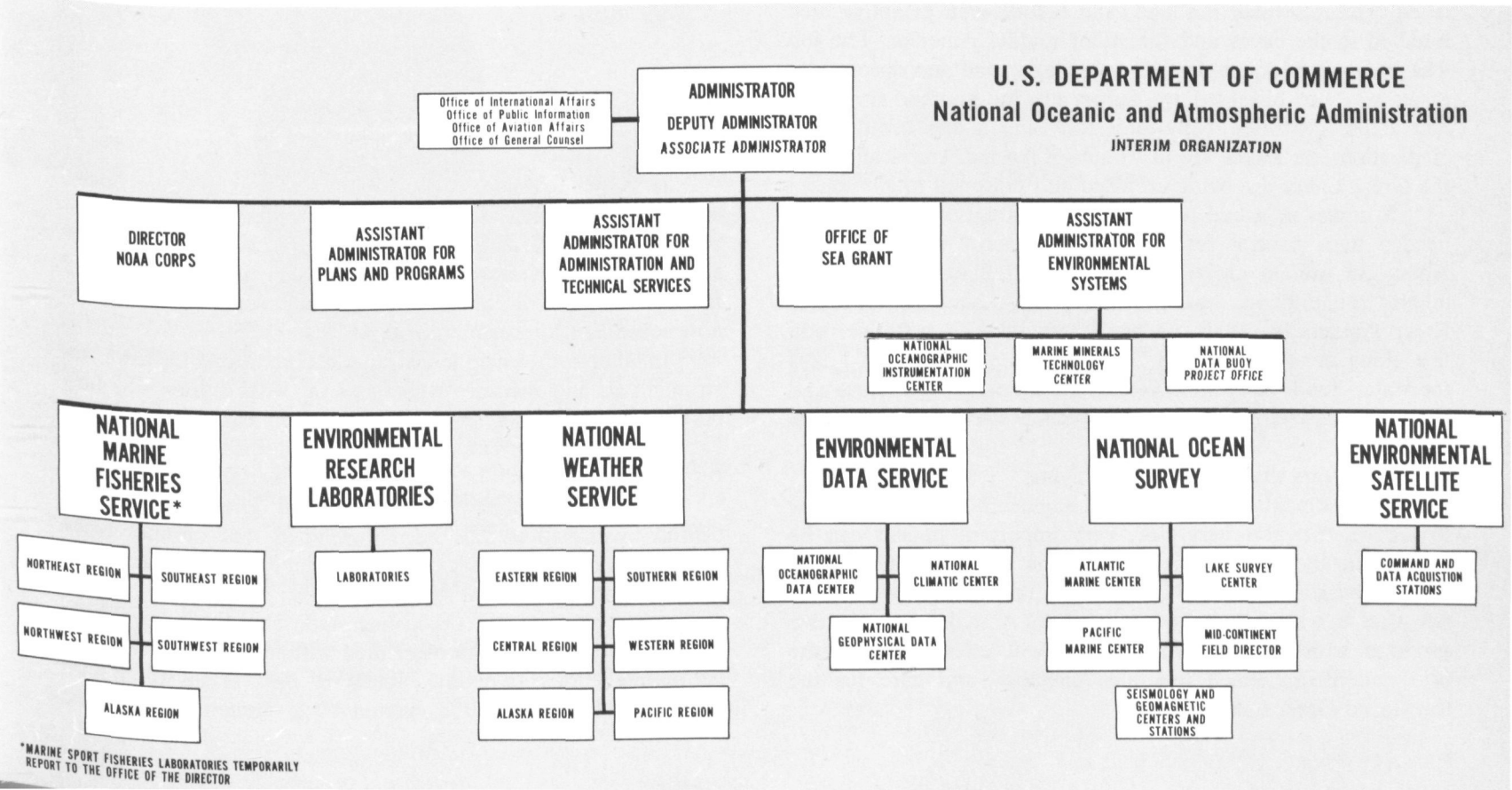
THE NATIONAL ENVIRONMENTAL SATELLITE SERVICE



DAVID S. JOHNSON

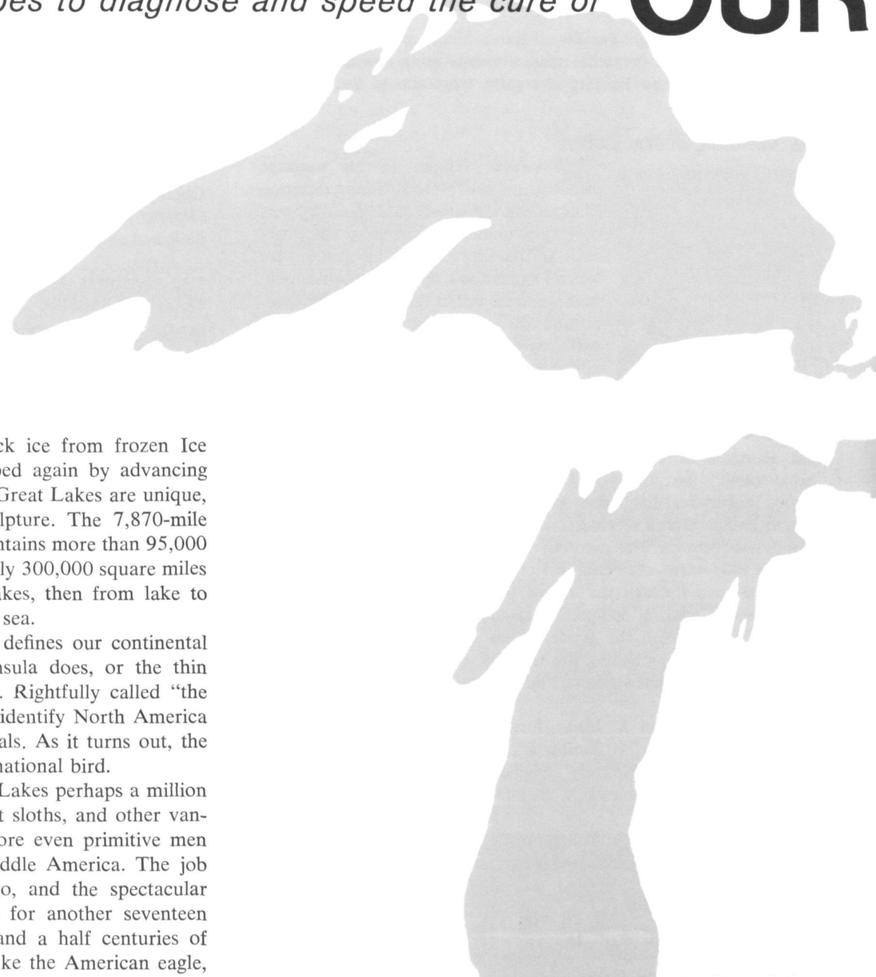
Satellites, and the sensors they carry, constitute one of the technological "quantum jumps" associated with the environmental science of the 1970's. The National Environmental Satellite Service, formerly ESSA's National Environmental Satellite Center, provides satellite observations of the environment, develops ways to increase the use of satellite data, and establishes and operates a national environmental satellite system.

David S. Johnson, who directed the ESSA satellite center, is Director of the National Environmental Satellite Service. From its Suitland, Md., headquarters the Satellite Service operates the national environmental satellite system through command and data acquisition stations in Gilmore Creek, Alaska, and Wallops, Va. Specialized offices—operations, system engineering, research—see that the present system stays operational, that future sensors and vehicles mature technologically, and that new methods are developed for using satellite data to improve man's comprehension and use of his environment and its oceanic resources. □



The International Field Year for the Great Lakes hopes to diagnose and speed the cure of

OUR AILING INLAND SEAS



SCULPTED by tongues of mile-thick ice from frozen Ice Age Canada, shaped and reshaped again by advancing and retreating glacial sheets, the Great Lakes are unique, the masterpiece of all Pleistocenic sculpture. The 7,870-mile shoreline of these coupled inland seas contains more than 95,000 square miles of fresh-water surface. Nearly 300,000 square miles of surrounding lands drain into the Lakes, then from lake to lake to the St. Lawrence River and the sea.

The familiar outline of the Lakes defines our continental map as definitely as the Florida peninsula does, or the thin leg of Baja California, or Hudson Bay. Rightfully called "the key to the continent," the Great Lakes identify North America as the eagle marks our currency and seals. As it turns out, the Lakes have much in common with our national bird.

Nature's work began on the Great Lakes perhaps a million years ago, when wooly mastodons, giant sloths, and other vanished creatures ruled the land, and before even primitive men huddled in the caves and forests of middle America. The job was completed about 18,000 years ago, and the spectacular result was not observed by Europeans for another seventeen and a half centuries. Now after four and a half centuries of civilization, the Lakes are in trouble. Like the American eagle, the Great Lakes are being crowded and poisoned to extinction.

It comes at a bad time, for North Americans have never needed their natural resources and treasured symbols more. About 35 million citizens of the United States and Canada inhabit the drainage basin of the Great Lakes-St. Lawrence River system. By 1980, an estimated 44 million people will live along these inland seas. A lot of people using the Lakes for water, food, recreation, industry, commerce; for refuse and sewage, industrial wastes, "development." A lot more people on the way.

One hears that the Lakes are dying.

Environmental scientists and engineers are moving now to see whether this very sick, very important patient can be saved, but they face difficult problems of information. Like skilled physicians wtih a sick Martian, they find it is easier to tell what is wrong than how to cure it. A major investigative program with the acronym IFYGL will attempt to fill the information gap which separates diagnosis and cure for the threatened Great Lakes.

IFYGL, the International Field Year for the Great Lakes, has been established as a joint United States-Canadian contribution to the International Hydrologic Decade. A single lake and basin, Lake Ontario, has been chosen as the "specimen" for this investigation, and the program's observational phase is now scheduled for calendar year 1972.

In simplest terms, IFYGL will take Lake Ontario, instrument it, and measure what goes in, what comes out, how lake waters (and their cargo of pollutants) circulate, and how chemical and biological characteristics of the lake change in response to those factors, and to seasonal variations.

Within this framework of time and intention, a set of central investigations has been developed that outlines those themes which must be explored in depth and detail if the IFYGL is to produce useable results.

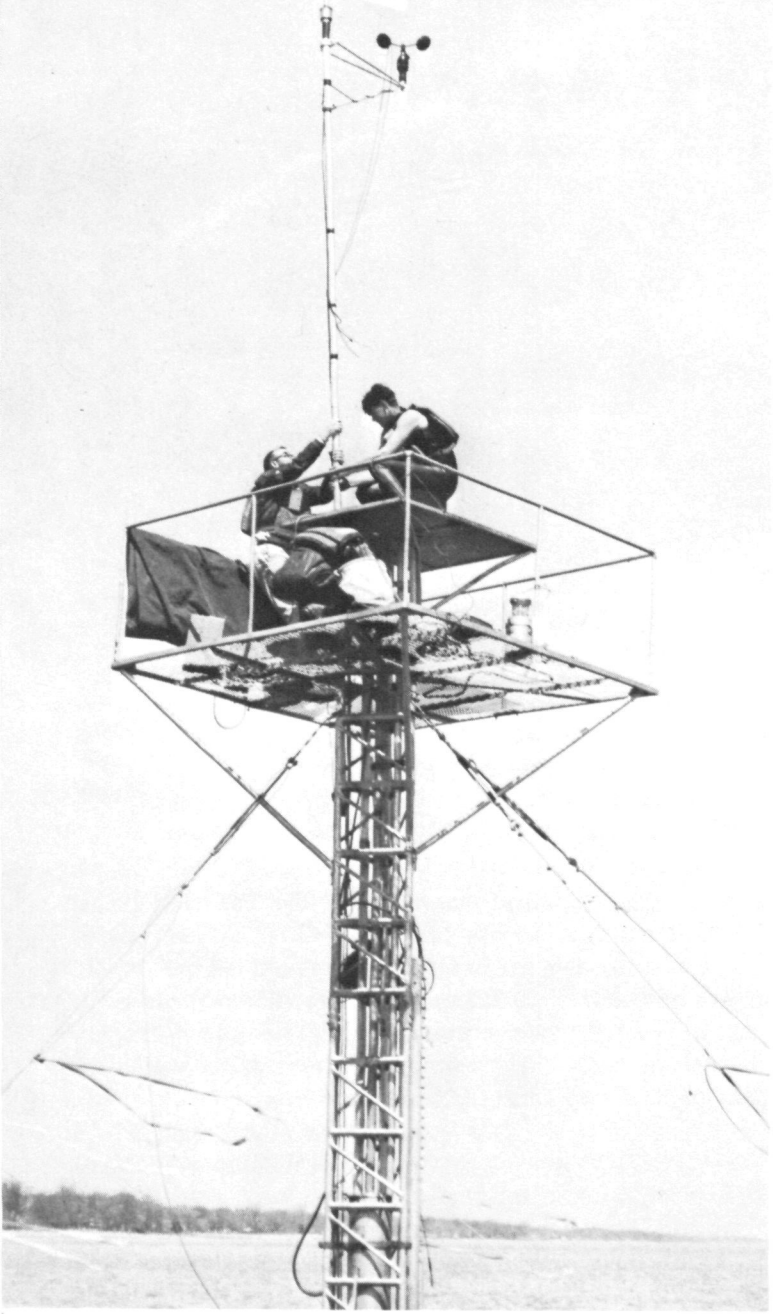
A program of IFYGL's magnitude could not have been planned and cannot be implemented without the dedicated and continuing efforts of many experts in the various disciplines involved. The plan itself is steered by a committee composed of four leading scientists from the United States and four from Canada. Scientific activities include lake meteorology, terrestrial water balance, energy balance, water movement, and chemistry and biology.

At present, IFYGL planners see scientists and their new-technology instruments getting ready during 1970 and 1971, for an intensive and coordinated data collection program during much of calendar 1972, field work at a much smaller scale and data reduction in 1973, and 1974 and 1975 as years for analysis, assessment, and publication of data. Field data collection will employ a network of towers and buoys emplaced in nearshore and offshore areas of Lake Ontario, research ships and aircraft, and shoreline meteorological stations. Individual research tasks will be carried out concurrently with the large, "synoptic-scale" measurements of weather systems and energy and water flows.

IFYGL participants include representatives of United States and Canadian universities, government agencies, and private industry. NOAA became lead agency for the United

continued

The familiar outline of the Great Lakes identifies North America, as the eagle does our currency and seal. Now, after four and a half centuries of civilization, the Lakes are dying. Taking Lake Ontario and its basin —indicated by the dashed line—as a specimen, the International Field Year for the Great Lakes will instrument it, and measure what goes in, what comes out, and how lake waters circulate. From this information may come a diagnosis and a cure for the multiple ills of our inland seas.



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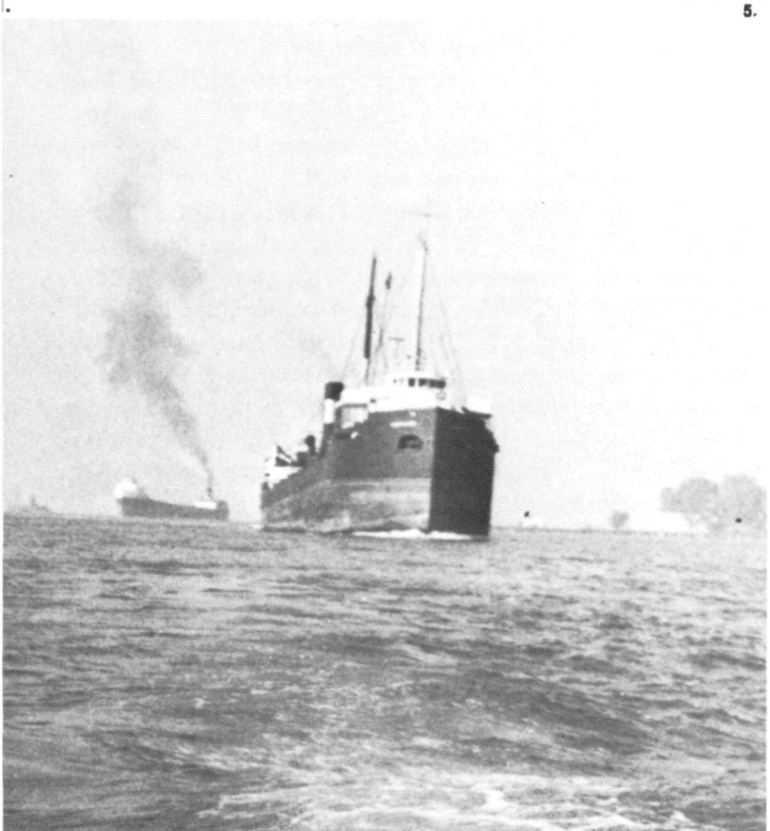

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States' part of the project on October 3, 1970, when elements of the Lake Survey were transferred from the Army Corps of Engineers by the reorganization plan creating the new agency.

Problems related to water quantity and water quality provide the main focus of a broadly interdisciplinary physical science program spanning the fields of geology, hydrology, limnology, and the atmospheric sciences. IFYGL investigators will study processes and effects commensurate with the scale of the specimen lake itself, with certain smaller-scale investigations undertaken mainly to support studies of larger-scale behavior.

The water quantity investigations will have two major goals. First, the observational programs will provide more accurate estimates of the individual components of the terrestrial hydrologic cycle—lake storage, surface and subsurface land storage, streamflow, precipitation, and evaporation. This will require a synthesis of information gained from the standard hydrologic observational networks, storm detection radar, remote infrared sensors, and direct measurement of the vertical flux of moisture in the atmospheric boundary layer. Final estimates of long-term evaporation from the lake will benefit from the analysis of data provided by scientists investigating the energy budget of the lake, and experimental calculations of the water budget of the atmosphere.

The water quantity investigations will also study the factors which affect the amount and distribution of precipitation over the basin. Atmospheric circulation features induced by the lakes themselves have a profound effect on the regional precipitation distribution, and these "mesoscale" circulation features a few miles in size will be studied in detail. Such studies should lay the ground work for improved understanding of the role of the lakes in modifying the continental scale climatic features. This, in turn, can be expected to lead to the numerical modeling of these features and the prediction of the local precipitation anomalies. The data will also provide input for weather modification studies aimed at favorable deliberate modification of the existing precipitation patterns.

The water quality investigation will focus on the measurement and understanding of the large-scale circulation features of the lake, and its thermal characteristics. An understanding of these physical processes is essential if we are to predict accurately the ultimate effect of existing or anticipated thermal, chemical, and biological pollution; moreover, such understanding must support any program to reverse the decline in quality.

Numerous features of the circulation and energy balance are unique to large lakes. These include such important circulation features as internal waves and coastal "jets" parallel to the shore. Significant thermal features which must be thoroughly investigated are the two-layer stratification of the lake in summer, the transition to a uniform stratification in winter, and the development and disappearance of the "Thermal Bar," a zone of concentrated temperature gradient in the surface layers which develops during the spring as a barrier to diffusion of pollutants. Since the lake is thermally and dynamically linked to the atmosphere at the lake-air interface, these investigations must include a coherent program of atmospheric boundary layer measurements of heat and momentum fluxes. Such measurements, with lake water movement and temperature observations under a variety of conditions, will lead to a better understanding of the response of the lake to changing conditions in the atmospheric boundary layer. Of special interest is the rate and direction of flow of life-supporting chemicals, including oxygen, nitrates, and phosphates, which the lake stratifies, then "overturns" in early winter.

The mounting of a geophysical program of measurements of this magnitude will be of major benefit in a number of areas not directly related to the core investigations. First of all, the location of the lakes, in mid-continent at a moderately high latitude, will permit some specialized studies. IFYGL will yield a description of over-water and over-land processes over a broad spectrum of stability conditions. Late fall over Lake Ontario allows study of transfer during marked local instability; in spring, the inversion above the lake dwarfs anything found in the tropic seas. Similarly, downwind air mass modification over the lake eclipses similar tradewind processes. This understanding will be useful not only for Lake Ontario, but for larger and smaller lakes as well.

IFYGL also offers a vehicle for the mounting of a number of subsidiary programs which could not otherwise be carried out. Specifically, these are programs of the type which do not disturb the basic data-gathering program, but which greatly benefit by being carried out in a thoroughly measured environment. In particular, IFYGL offers an unparalleled opportunity for a major program of chemical and biological studies of the lake, undertaken during a period when the movement and thermal structure of the lake will be known in some detail.

The hope is that the International Field Year for the Great Lakes, and other, future projects, will point the way toward successful treatment of the myriad aches and pains troubling this chain of landlocked oceans. Hopefully, IFYGL will become one of the milestones on the long hard road to the Great Lakes' full recovery. □

Field data collection for the Great Lakes study will employ a network of towers and buoys emplaced in nearshore and offshore areas of Lake Ontario, research ships and aircraft, and shoreline meteorological stations. 1. Weather observations, together with lake water movement and temperature measurements under a variety of conditions, will lead to a better understanding of the lake's response to changes in the lower atmosphere. 2, 3, 4. Lake water samples will be collected and analyzed, in hopes of predicting the ultimate effects of pollution and reversing the decline in water quality. 5,6. About 35 million citizens of the United States and Canada inhabit the drainage basin of the Great Lakes-St. Lawrence River system. By 1980, an estimated 40 million people will live along these inland seas . . . a lot of people using the lakes for water, food, recreation, industry, commerce; for refuse, sewage, industrial wastes, "development."

The National Marine Fisheries Service is developing an automated system that could change commercial fishing

FROM A HUNT TO A HARVEST

Since ancient times, man has fished with nets, traps, lines, or similar types of gear. Despite modern innovations and improvements, the basic techniques of commercial fishing have changed little. True, today's vessels are larger and more powerfully driven, the nets are bigger and better, and the electronic gear becomes more sophisticated every year. But the commercial fisherman still must find the fish: he is still the hunter of the seas.

At the National Marine Fisheries Service Exploratory Fishing and Gear Research Base in Pascagoula, Mississippi, research is in progress to change this ancient approach to fishing. According to Dr. Edward F. Klima, Base Director, an automatic fishing platform is now being developed and may be in operation by next year. Dr. Klima explains that marine fishery resources off the United States yielded only 2.3 million tons last year. Scientists estimate that this yield could be increased manyfold. The large latent potential of the gulf region is one reason for the development of the automatic fishing platform.

The basic idea of the fishing platform is to attract small, loosely-schooled fish with submerged rafts, guide these fish with special lighting to a central location where they can be concentrated with an electrical field, and pumped aboard a floating platform. The fish could then be automatically processed for human and animal food.

The principals behind the automatic fishing platform are not really new. The Base has been studying aspects of the problem for several years. Observations by scuba divers in the northern Gulf of Mexico indicate that small submerged rafts attract and concentrate fish. The submerged structures, which resemble small tents, attract two types of fish. One group, designated "jacks," consists of amberjack, blue runner, and rainbow runner. The second group, designated "baitfish," is more loosely associated with the structures and consists of Spanish sardine, scaled sardine, and round scad. Daily observations show that baitfish are attracted in quantities exceeding 100,000 fish at each structure. Studies at the Base will determine the best shape and size of the submerged rafts for attracting fish.

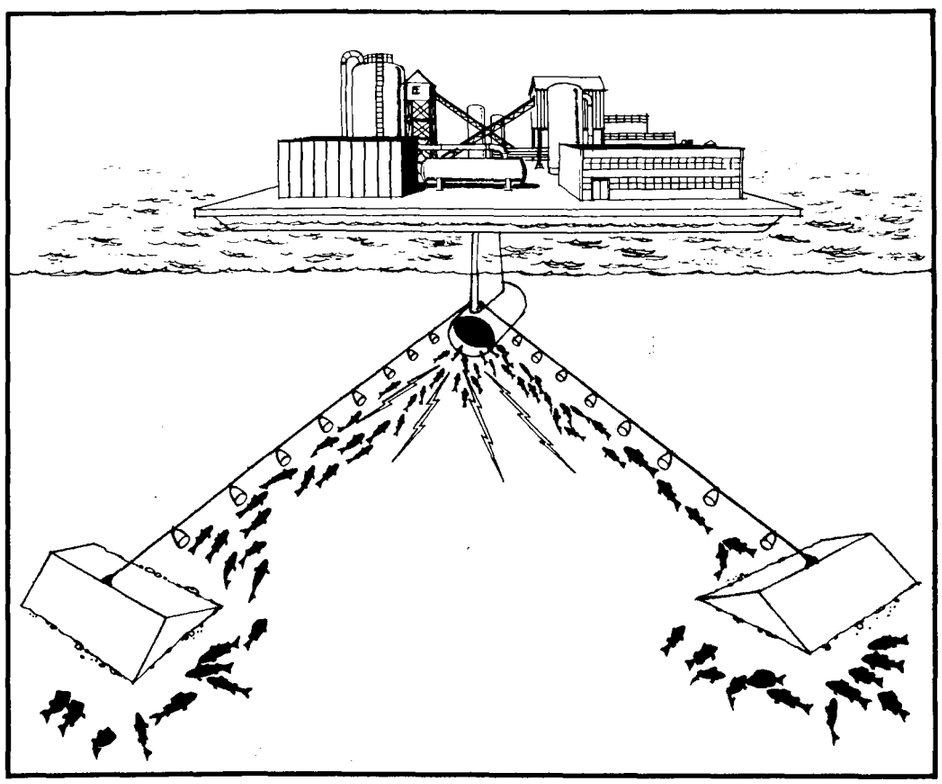
Lights have been used for many years to concentrate fish for commercial fishing. Various species of herrings, anchovies, jacks, squids, and some mackerel-like fishes have been concentrated in large quantities around surface and subsurface lights. These fish, generally of small size and in small schools, are distributed along most of the coastal areas of the gulf and the Atlantic.

For several years, scientists at the Pascagoula Base have been evaluating means of harvesting these fish with existing commercial gear. In studies using underwater mercury vapor lights, scientists were able to concentrate and catch up to three tons per purse seine set of these coastal pelagic fishes. Commercial purse seining around these lights was economically feasible, but catches were about one-third lower during full-moon periods than during new moon. Further studies are in progress to evaluate the correct type and amount of light required to attract and control these pelagic fishes.

In addition, submerged lights attached to a fish pump were used as early as 1966 to sample pelagic fishes in the Caribbean. Although catch rates sometimes reached 900 to 1800 fish pumped per minute, the fish were not sufficiently concentrated for this process to be commercially feasible. The scientists feel, however, that electricity will concentrate even greater numbers of fish at the intake.

Laboratory studies using modern electronic components show that specific types of pulsed direct current can effectively lead and concentrate many pelagic fishes. Present research at the Base will evaluate and determine the optimum kind and amount of electricity for attracting and leading fishes. Results will be used in field-tests of the commercial harvesting system utilizing light, electricity, and pumps.

"The development of this new harvesting and processing system will hasten the profitable development of underutilized fish stocks in the gulf," says Dr. Klima. "The need for food from the sea will become greater as our population and the world population continue to grow. One of the goals of the National Marine Fisheries Service will be to develop techniques to more fully utilize the tremendous protein resources of the sea. The automatic fishing platform will be one of many steps to help meet this challenge." □



The automatic fishing and processing platform under development at the Marine Fisheries Exploratory Fishing and Gear Research Base in Pascagoula, Mississippi, may revolutionize present commercial fishing techniques and allow economical harvesting of many little-used species. Underwater lights attract the fish, and an electric field concentrates them at the intake of a pump. On board the platform, the fish can be processed for human and animal consumption.

Q. Having been with ERL a little over a year now, how do you like it?

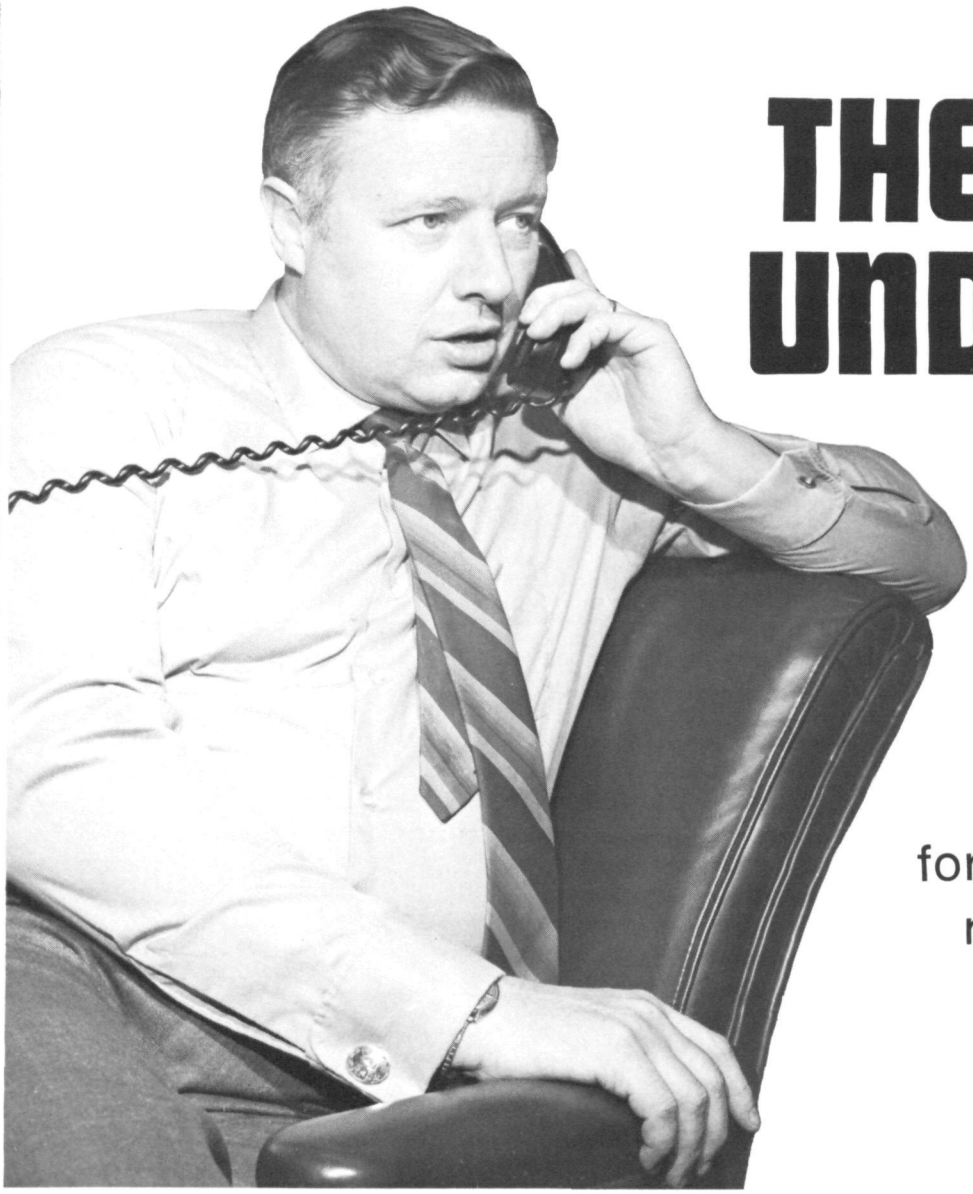
A. It's just great. Moving from NASA to ERL was a definite step toward my own personal objective of working within a scientific framework and seeing the results of significant scientific activities undertaken by a large number of qualified people.

Q. Where do you think ERL is heading in the next year?

A. In the context of the new NOAA organization, I think ERL research will probably have more emphasis on oceanography. For example, since the National Marine Fisheries Service is a biological organization oriented toward commercial interests, it might be appropriate for us to get involved in this area of research. That is, we would like to participate in the biological oceanography business as well as physical oceanography and meteorology. I would also think that the business of weather modification may blossom this next year. If we in the research laboratories are to contribute scientifically to all NOAA services, then the laboratories will have larger jobs and, of course, need more money.

Q. Where will we be five years from now?

A. In five years, we should see considerable expansion in ERL's activities. You read about the environment in the paper every day. People are very much concerned about what's happening to it and, I think, this concern is broader than just worrying about the pollution caused by car exhaust. We have not thought adequately about man's effects on the earth we live on, yet we keep moving forward with new industrialization and technology. We have not given adequate attention to understanding of the environment. We have not attempted to keep an equilibrium between man's activities and our environment. We talk about many environments—the oceans, atmosphere, solid earth, and space. We need to understand the oceans, the atmosphere, the solid earth, and near space to develop intelligent programs that keep things in balance. ERL has a signifi-



THE NEED TO UNDERSTAND

In a special interview for NOAA magazine, Dr. Wilmot Hess, Director of the Environmental Research Laboratories, foresees new directions for research and some major projects nearing fruition.

cant role in defining the natural environment and attempting to make peace with it. I expect our programs to constitute a major national effort.

Q. How do ERL scientists compare with others in their fields?

A. We stack up very well. In atmospheric sciences some of our people are world leaders. The work in global atmospheric modeling at the Geophysical Fluid Dynamics Laboratory under Dr. Joseph Smagorinsky is the best there is. The remote-sensing instruments being developed by Dr. Gordon Little and his Wave Propagation Laboratory people are leading the field. In oceanography, we are newer and smaller and cannot quite compare with the large, established organizations like Scripps. But we have some first-class people moving towards a more than adequate comparison. Our hurricane research is in front of the field. So, in certain areas, there is no question that our people are out in front. In general, I think our scientists are doing first-class substantial work. If I didn't believe that, I wouldn't be here.

Q. What problems are there in running such a geographically far-flung and scientifically diverse organization as ERL?

A. Boulder is a delightful place to live and work, and I wouldn't want to change it. Having an organization with lots of laboratories and different locations is of course a problem. It is relatively hard to make it into a coherent operation. I try to get around to all of the laboratories once or twice a year, and we try especially hard to make sure that the laboratories not located in Boulder don't suffer by not being close to ERL headquarters. We try so hard to be fair to the non-Boulder labs that I'm afraid we sometimes treat our Boulder-based laboratories a bit badly.

Concerning the scientific diversity, I enjoy geophysics and am having a lot of fun learning meteorology and seismology and oceanography. These are all challenging scientifically and really all parts of the larger subject of geophysics, so while they are diverse they are also unified.

Q. What is the mood of ERL people after so many years of austere funding and reorganization?

A. Being a short timer, I'm not sure I can answer adequately. Unquestionably, there have been hard times. Inadequate money last year made it necessary to reduce personnel in some areas. We have had to defer some programs. A situation like this is always unhappy for the people who are involved in the slowdown areas. In general, however, we are moving ahead with reasonable speed. We may not be doing all the things we want to do but, on the other hand, we won't lack support for what we are doing. I'd say the mood of ERL, particularly since the establishment of NOAA and the rapid blooming of public concern about the environment, is one of cautious optimism.

Q. What do you think of union activity in ERL?

A. I recognize and respect the right of ERL employees to join or not join labor organizations as they may choose. I think unions are useful in communicating problems to management. If we don't know about the existence of problems we can't hope to understand them and solve them.

Q. In hard times, how do you decide where the limited ERL funds are going to go?

A. There is no clear-cut way to make these decisions. There are always some programs that float to the top as the most productive. Others are near a payoff. For instance, the work that has been done in the last year in hurricane modification has led us to the distinct possibility that, in the next couple of years, we'll understand enough about hurricanes to alter them beneficially and reduce their winds. The payoff in a project like this is tremendous to a large number of people and industries along the Gulf and Atlantic coasts. There is no question that we have to move vigorously with that program. If doing so means some other programs have to suffer, that's the way it must be. Hopefully, the programs that suffer will be supported at some later time.

Another very promising area is remote sensing in the Wave Propagation Laboratory. Here we can see possibilities of measuring meteorological parameters in three dimensions. So a limited number of fixed ground stations could get vertical profiles of temperature, pressure, wind, and turbulence in a way that is not now possible. This is a completely new technique in meteorology that will enable us to move into the mesoscale meteorology (medium-sized weather systems) which is so important for improved forecasting and weather modification. In general, program priorities are set in my office as the result of continual discussions with lab directors, and these priorities are used to decide funding priorities.

Q. We often hear that overhead and support is gobbling up increasing amounts of the research dollar. Is this complaint justified in ERL?

A. No, it is not justified. ERL has not changed its overhead charges in the past year. In fact, we reduced the number of administrative and support personnel in ERL when the Institute of Telecommunication Sciences (ITS) separated from ERL a few months ago. In reducing the support staff to compensate for reduced funding brought on by the loss of ITS, we even went beyond what was necessary. I consider this a sound move.

Q. Are we still going to be dependent to some extent on outside funding?

A. Yes, we now get about 40 percent from outside the Department of Commerce. In one lab, it is as large as 95 percent. This is hazardous. It is a good idea for us to take on work for other government agencies, because ERL facilities and talents constitute a national resource. But we should not let outside commitments get so large as to jeopardize our own programs. I would like to see a maximum of something like 25 percent outside funding spread more evenly around the laboratories.

Q. Would you mention some of the significant work going on at the laboratories? The Aeronomy Laboratory, for example.

A. The Aeronomy Laboratory has a continuing program towards understanding the dynamics, physics, and chemistry of the upper atmosphere. One thing they have done recently, which is quite exciting, is to measure atomic oxygen for the first time at an altitude of about 90 kilometers. No one has been able to do this in the past. Our AL people used rockets to make direct measurements of atomic oxygen, one of the very important constituents of this part of the atmosphere. It enters into the formation of ozone—a pollutant which is bothersome at lower altitudes. A year ago, the laboratory showed that the most important ion in the atmosphere at about 85 kilometers is clusters of water ions in the form of two water molecules attached to a proton. Before this work, the H_5O_2 process was not considered important, but now we realize that it is one of the dominant processes in the atmosphere at this altitude.

Q. What does the new Research Flight Facility aircraft mean for ERL research?

A. Primarily, the new C-130 will provide ERL with a new altitude capability, between 20,000 and 30,000 feet, for airborne meteorological research. Up to now, the RFF DC-6's have flown at all levels below 20,000 feet, and the B-57 has handled the programs above 30,000 feet. The maximum range of the C-130 is in excess of 3,000 miles. With additional fuel in an internal tank, the range can be increased. This compares with a 2,400-mile maximum for the DC-6's at their lower altitudes. One of the first and most important applications of this aircraft will be in Project Stormfury hurricane research. We really can't be certain whether our seeding has the effect we think it does unless we can measure water and ice in a hurricane at C-130 altitudes. We plan to use the aircraft in our other weather modification experiments, such as the Lake Effect Snow Redistribution Project and the Florida Cumulus Project.

Q. Is weather modification still in the basic research stage?

A. Yes, but I would be surprised if we aren't somehow involved in operational weather modification within five years. My two best guesses would be hurricane abatement and rain or snow making. Drs. Joanne Simpson and William L. Woodley of the Atlantic Oceanographic and Meteorological Laboratories have adequately demonstrated that we know how, when, and where to seed single cumulus clouds to increase rainfall substantially. There are major social and legal problems that must be faced before anyone (not necessarily ERL) can really undertake operational weather modification.

Hurricane abatement may be a special situation in which we will become operationally involved because we have the major competence in the business. Here again, there are enormously complicated social, economic, and legal problems. One of the unknowns is whether seeding a hurricane will change its track. This could certainly be a problem because the seeder might inadvertently steer a storm into a populated area. We have to understand all these possibilities before we can make decisions in an actual operation.

Q. How far is the Geophysical Fluid Dynamics Laboratory from a global numerical model that could be used for weather modification research?

A. Long-term trends involving inadvertent weather modification, which are terribly important to the well-being of mankind, can be handled reasonably well by models available at GFDL now. These models cannot describe local circumstances, such as smog in Denver, but it can tell us how increasing the carbon dioxide content of the atmosphere should change the earth's temperature.

Q. How are the heavy computing needs of the laboratories handled?

A. I was surprised to find quite diverse computing arrangements. GFDL at Princeton University has maintained a first-class computing facility. Next year, we expect to get for them the next generation computer, one of the world's largest and best. It will approach John Von Neumann's objective, stated more than 20 years ago, towards meeting the tremendous demands of practical global atmospheric modeling. In other laboratories, we are not doing as well. Some don't require much computing, and others don't use available computers because they are not convenient or sufficiently low-cost.

Our computing capability in Boulder probably will be upgraded in the next few years to meet increasing demands. Also, we must increase our computing capability in Miami for both our Atlantic Oceanographic and Meteorological Laboratories, and NOAA's National Hurricane Center and possibly other NOAA activities.

Q. Many ERL facilities are in rented quarters. Do you foresee permanent buildings for any of our tenant laboratories?

A. We are working actively toward getting permanent buildings for the National Severe Storms Laboratory and Pacific Oceanographic Laboratories—at the University of Oklahoma and the University of Washington respectively. We also have started discussing

Photo by Gordon Chesy

the possibility of a permanent building consolidating our NOAA activities in Boulder.

Q. Pacific Oceanographic Laboratories is relatively new. How is it doing?

A. It is a small organization that we hope will grow in the next several years. It is situated in an important area of the country, the northwest. Both the State of Washington and the University of Washington are strongly interested in oceanography, and we plan to play a strong role in the Pacific northwest in the development of an oceanic program. I personally hope that we can double the staff at POL in the next three or four years.

Q. Do you foresee any ERL efforts in upper atmosphere or direct space experiments?

A. The Space Disturbances Laboratory has started discussions with other government agencies about cooperative satellite ventures in which we would fly experiments on other people's satellites to make research measurements. This would help us understand the magnetosphere and space environment and provide better information for our space disturbances forecasts.

Q. Who are the customers for the Space Disturbances Laboratory's four-times-a-day solar forecasts?

A. Probably their biggest customer is next door to them—the Office of Telecommunications, which uses their forecasts to predict what the ionosphere is going to do in response to space disturbances. Many people are interested in the ionosphere because the ability to propagate radio waves long distances is strongly related to ionospheric properties. The SDL people are providing basic information to the telecommunications people, who then predict radio propagation characteristics. Another agency that SDL services is NASA. We now have the responsibility for providing all basic information to NASA in connection with astronaut radiation and safety problems.

Q. How do the projects of the Air Resources Laboratory relate to the air pollution studies of the Air Pollution Control Office in the Environmental Protection Agency?

A. Dr. Lester Machta of the Air Resources Laboratory has a very close working relationship with APCO, which provides a large part of ARL's funding. We are the main data-gathering arm for many APCO programs. One of the future collaborative efforts between ARL and APCO may be a large-scale urban meteorology experiment centered in a single region, possibly around St. Louis, in 1973 and 1974. APCO and ERL would be the major participants, but many other organizations would be involved, such as the Illinois State Water Survey and the National Center for Atmospheric Research. This project will be designed to develop a detailed picture of the mesoscale meteorology in an urban setting, pollution sources, diffusion and transport of pollutants from the city to the outskirts, and effects of the pollutants downwind. A cooperative effort like this could lead us to important new information in mesoscale meteorology and pollution effects.

Q. Are we close to predicting earthquakes?

A. I don't believe the Earth Sciences Laboratory people think we are going to be able to do that with earthquakes, but they know of some interesting precursors to earthquakes. There appears to be a small magnetic change that frequently occurs before small slippage events in the San Andreas area. If this magnetic change is characteristic of major earthquakes—and we don't really know this right now—we might be able to tell people somewhat ahead of time when an earthquake is suspected in their area, but probably not predict it accurately in time at all. This is an area for research by ESL's Earthquake Mechanism Laboratory in San Francisco. □

One future collaborative effort may be a large-scale urban meteorology experiment centered in a single region. This project will be designed to develop a detailed picture of mesoscale meteorology in an urban setting, pollution sources, diffusion and transport of pollutants from the city to the outskirts, and effects of the pollutants downwind.

Dr. Wilmot N. Hess, now Director of NOAA's Environmental Research Laboratories, became head of the ESSA Research Laboratories in July 1969. The Laboratories conduct a wide range of fundamental investigations to increase knowledge of the geophysical environment and to develop advanced environmental services.

Before his appointment to the ESSA post, Dr. Hess had been Director of Science and Applications at NASA's Manned Spacecraft Center in Houston, Texas, where he managed the Lunar Receiving Laboratory. He planned and conducted research in earth and lunar sciences, provided environmental data required to support mission and spacecraft design, developed and integrated experimental meteorological programs and instrumentation for space, and provided space environment data and support during manned space flights.

Dr. Hess went to Houston in 1967 from NASA's Goddard Space Flight Center in Greenbelt, Md., where he had served since 1961. As head of Goddard's theoretical division, he directed research in almost every discipline of space science, including particles and fields, aeronomy, ionospheric physics and geodesy. His groups were active in quantum mechanics, studies of atomic collisions, celestial mechanics, the origin and development of the radiation belt, theoretical astrophysics, and lunar science.

From 1959 to 1961, he was associated with the Livermore Radiation Laboratory in Livermore, California, where he directed nuclear and space physics research.

Dr. Hess was born in Oberlin, Ohio, and was graduated from Clinton, N.Y. High School in 1943. He served in the Navy at Columbia University from 1944 to 1946, and was graduated from Columbia in 1946. He did graduate work at Purdue University and Oberlin College, and received his master's degree in physics from Oberlin in 1949. He received his Ph.D. in physics from the University of California in 1954.

He was named one of the Ten Outstanding Young Men of Government in 1967 by the U.S. Junior Chamber of Commerce. □

There's nothing but trouble ahead for the unwary who fail to heed the Weather Service's warnings when

DANGER RIDES THE WAVES

BY GORDON C. SHIELDS
National Weather Service

IT'S COLD and lonely on the northern beaches now, with only an occasional, die-hard, wetsuited surfer to be seen floating out in the swell waiting for a favorable set of waves.

Six months earlier, a much different sight would have greeted your eye. In the summer, the word that "surf's up" spreads like wildfire. Within hours, surfboard-bristling "wheels" are weaving their way toward already crowded beaches. There's a feeling of exhilaration as visions of hissing waves, gliding grace, and bone-jarring wipeouts flash through the minds of surfers.

A more somber, businesslike mood permeates the many lifeguard headquarters, where rescue equipment is being checked and rechecked for inevitable use and where deployment of extra lifeguards is already underway.

But that was last summer. The air temperature is down in the lower 50's now, and along the Washington, Oregon, and northern California coasts heavy breakers pounding deserted beaches go practically unnoticed. In these waters, the critical danger area shifts from a narrow surf zone to the more turbulent waters over offshore bars.

Predicting winds and waves on the nation's west coast is of year-round importance and one of the most taxing jobs of the National Weather Service's marine meteorologists. Heavy breakers are the product of swells born in a far-distant storm. They do not simply loom out of nowhere without warning. They can be forecast, and warnings of dangerous conditions can be issued many hours—often several days—in advance of their arrival by Weather Service marine meteorologists who have been watching their turbulent source. Perhaps there is an intense storm in the far-away South Pacific Ocean. Or maybe a tropical storm off Acapulco, Mexico, has wound into a hurricane that is spewing out heavy swells as it plods northwestward some thousand miles from southern California. In winter months, the storm-breeding area shifts generally to the waters north of Hawaii. Wherever they come from, these crashing combers are awe-inspiring and often dangerous.

When a wind comes up over a smooth sea surface, tiny ripples spring up and move forward with the wind in long and more or less regular arcs. As the winds continue to blow, the ripples increase in height and become waves, while new wavelets are born. At some points, crossing wave crests may be exactly "in phase" and combine to form a high wave peak. Nearby, a trough from one wave may exactly nullify the crest of another wave. Elsewhere, two wave troughs may be in phase, and a relatively low point on the sea surface will form. As this confused process continues, a near-infinite progression of randomly spaced, irregular waves (known as seas) is formed. The stronger the winds and the longer they blow over a sufficient expanse of ocean, the bigger the waves grow.

Once set in motion, wind waves travel along in roughly the same direction, with longer period waves outracing shorter period waves. (A wave period is the time interval between the passage of successive crests.) Thus, within 18 to 24 hours after wind waves leave the area of their birth, they have stretched out to long, uniform, crested waves known as swells. As a swell train moves forward over great distances, the speedier frontrunners stretch out to wave lengths (the distance between successive crests) in excess of 1,000 feet with periods of 20 to 25 seconds. Carrying abundant energy, these very low, long swells often travel undetected for thousands of miles before shoaling up in a crashing crescendo on some far-distant shore.

Much remains to be discovered or developed to attain a complete understanding of the physical processes involved in coupling wind energy to water-wave formation, but present wind-wave forecasting techniques provide quite reliable estimates of seas in the generating area and subsequent decay of swells as they travel to distant points. From weather charts, the marine meteorologist determines the strength of a uniform wind field, how long and over how great an area the wind has been blowing, and the direction that waves will propagate away from the wind field. With this information, and from certain formulas developed through years of experience, a remarkably accurate wave forecast can be prepared.

From late spring through early autumn, tropical storms and hurricanes form off the Central American coast and drift westward across low latitudes of the eastern North Pacific Ocean. When these relatively small but intense storms move to the west or northwest, they develop very heavy, but localized, seas. However, the duration of strong wind over any given stretch of water is quite short with only a moderate, rather narrow, swell ray being propagated out of the storm area. If, on the other hand, the storm remains nearly stationary or moves northward, the effective wind duration directing waves northward is longer, and a much heavier swell will be propagated toward southern California.

Also, during the months of May through October, Southern Hemisphere winter storms roam eastward across the Indian Ocean and far southern latitudes of the South Pacific Ocean. These storms, spawned off the Antarctic ice sheet, may pack winds of 50 to 60 miles per hour and remain nearly stationary for days at a time. The howling gales produce monstrous seas that, when properly aligned, direct heavy swells into the Northern Hemisphere. Due to its geographical orientation, the southern California coastline is especially vulnerable to swells arriving from either of these southerly source regions.

Tenaciously driving forward on their long journey, southerly swells invariably encounter resistance from opposing or crossing wave trains, adverse winds and intervening islands. The final result is that they arrive off southern California not as an orderly progression of uniform heights but in variable sets. A dozen or so large breakers may crash onto the beach, followed by a 15- to 20-minute lull before the next heavy set rolls in.

It is this irregular spacing of larger breakers that creates the greatest hazard for the unwary swimmer or surfer. Content to sit on the beach during the boomers, he may return to the water during a period of low breakers only to be caught by the next set of heavy breakers. If he is not ground into the sand, he may find himself being carried out to sea by a strong rip current. Panic sets in and the victim furiously paddles straight for the beach, directly against the flowing current and often in water only waist deep. During a siege of these heavy and variable breakers with shifting rip currents, lifeguards may rescue as many as 1,000 potential drowning victims each day. It is not uncommon to see a lifeguard laboring toward the beach with two or three exhausted

continued

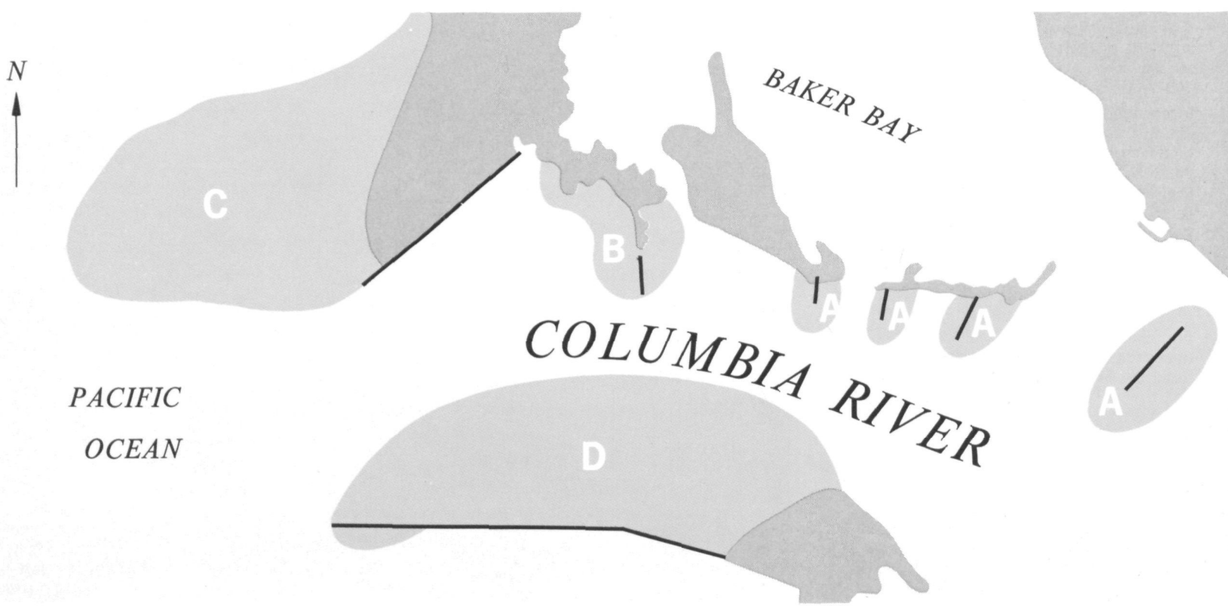
STATEMENT ON HEAVY SURF ISSUED AT 0900AM PDT FRIDAY 25 JULY 1969

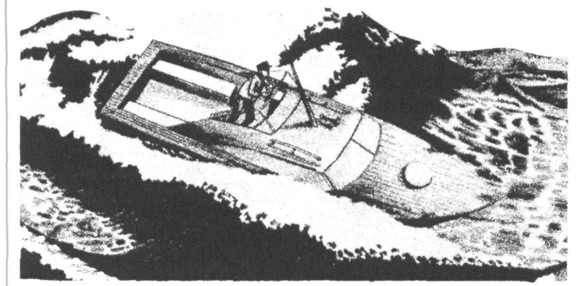
SURF BEGAN TO INCREASE ON MANY OF OUR BEACHES THURSDAY AFTERNOON. ABOVE TO MUCH ABOVE NORMAL SURF IS EXPECTED ON BEACHES EXPOSED TO A SOUTH SWELL TODAY WITH A GRADUAL DECREASE SATURDAY. HEAVIEST BREAKERS WILL OCCUR WITH THE HIGH TIDE NEAR SUNSET THIS EVENING. ZUMA BEACH TO MALIBU AND FROM SEAL BEACH SOUTHWARD TO THE CITY OF OCEANSIDE ARE THE AREAS MOST SUSCEPTIBLE TO LARGE BREAKERS. SWIMMERS SHOULD BE ALERT FOR EXCEPTIONALLY STRONG AND DANGEROUS RIP CURRENTS.

THIS HIGH SURF IS THE PRODUCT OF A SOUTH SWELL THAT HAS TRAVELED NEARLY 5000 NAUTICAL MILES FROM ITSORIGIN IN AN INTENSE STORM CROSSING THE SOUTH PACIFIC OCEAN LAST WEEK. EVEN THOUGH THE PARENT STORM BLEW ITSELF OUT OVER CHILE ON MONDAY IT WILL BE LATE SATURDAY TO EARLY SUNDAY BEFORE THE SOUTH SWELL DISAPPEARS FROM OUR COASTAL WATERS AND THE SURF DROPS TO NEAR NORMAL.

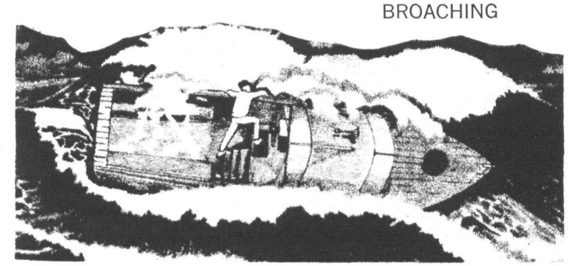
Heavy breakers, such as this 12-footer, are the products of swells born in some far-distant storm. They arrive off southern California in variable sets, a dozen or so large breakers followed by a lull.

Forty foot Coast Guard vessel beating its way over the Columbia River bar.





BROACHING

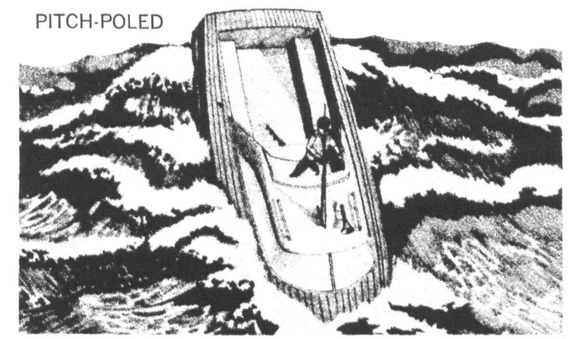


Most boating accidents on the coastal bars are caused from broaching, which results in capsizing. This operator did not keep his boat square before the seas. The sea has caught the boat on the port quarter which will force it to broach.

Having broached (veered) before a breaking sea, the bottom of the boat is exposed to the wave thrust which will cause it to capsize. A breaker which is six feet high will produce 3,000 pounds of pressure per square foot.

Another danger in high seas occurs when a small boat operator lets his craft get close to the top of a crest. Sliding down the steep wave slope, the boat's bow plunges into the water. It may not be able to recover.

PITCH-POLED



EXAMPLE OF BAR INFORMATION (FROM U.S. COAST GUARD BAR GUIDE)

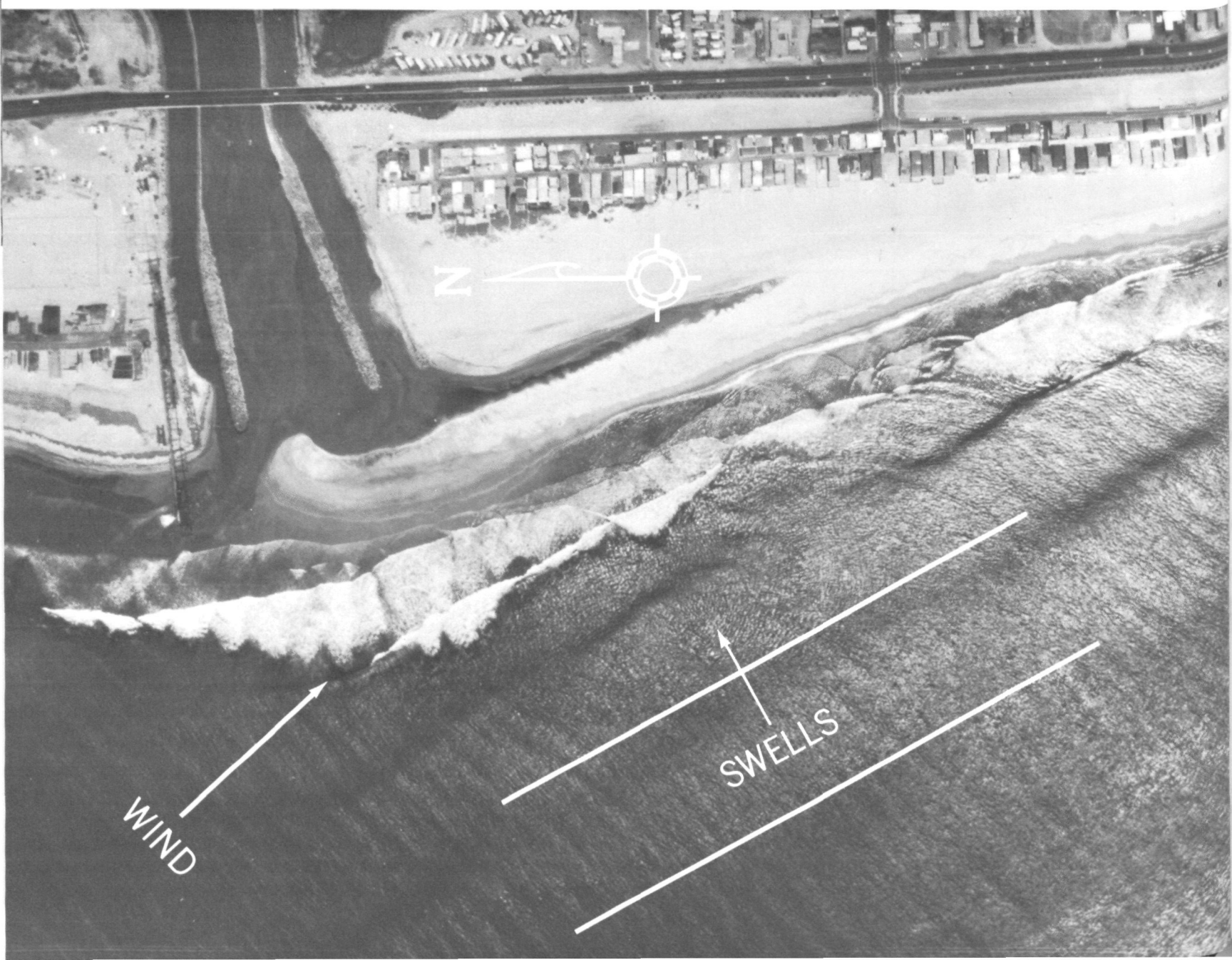
A CHINOOK SPUR, UPPER, LOWER AND MIDDLE SAND ISLAND SPURS are built on two rows of staggered pilings. Currents flowing through these pilings attain a velocity of up to 5 knots. A boat which becomes disabled or is maneuvered in such a way as to let it come in contact with any of these spurs is almost sure to suffer damage. Even large boats have been capsized in these areas. Give these spurs a wide berth and never get close to them on the upcurrent side.

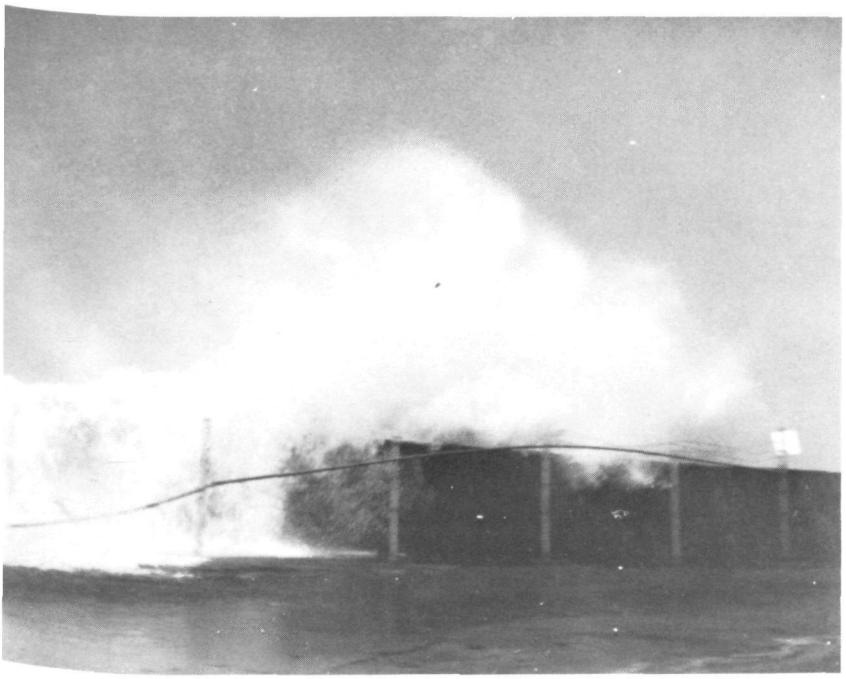
B JETTY A, which is southeast of Cape Disappointment, presents a particular danger when the current is ebbing. Water flowing out of the river is deflected by the jetty, and frequently the current reaches 8 knots. This often causes waves up to 8 feet high. Boats proceeding into Baker Bay West Channel make very little speed against the swift current and are exposed to the rough water for long periods of time. The shallow, sandy area should be avoided by small craft when heavy seas are running because of the surf which breaks on the beach.

C PEACOCK SPIT. The gentle swell encountered in the channel is somehow magnified here and the breakers are heavy in any type of current. Sports craft leaving the river should *NEVER* be on the north side of the black buoys. When rounding Peacock Spit, even on a calm summer day, one should give the breakers at least a half-mile clearance. Many times on these same summer days "sneakers", or unusually large swells coming in from the sea, suddenly commence breaking ¼ to ½ mile outside the usual break on the end of the north jetty. Along with Peacock Spit, Clatsop Spit is the gravest danger faced by the sport fisherman.

D CLATSOP SPIT is the most unpredictable area of the river entrance. During flood currents and slacks it may be relatively calm with only a gentle swell breaking far in on the spit. Yet 5 or 10 minutes later, when the current has started to ebb, it can become a roaring monster with breakers extending far out toward the channel. You should remain north of the red buoys in this area, particularly just before or during the ebb. Peacock and Clatsop Spits are called the graveyard of the Pacific for good reason.

(Left) Irregular spacing of large breakers creates a great hazard for the unwary swimmer or surfer. Content to sit on the beach during the boomers, he may return to the water during a period of low breakers, only to be caught by the next set of heavy breakers. (Below) Swells and crossing wind waves at the mouth of the Santa Ana River illustrate the surf forecaster's problem. From observations and certain formulas developed through years of experience, a remarkably accurate wave forecast can be prepared.





Heavy breakers pounding deserted beaches go practically unnoticed in winter, but forecasts are issued for surfers and boaters.

The sources of winter waves are closer to California, and heavy seas drive directly into coastal waters.

swimmers clinging to his rescue can.

Utilization of southern California swimming beaches declines during winter months, but there is still extensive participation in surfing and boating activities with a continuing requirement for a marine forecast program. Now, however, the South Pacific and tropical eastern North Pacific waters become quite tranquil with the sea-state forecast problem shifting to temperate latitudes of the North Pacific Ocean. Storms moving into the area north of Hawaii develop seas that drive heavy swells toward the west coast. Due to the sheltering effect of headlands west of Santa Barbara, only those seas developed south of the 40th parallel may reach southern California coastal waters. While the period between origin of heavy seas in a storm and subsequent arrival of swells on the coast is much less than that for the summer season's southerly swell arrival, the much greater abundance of oceanic weather and wave observations from merchant shipping provide data for more accurate sea state and breaker height forecasts.

As has been noted, summer seas usually travel great distances before reaching southern California and arrive as a long low swell. This does not present a problem to small-boat operators, but creates large breakers confined to a narrow surf zone directly on the beaches. In winter, however, decay distances from ocean waves are usually much shorter, with heavy seas driving directly into the coastal waters and with giant breakers periodically pounding the entire shoreline.

Major hazards to mariners in the Pacific Northwest are the sand and silt bars that form at river and inlet entrances. When a swift outgoing tidal current meets heavy seas rolling in from the Pacific at these shallow bars, the opposing forces cause the seas to "pile up" and breakers to form. Even on calm days, a swift ebb may create a bar condition which is too rough for small craft.

From the seaward side, there is no evidence of the turbulence ahead. The unwary mariner sees only the smooth backsides of shoreward breaking waves. This deceptively calm appearance may lure him on to the bar where heavy, plunging breakers may swamp him in a minute, although smooth seas and safety lie only a few hundred feet away on either side of the bar.

A following or flood tidal current, on the other hand, tends to lower wave heights and increase the length of incoming waves, generally producing flatter seas. Thus a harbor or channel entrance may be navigable during slack water and flood tide and impassable during ebb tide. Along the Oregon-Washington coast, navigable bays and estuaries are typically large relative to the width and depth of their respective channels. This results in strong tidal currents which tend to induce unstable breaking waves and to compound the problem by contributing material to build and maintain offshore bars.

In forecasting sea states near a harbor entrance, or over an offshore bar, the marine meteorologist is confronted with a threefold problem. First, he must predict the offshore or open water sea state, taking into account both local wind waves and swells arriving from distant storms. The next step is to estimate shoaling effects and wave stabilities as deep-water waves move over an offshore bar and into shallow water. Finally, he must compute the additional change in wave height and stability as incoming shoaling waves encounter a tidal current. In this last step, it is important to note that maximum ebb and flood of a tidal current does not necessarily correspond, at each location, with time of most rapid change in vertical height of the tide, nor does time of slack water generally coincide with time of high or low tide. With these local, rather large, differences in strength and timing of tidal currents, individual attention must be given to each bar or channel entrance.

The goal of a sea-state forecast is to extend planning guidance and timely warnings to mariners. In areas affected by strong tides and offshore bars, main emphasis of the forecast may frequently center upon a close integration of expected offshore wave heights and tidal flow. With such advisories a fisherman, for example, may schedule his departure so as to take advantage of calmer seas during flood tide or slack water. He may then safely remain outside the bar during higher seas of ebb tide and return to port during the next period of calmer seas. □

Development and conservation of the marine environment are combined in Sea Grant projects

POWER WITHOUT POLLUTION

BY ROLAND D. PAINE, JR.

Photo by Frank Oxley

THE DAY was windy, warm, and humid—typical of the Virgin Islands in early August. On the St. Croix beach, down the hill from an old plantation building (now a modern laboratory), a group of about 200 persons gathered. Brief ceremonial remarks were made. Government Secretary David Maas then pressed a green button on a pump, and rich cold water from a depth of 830 meters began to flow into a concrete pond near the site, through a mile-long, 3½-inch plastic pipe.

Afterward, all the guests—including Governor Melvin Evans of the Virgin Islands, Sea Grant head Robert Abel, and Dr. Maurice Ewing, Director of Columbia University's Lamont-Doherty Geological Observatory—had a sandwich lunch at the plantation/laboratory, and discussed the project's exciting possibilities for commercially important, pollution-free economic development of the area.

The event was the formal opening of Columbia University's "artificial upwelling" project, a Sea Grant activity. Under development for more than a year, the first step of this ambitious project is now bringing cold, nutrient-rich deep sea water into concrete basins to create a seawater "garden" of microscopic plant life—phytoplankton—to produce fish for food use.

The project itself is indicative of one of the major thrusts of Sea Grant, whose primary purpose under its Congressional charter is development of marine resources. The term "Sea Grant" was chosen to emphasize the parallel between today's need for ocean resource development and the need for land development at the time of the Morrill Act of 1862, which established the Land Grant program. Significantly, too, one of the principal concepts of Land Grant has been carried over to Sea Grant—that it provides a means for linking the skills and resources of colleges and universities with the practical needs of the nation.

The Columbia University Sea Grant project is a synthesis of the hopes that the architects of Sea Grant held out for it. It is, in addition, a fascinating example of imaginative university scientists and technicians working, with both government and private aid, on a far-reaching and creative amalgam of research, development, and technology.

Management of water and land resources in the Puget Sound area is the subject of a major Sea Grant study.

The Virgin Islands location was selected because of the steep offshore slopes making possible the use of nearby deep cold ocean water. Scientists have long known that the cold waters of the ocean are far richer in nutrients than the warm surface waters. Areas of natural upwelling, such as the Humboldt current off the coast of Peru and the Antarctic convergence, where cold polar waters meet the warmer waters of the world's southern oceans, are areas where vast amounts of sea life are found. In the Virgin Islands, the scientists are pumping up this deep cold water (hence, "artificial upwelling"). Shellfish, crustaceans, and food fish will be grown and harvested in the artificial ponds on shore. In that area, the deep water temperature is about 41°F (5°C), while the surface water ranges from 75° to 84°F (24°–29°C).

In the limited time since the beginning of the experiment, the Columbia scientists under project director Dr. Oswald Roels have reported progress according to plan. Both phytoplankton and zooplankton—microscopic animal life—have appeared in satisfactory quantity, and on November 9 the first seed oysters were placed in the ponds, where they are feeding and growing.

Thus the first stage is well under way. Objectives of the first stage are twofold:

1. A research objective, to enable the scientists to study upwelling and determine, systematically, its effect on marine productivity;

2. A development objective, to make it possible for them to establish the most efficient protein production in the marine food chain, using the deep sea water as raw material.

Once the marine productivity phase of the project has been established, the scientists hope to undertake the second phase, whose aim is air conditioning. An economic and engineering feasibility study has just been completed by the group's project engineer. He has calculated that the use of cold deep sea water for central air conditioning systems—even of modest size—will prove of great economic advantage as compared to the conventional approach.

Private development firms in the area, which have contributed to the support of this Sea Grant project, are greatly interested in this study and its potential applications.

Thus far, the plan calls for two uses of the natural resource—cold ocean water—in a way that leaves no waste or pollutants other than that produced by the power station needed to pump the water up from the ocean. The third stage of the project, as planned, will provide an exhaust-free power source using the same natural resource. In this stage, the Columbia team will use the cold water to cool the condenser portion of a Claude-type electrical power generator that operates on the thermal difference between the surface water and the deep water.

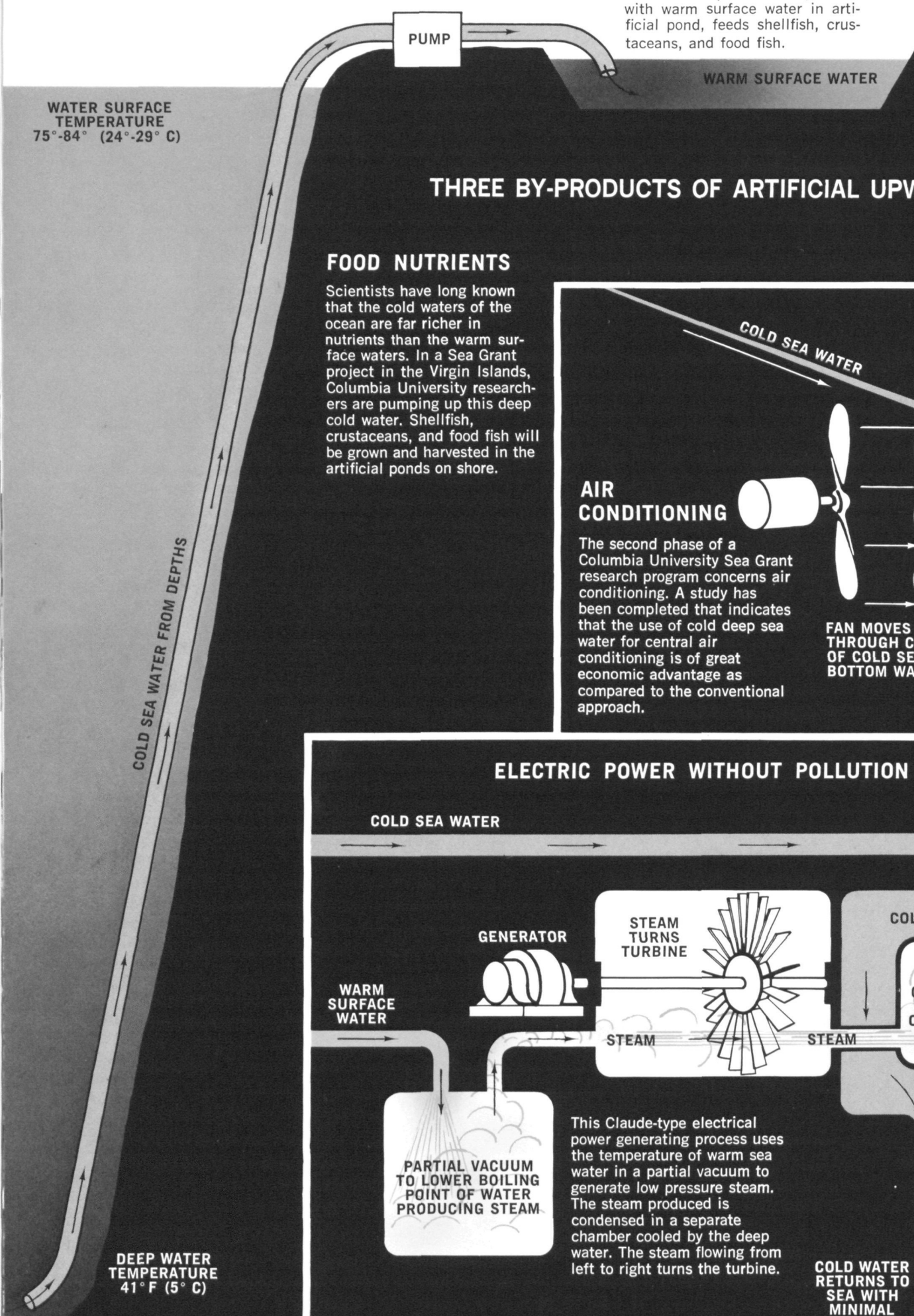
The Claude process is named after the French engineer who, in 1930, built at Matanzas, Cuba, a low-pressure steam-power generator with a capacity of 22 KW of electric power, using a 14° C thermal differential.

The Claude process uses the temperature of warm sea water in a partial vacuum to generate low pressure steam. The steam produced is condensed in a separate chamber cooled by the deep water. Between the evaporator and condenser stages is a turbine generator turned by the low pressure steam flowing from one chamber to the other.

The same type system was used by a French corporation (Energie Electrique de la Cote d'Ivoire) at Abidjan during the 1950's, and was planned to produce 7,000 KW of electricity based on a thermal differential of 20° C. Although difficulties of maintaining the three-mile-long pipe prevented full realization of the plan, the plant did achieve production with about 25 percent of the power output used by the plant itself.

The first large-scale operation of this principle is now under study by the Columbia group, looking toward industrial cooling applications, and with the cooperation of private industry in the area. *continued*

Nutrient-rich cold water pumped from the depths of sea, mixes with warm surface water in artificial pond, feeds shellfish, crustaceans, and food fish.



THREE BY-PRODUCTS OF ARTIFICIAL UPWELLING

FOOD NUTRIENTS

Scientists have long known that the cold waters of the ocean are far richer in nutrients than the warm surface waters. In a Sea Grant project in the Virgin Islands, Columbia University researchers are pumping up this deep cold water. Shellfish, crustaceans, and food fish will be grown and harvested in the artificial ponds on shore.

AIR CONDITIONING

The second phase of a Columbia University Sea Grant research program concerns air conditioning. A study has been completed that indicates that the use of cold deep sea water for central air conditioning is of great economic advantage as compared to the conventional approach.

ELECTRIC POWER WITHOUT POLLUTION

This Claude-type electrical power generating process uses the temperature of warm sea water in a partial vacuum to generate low pressure steam. The steam produced is condensed in a separate chamber cooled by the deep water. The steam flowing from left to right turns the turbine.

Cold nutrient-rich water from 830 meters under the ocean surface flows through a mile-long pipe into a concrete pond. Since the beginning of the experiment in August 1970, phytoplankton and zooplankton have appeared in the tanks, and seed oysters placed there are feeding and growing.

Another application of artificial upwelling, earlier envisioned by the Columbia team, is now in the planning stage by Sea Grant scientists from another great oceanographic laboratory. Researchers from the Scripps Institution of Oceanography of the University of California at San Diego are investigating the possibility of harnessing the waste heat of large power plants to create artificial upwelling (and heating) of the deep nutrient-rich water, and using the water to increase the sustained yield of animal protein.

Using this deep cold water as a coolant for large power plants—for example, nuclear plants—will avoid thermal pollution, the scientists point out, because the discharged water would be at virtually the same temperature as the natural surface waters.

Still in preliminary study form, the idea encompasses the possibility of building an artificial lagoon with adjacent large power plant close to existing centers of population and a source of deep water. Such sites exist in southern California.

A coral atoll, however, might make a better test site, the Sea Grant planners point out. It has the advantages of providing a confinable, easily studied body of water in a location where deep cold water is readily available. Large amounts of power would not be required for the testing phase.

Preliminary work on investigations of atoll porosity are, therefore, being made by a graduate student supported from Sea Grant funds. In addition, studies are under way on how heating sea water affects the ecology of the San Diego area.

The Scripps project is concerned with the possibility of meeting the increased power needs of an expanding population without a concomitant increase in thermal pollution. Another project, part of a widespread Sea Grant effort at the University of Wisconsin, is concerned with finding out just what thermal pollution is going to be caused by increased power generation, and what the ecological effects are likely to be.

There is no source of cold deep water on the Great Lakes to provide a possible artificial upwelling coolant system. Nor are cooling towers likely to be widely used, as they are expensive and cause fogging. So the practice of pumping cooling-water back into rivers and lakes is likely to continue. On the Great Lakes, it is predicted that at least seven nuclear plants and more than 16 fossil fuel plants will be added in the next few years. Moreover, they will be very unevenly distributed. At Kewaunee, Wisconsin, on Lake Michigan, for example, the cooling-water disposal areas of two nuclear plants may overlap and be detectable several miles offshore. One was scheduled to begin operation in late 1970; the second, next fall.

The Wisconsin Sea Grant group will monitor the effects of discharge water from the two plants, and is now making baseline studies. The water flowing from them into the lake will be about 15° F warmer than the lake water, and radioactivity is a potential problem. The short-term goal of the Sea Grant group is to describe the waste water "plume" in great detail. To accomplish this, they are currently making monthly bathythermograph runs along three lines extending ten miles perpendicular to the coast, using their new University of Wisconsin research vessel, AQUARIUS. Aerial infrared radiometry and multiband photography is also used, and long-period wave gages will be put in operation.

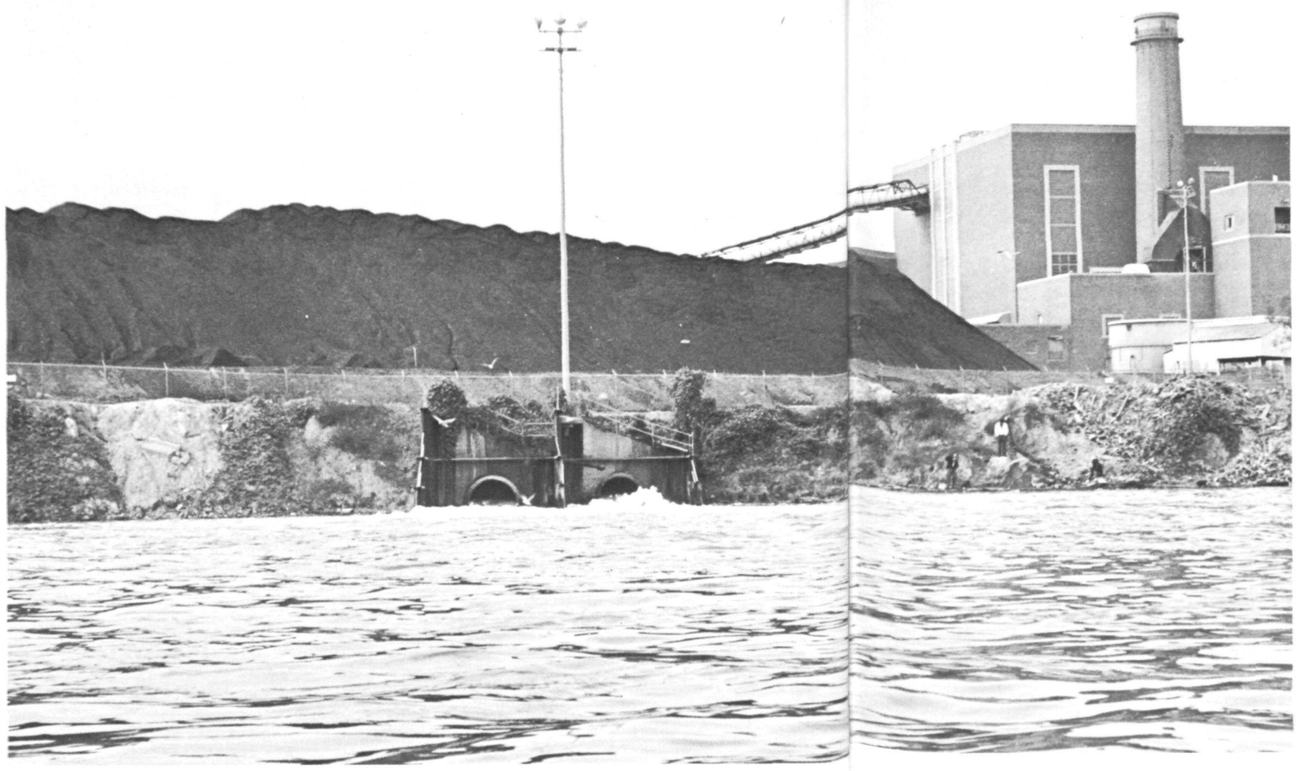
Longer-term goals of the group are to understand thoroughly how the plume will interact with the coastal circulation of Lake Michigan, and how to predict its features in much the same way that wave forecasts are now made.

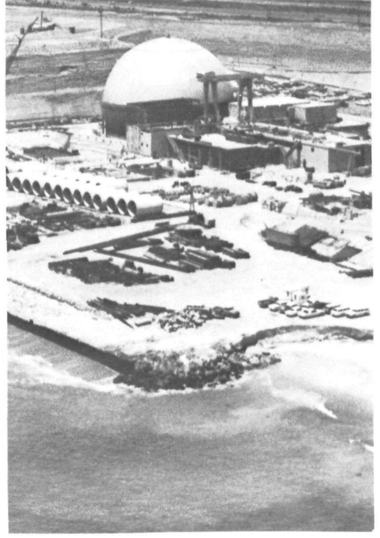
Another Great Lakes university is undertaking a broadscale Sea Grant Program—one of the few in the nation designed to examine the natural aspects of a regional environment within their social, economic, legal, and political context. The goal of this vigorous and imaginative program, at the University of Michigan, is nothing less than development of Great Lakes resources to their full social potential. It will move through phases of scientific inquiry and description into systems modeling and integration, and finally into a long-range plan for Great Lakes resource management.

The Great Lakes constitute the largest body of fresh water on earth, and are specifically included in the Sea Grant program

continued

Robert Abel, head of the Office of Sea Grant, spoke at the ceremony opening the artificial upwelling project, which is now bringing deep sea water into concrete basins to create seawater "gardens" of microscopic plant life for fish production.





Power plants, both conventional (left) and nuclear (above) release warm water into lakes and rivers. Scripps Institution of Oceanography and the University of Wisconsin are seeking ways to meet the power needs of an expanding population without a concomitant increase in thermal pollution.

Governor Melvin Evans (left) of the Virgin Islands and Project Director Dr. Oswald Roels of the Lamont-Doherty Geophysical Observatory viewed the inauguration of the artificial upwelling project at St. Croix.

by law. Within the American watershed of the Great Lakes live 14.4 percent of the national population—nearly 30 million people in eight states. Additional millions live in the adjoining Canadian province of Ontario. The population of the region is expected to double in the next 50 years. Even with this mass of inhabitants, water *quantity* will not be a problem, but—if man continues to interfere with the natural processes of the lakes—water *quality* will.

The problem in the Great Lakes is accelerated aging. Lakes, like people, experience an orderly process of evolution from youth to old age. In nature, as soon as a lake basin forms and fills with water, processes are set in motion that tend to destroy it. Erosion lowers the surrounding walls, sometimes permitting some of the water to escape. The wind and inflowing streams bring foreign materials to the lake. Some of these settle out as organic matter that is decomposed, and some are nutrients such as nitrogen and phosphorus that are vital to the growth of plants and animals. As the organic matter builds up and decomposes, it uses the oxygen in the water. When the oxygen is depleted from overuse, the organic matter does not decompose, hastening the filling of the lake. Eventually plants can take root, and in the case of smaller lakes, at least, the body of water shrinks, changing gradually to a pond, then a marsh, and then land.

While the Great Lakes may not be following this pattern exactly, parts of them are experiencing—at an increasing rate—some of its characteristics. The most critical case, and certainly the best known, is that of Lake Erie, shallowest of the Great Lakes and with the greatest influx of wastes. The ecological consequences have been striking. The more desirable fish species that prefer relatively pure water—whitefish, walleye, and others—have declined disastrously, while less desirable species—carp, sheepshead, yellow perch, and smelt—have increased. Although Lake Erie continues to produce about 50 million pounds of fish each year, commercial fishermen suffer because of the much lower prices brought by less desirable species. And the change in species indicates rapid aging of the lake.

The Sea Grant scientists at Michigan are constructing a mathematical model of the entire interlocking system of causes and effects in the Great Lakes. This model will show how changes in any one area can generate effects in another. It will make possible wiser planning.

The first step, now under way, is collecting and deriving data on the resources and characteristics of the lakes—lake levels, water quality and circulation, plants and animals, physical descriptions of the lake basin, character of the shorelines. The second step, also under way, is the assembly of information on man's use of the Great Lakes resources—aesthetics, shoreline urbanization, recreation, mining, fishing, waste disposal, municipal water supplies, and all the many others.

Once the data are assembled, the interdisciplinary group will construct a series of mathematical submodels, making use of statistics and probability in their descriptions. They will then have the scientific tools needed for predicting how any proposed activity by man will add to or subtract from the resource potential of the Lakes.

Members of the group that will integrate the model and use it for devising solutions to specific problems include scientists in such diverse fields as environmental chemistry, conservation, public health engineering, zoology, civil and marine engineering, resource planning, geology, fisheries, water resources, and business administration.

Still another major Sea Grant study looking toward more productive, less harmful use of a great national marine resource is being undertaken by the University of Washington. As in the case of the Michigan project, the Sea Grant team at Washington is interested in man's social as well as technical inputs into the natural system. Entitled "Socio-Economic, Institutional, and Legal Considerations in the Management of Puget Sound," the Washington project involves political scientists and economists as well as oceanographers. It will, when completed, provide the single major source of information on management of water and land resources in the Puget Sound area. It is planned so as to be of direct use to physical and biological scientists looking toward new and relevant research efforts, and to public policy makers at all levels of government.

The project is now under way, and includes a study of seven major land-water use conflicts in the Puget Sound area. These conflicts involve the location of oil and aluminum refineries, intense recreational developments, sport versus commercial salmon fishing, industrial development, and the siting of a nuclear power plant. The formal governmental and legal processes are analyzed in combination with the ecological and economic data needed to determine rational solutions. The Sea Grant scientists will also develop simulation models of their findings, and translate the findings of their study into operational games.

Thus, in a whole variety of projects stretching across the nation, the Sea Grant program is involved with ways to make the best use of our marine environment, develop new power sources, and at the same time protect and enhance this critically important national resource. Progress is being made. The federal government, in cooperation with the universities, state and local agencies, and private organizations, is through the Sea Grant program providing impetus and hope. The Scripps scientists in their project prospectus have keynoted the effort:

"In an otherwise discouraging picture of pollution, unplanned landfill, destruction of marine life and fisheries, overcrowding and beach erosion a few forward-looking steps provide encouragement to the belief that the situation is not politically, economically, or scientifically impossible." □

Virgin Islands Government Secretary David Maas pushed the button that started deep sea water flowing into ponds.

The National Ocean Survey's ships this year will probe the oceans and chart the nation's coastline.

mapping the underwater world

BY RAYMOND WILCOVE
National Ocean Survey

From Pago Pago in the Samoan Islands to the African waters off the Spanish Sahara and Mauritania, 15 sea-going and coastal vessels of the National Ocean Survey will pursue their quest this year for more knowledge of man's last frontier on earth.

The abyssal depths of the Pacific and Atlantic will be reconnoitered from the larger ships, while others will center their attention on the Caribbean, the Gulf of Mexico, America's submerged continental shelves, the coastal waters and estuaries of the United States, and the frigid waters of Alaska.

Involved in the overall operations will be approximately 880 scientists, technicians, officers, and crew.

Year in and year out, the NOS vessels have probed the deep sea and the shallower offshore waters of the United States in a never ending task.

For the work of these vessels is part of man's unending search for more knowledge of his environment, such as the evolution aeons ago of the continents and the oceans, and—perhaps less colorful but more essential for the present—surveys of the waters through which America's sea commerce moves.

For more than a century and a half, the National Ocean Survey and its predecessor, the Coast and Geodetic Survey, have surveyed and mapped the coastal waters and estuaries of the continental United States, Hawaii, Puerto Rico, and the Virgin Islands. Millions of soundings have been taken in hydrographic surveys, thousands of miles of coastal waters have been searched for hidden navigational hazards, and the often treacherous currents off the coasts and in bays and estuaries have been tracked and noted. The results are to be found on the nautical charts and in related publications, whose data on the sea and its environs help provide safe passage for American and foreign vessels, from the big ocean liners, cruise ships and aircraft carriers to the ubiquitous small recreational craft of America's weekend sailors. And in between, but no less essential, the fishing vessels, cargo ships, and even tug boats. For the scientist, for ocean exploration and for defense needs, there are the bathymetric maps of the ocean's bottom.

Research activities are carried out in support of NOAA's Atlantic Oceanographic and Meteorological Laboratories in Miami, Fla., and the Pacific Oceanographic Laboratories in Seattle, Wash.

In 1971, as during the past few years, NOAA scientists are interested in continuing research on the interrelated theories of continental drift, sea floor spreading, and plate tectonics.

According to the continental drift theory, the earth at one time had one or two large land masses which began to split some 200 million years ago. The theory postulates that as the sea floor spreads, the continents are drifting at about an inch or so a year in the earth's mantle. The mantle is that part of the earth's interior which lies between the molten core and the crust. The drifting resulted in the separation of the supercontinent or supercontinents. The theory of global tectonics holds that the earth's crust is comprised of gigantic rigid blocks or plates that move relative to one another.

Research on these theories will be carried out aboard the NOAA Ships DISCOVERER, OCEANOGRAPHER, SURVEYOR, and RESEARCHER. The Miami-based DISCOVERER will spend two and a half months this spring studying a cross-section of the Atlantic seabottom between Cape Hatteras, North Carolina, and Cap Blanc, Mauretania, in northwest Africa. Using her highly sophisticated electronic equipment, scientists aboard this oceanographic floating laboratory will seek to establish a standard crustal section across

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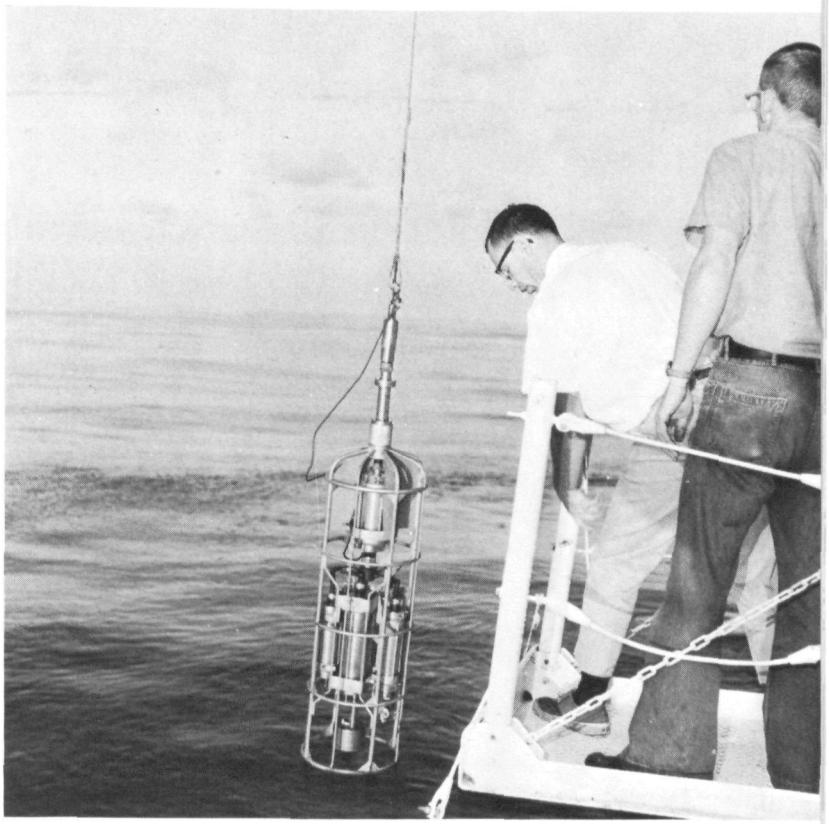
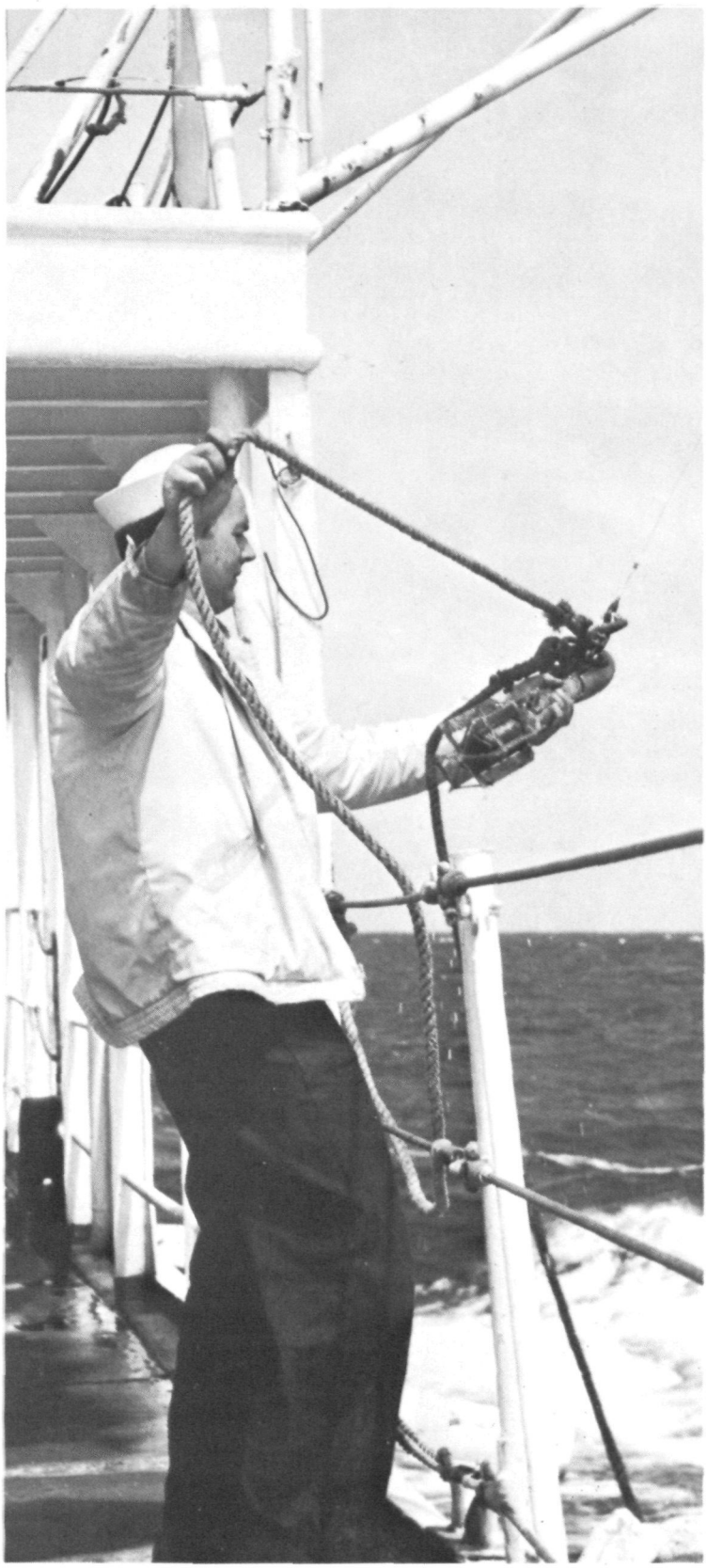


(Top) Readying a plankton sampler. (Bottom) Multisensor package senses salinity and conductivity, temperature and depth, and relays these measurements to electronic equipment in the ship's oceanographic laboratory.



Up comes the bathythermograph, with its recording of temperatures at various depths in the sea.

the North Atlantic that will contribute to an understanding of the evolution of continents and ocean basins. The standard crustal section will represent a well-mapped stripe across the Atlantic in which bottom topography and the gravity and magnetic fields will be extensively researched.

This is a continuation of the 3500-mile-long trip across the Atlantic between Cape Hatteras and Cap Blanc made last year by the ship, during which electronic instruments recorded the shape of the ocean bottom and subbottom rock strata, including rock layers several miles beneath the ocean floor, and their magnetic and gravity fields.

The RESEARCHER, the newest of the NOAA ships, will conduct studies in the Caribbean, seeking to relate development of the Lesser Antilles Arc of West Indian Islands to the concepts of sea floor spreading and plate tectonics.

The RESEARCHER's studies are part of the United States' contribution to the Cooperative Investigation of the Caribbean and Adjacent Regions (CICAR), an international program of the Intergovernmental Oceanographic Commission of UNESCO. The geophysical portions of the Caribbean investigation are directed towards providing the basic understanding of overall geological patterns that is essential to development of the area's potential.

The DISCOVERER also will be engaged in CICAR projects during the year. Her studies will include an investigation of the circulation of the western Caribbean and Gulf of Mexico, to be conducted in conjunction with the RESEARCHER. In addition, CICAR studies by the DISCOVERER will include physical and chemical oceanographic studies in the central Caribbean and in the Antilles Current region north of Puerto Rico; also, sea and air interaction studies in the vicinity of Puerto Rico. The latter will involve special emphasis on the ocean environment in an effort to interpret changes in the top layer of the ocean due to atmospheric forces. Of particular interest will be the short-term hourly and daily changes in the ocean due to atmospheric influences.

In the Pacific, the Seattle-based OCEANOGRAPHER, the DISCOVERER's sister ship, will delve into the relationship between magnetic anomalies (unusual magnetic formations in the seabottom and subbottom) and sea floor spreading. The patterns defining the history of sea floor spreading that have been worked out to date are based entirely on linear magnetic anomalies and fracture zones. The latter are giant gashes in the ocean bottom. Previous study of an abyssal (deep sea) hill region south of the Aleutian Trench has shown that the surface topography is closely related to the sea floor spreading magnetic anomalies. The abyssal topography may thus prove to be a valuable tool in delineating the spreading history in regions termed "quiet zones," without magnetic anomalies.

Before making detailed studies within "quiet zones," NOAA oceanographers wish to determine if and how the topographic anomaly relationships are maintained from region to region. The OCEANOGRAPHER will look at these relationships in a region between the Pioneer and Murray fracture zones about 600 miles off the California coast. In this area, the same magnetic anomalies occur as those in the area south of the Aleutians.

Adding further knowledge to the continental drift-sea floor spreading-plate tectonics theories, the Seattle-based SURVEYOR will carry out a six-week investigation of major geological and geophysical structures in the North Central Pacific seabottom. These studies will be made south of the Hawaiian Islands.

Prior to launching this investigation, the ship will spend about six weeks charting the approaches to Pago Pago Harbor in American Samoa. Later in the year, the SURVEYOR will conduct systematic deep ocean surveys in the north-central Pacific Ocean as part of a long-

range international program to map the bottom of the Pacific.

The mysterious internal wave—an undulating motion of the water beneath the surface of the sea whose origin and effect is not precisely known—will come under further study off Vancouver Island, Canada, by the OCEANOGRAPHER. Observations will be made to show the relation between one class of internal wave and the ordinary surface tide in the Pacific.

The OCEANOGRAPHER will also conduct a three-week study of a massive underwater range of mountains, known as the Musicians Seamounts, north of the Hawaiian Islands. This range at the bottom of the north Pacific consists of approximately 75 mountains averaging 9000 feet in height and extending northwest from the Hawaiian Islands about 620 miles.

Still other projects scheduled for the OCEANOGRAPHER involve a six-week study of the Aleutian Trench, the more than 2000-mile-long trench south of the Aleutian Islands which is so vast that the Grand Canyon of the Colorado would be lost in it, and a six-week investigation of the magnetic characteristics of the Surveyor fracture zone between Hawaii and the Aleutians, to determine whether changes there are related to changes in the earth's magnetic field.

Late in the season, a study will be made of the bottom currents on the slope of the continental shelf, where a recently published theory predicts a reverse jet current appreciably larger than the mean ocean bottom current. If substantiated, the findings will have significant effects on concepts of mixing and dispersal of pollutants and the many oceanographic processes dependent on current flow.

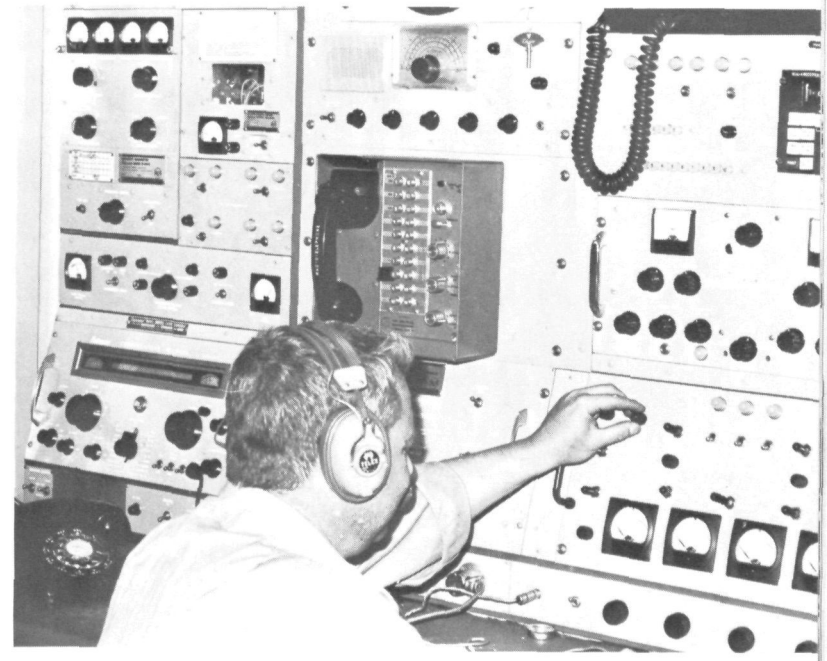
Much of the work to be done by NOAA ships during 1971 is essential to safe navigation. In addition to the SURVEYOR's work in Pago Pago, Samoa, hydrographic surveys will be carried out by the PATHFINDER, RAINIER, FAIRWEATHER, DAVIDSON, MCARTHUR, MT MITCHELL, WHITING, PEIRCE, and a land-based hydrographic survey party.

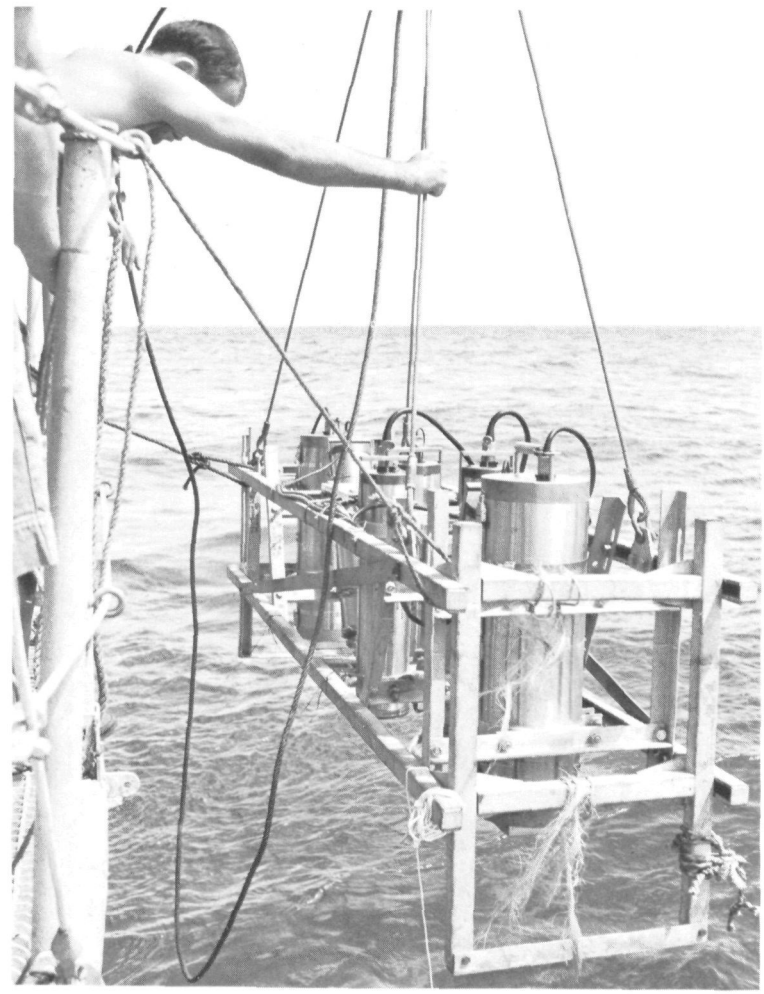
In addition, the wire drag ships RUDE and HECK will scour the sea lanes along America's shores for underwater obstacles hazardous to navigation, such as wrecks, outcroppings of rock, pilings, and abandoned oil derricks. These two sister vessels are unique in the nation. Also one-of-a-kind is the FERREL, which will continue surveying tidal currents.

Conducting hydrographic surveys, the PATHFINDER will operate in Clarence Strait and Cook Inlet, Alaska, and off the island of Hawaii; the RAINIER in Shelikoff Strait, Alaska, and off the southern California coast; the FAIRWEATHER from Cape St. Elias to Montagu Island and in Felice Strait, Alaska; the DAVIDSON in Sumner Strait, Alaska, and Umpqua River in Oregon; the MT MITCHELL in Puerto Rico; the WHITING off South Carolina and in Delaware Bay; the PEIRCE off Massachusetts and the South Carolina coast; and Hydrographic Field Party 742 in Lake Borgne, La., the Potomac River, Md., and Pensacola Bay, Fla.

The RUDE and HECK will drag the sea lanes into major ports along the east coast and Texas. The FERREL will carry out current observations in Charleston Harbor, S.C., and in the vicinity of Boston Harbor.

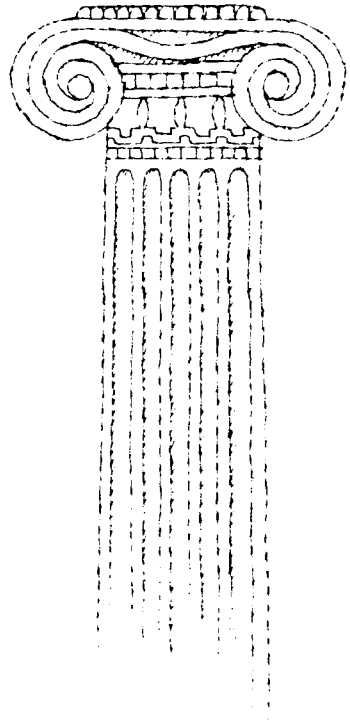
In addition, NOAA's versatile fleet will conduct still other operations. The MCARTHUR will carry out bottom gravity observations on the west coast continental shelf; the RESEARCHER will conduct geophysical surveys of the continental shelf off Virginia and North Carolina and will take time out to deliver supplies to a U.S. weather station on tiny Swan Island in the Caribbean; and the MT MITCHELL will chart the seabottom off the Virginia and North Carolina coasts for bathymetric maps of the topography of the continental shelf. □





(Top) Communication center aboard the Ocean Survey's newest ship, the RESEARCHER, which will join an international study of the Caribbean. (Bottom) A deep-sea camera is lowered from the NOAA Ship OCEANOGRAPHER.

ERATOSTHENES FOUNDER OF GEODESY



BY PATRICK HUGHES
Environmental Data Service

FOUR HUNDRED YEARS before the birth of Christ—and nineteen hundred years before Columbus set sail—Greek scholars had already concluded that the world was round. About 240 B.C., one of the ablest and today least known of these scientists of antiquity, Eratosthenes of Cyrene, succeeded in scientifically and accurately calculating the circumference of our planet.

Eratosthenes was a man of many talents. A mathematician, poet, astronomer, grammarian, the first geographer of note, and the founder of scientific cartography, his nickname was "Beta," the second letter of the Greek alphabet, which some historians think meant he was considered the second greatest scholar in each of the scientific fields of his day. His students called him "the second Plato," after the greatest of ancient Greece's wise men.

Born in Cyrene about 276 B.C., Eratosthenes was educated at Athens and Alexandria and, in 235, was appointed head of the Library of Alexandria, then the world's greatest center of learning. The library had been founded by Ptolemy I, one of the leading generals of Alexander the Great and the first Macedonian king of Egypt, who had earlier established the school of mathematics where Euclid, the father of modern geometry, taught. A few simple principles of Euclid's geometry were all that Eratosthenes needed to make his amazingly accurate measurement of the earth.

Eratosthenes knew that at noon on the longest day of the year, June 21, the summer solstice—when the sun (sol) was farthest from the Equator and appeared to pause (sti) before starting southward again—an upright column at Syene (now modern Aswan) in central Egypt cast no shadow on the ground, indicating that the sun was directly overhead. (Eratosthenes checked this by noting that the sun's rays shown directly down a deep well at Syene, illuminating it to its depths, with the sides casting no shadows on the water's surface. (At the same time, however, in Alexandria, a similar column did cast a shadow; there the sun was not directly overhead.

Now Eratosthenes assumed that Syene was exactly south of Alexandria (not quite), and he knew that at noon the shadow on the ground at Alexandria lay due north and south. From this he reasoned that the columns at Syene and Alexandria, the center of the earth, and the center of the sun—as it paused directly over Syene—must all lie in the same plane. Working from this assumption, the solution to the problem of the earth's circumference was simple.

Since perpendicular lines through the columns at Alexandria and Syene must meet at the center of the spherical earth, and since the rays of the sun are parallel to each other as they strike the earth, Eratosthenes knew—from Euclid's geometry—that the angle between the perpendicular lines meeting at the center of the earth was equal to the angle between the column at Alexandria and the sun's rays.

By measuring the length of the column's shadow, he calculated that the angle made by the sun's rays and the column was equal to seven degrees, twelve minutes, or 1/50 of the circumference of a circle, 360 degrees. Therefore, the angle at the center of the earth, and its arc—the distance between Alexandria and Syene—also equaled seven degrees, twelve minutes, or 1/50 of the earth's circumference. To find the circumference of the earth, all Eratosthenes now had to do was to multiply the distance between the two cities by 50.

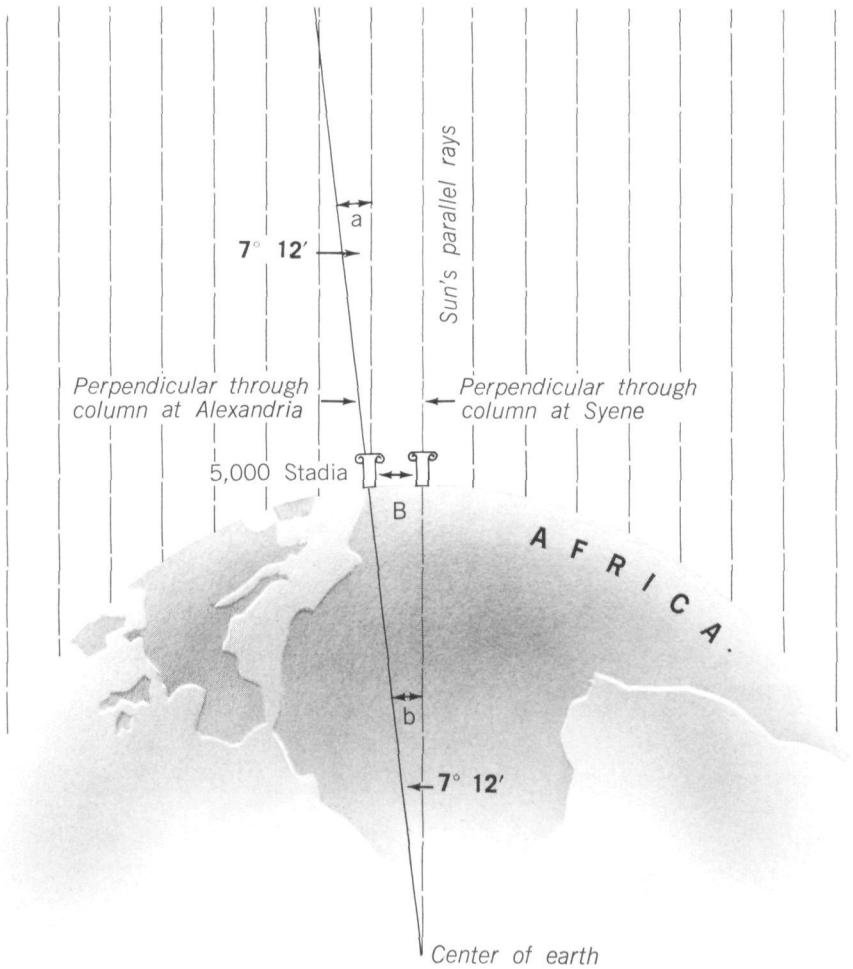
Such distances had been measured by the surveyors of Alexander the Great and King Ptolemy during the conquest of Egypt. Eratosthenes used a figure of 5,000 "stadia" (a measure based on the length of a stadium) for his calculations, probably an approximation to enable him to work with round numbers.

Thus, the polar circumference (since he was measuring north and south) was equal to 5,000 stadia multiplied by 50, or 250,000 stadia. Since the usually accepted value of Eratosthenes' unit of measurement is roughly 1/10 of a modern mile, this would give a circumference of approximately 25,000 miles; the actual polar circumference is 24,860 miles. Eratosthenes' magnificently accurate measurement was, no doubt, due in part to a happy cancelling out of minor errors and approximations, but his logic was clear, his concept brilliant, and his method scientific.

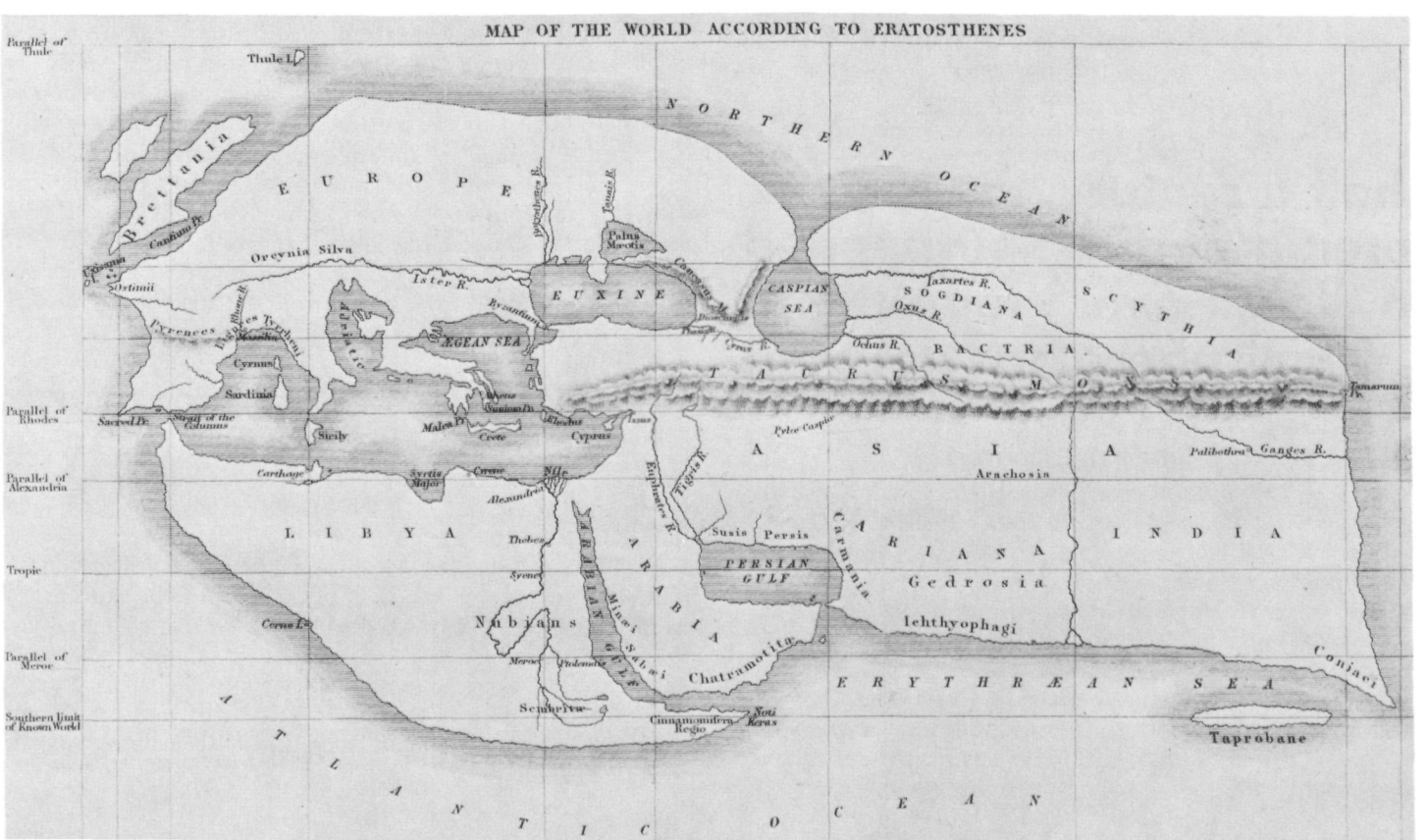
Using his value for the circumference, Eratosthenes computed the length of the polar axis of the earth to be about 7,850 miles—only 50 miles less than the modern value. According to Plutarch, the famous Greek biographer, he also calculated the distance to the sun to be 804,000,000 stadia or 80,400,000 miles. This was also a remarkable measurement, considering the crudeness of the instruments available; today we know that this distance, on the average, is equal to about 92,900,000 miles.

Later in his life, around 200 B.C., Eratosthenes constructed a map of the then-known world, the first map, so far as we know, on which lines of latitude and longitude appeared. He called his latitude lines "parallels" and those of longitude "meridians," as man has done to our own day. Eratosthenes' map really marked the beginning of the science of navigation, just as his accurate measurement of the earth's circumference was a major milestone in the science of geodesy. His work was a forerunner of the extensive programs in both cartography and geodesy carried on today by NOAA's National Ocean Survey.

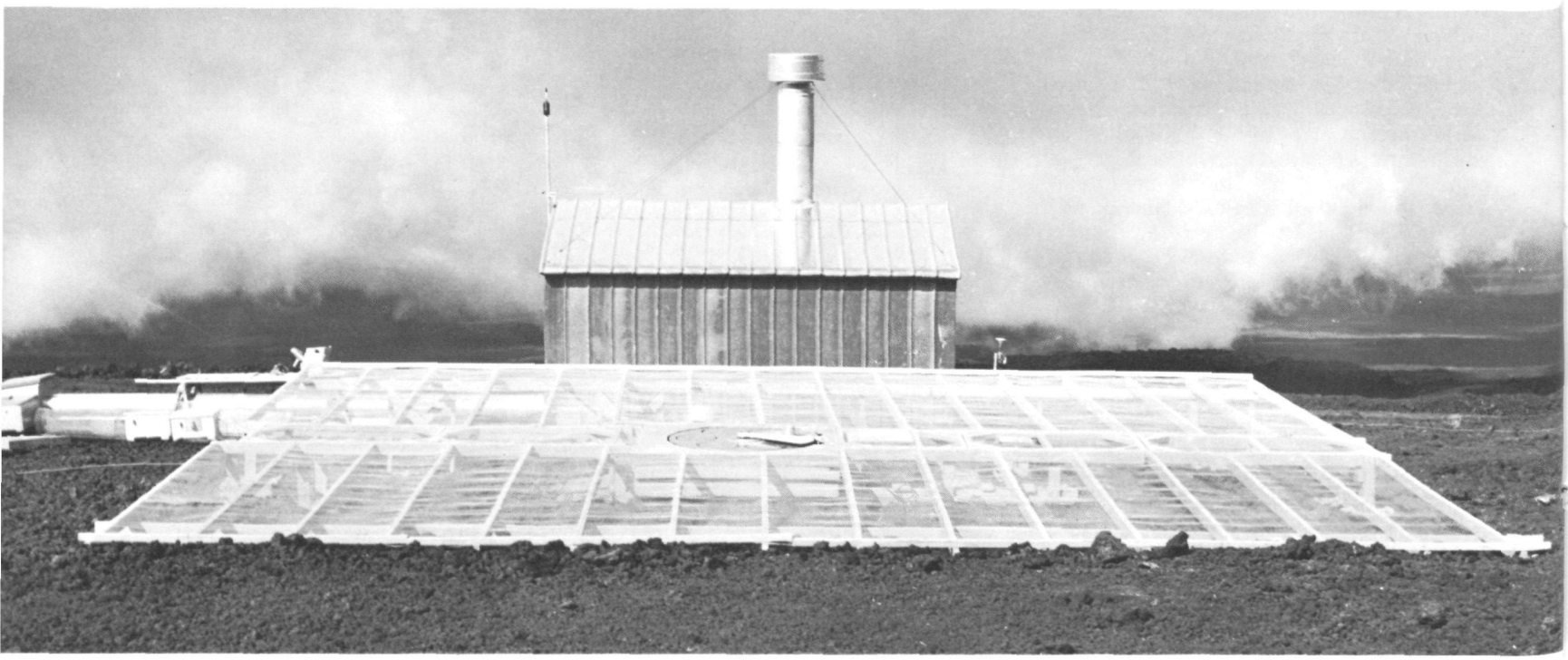
The earth was later "measured" by Posidonius, a native of Apameia, Syria, who came up with a figure of 18,000 miles for its circumference. This value was accepted by Claudius Ptolemy, whose maps underestimating the size of the earth were to dominate cartography and geography for some 1,500 years and play a decisive role in convincing Columbus that he could reach Asia by sailing westward. If Ptolemy's maps had been based on Eratosthenes' measurement of the earth's circumference, rather than that of Posidonius, Columbus might never have attempted his historic voyage. □



Eratosthenes' Calculation: According to Euclid, when a straight line (the perpendicular through the column at Alexandria) intersects two parallel lines, the corresponding angles are equal. Therefore, angle "b" equals "a" which equals 7 degrees 12 minutes or 1/50 of the circumference of the circle. Arc "B," then, 5,000 stadia long, represents 1/50 of the earth's circumference.



OUR OVERBURDENED ATMOSPHERE



A ground screen at Mauna Loa measures the flow of electric currents from ionosphere to earth. These measurements respond to worldwide meteorological influences.

In half a century, the number of foreign particles suspended in the air over the Northern Hemisphere has doubled.

BY JOANN TEMPLE DENNETT
Environmental Research Laboratories

South Pacific islands still bask in unfiltered sunshine, but the atmosphere over the North Atlantic is getting progressively dirtier.

One possible effect of this increasing pollution could be an irreversible cooling of the earth's climate, leading to a new ice age.

A recent study of electrical conductivity, comparing measurements made during the 1967 OCEANOGRAPHER world cruise with those made early in the century by Carnegie Institution sailing ships shows that airborne particle pollution has doubled since 1909.

Such a change in atmospheric conductivity is indicative of an environmental trend that could have serious future implications, according to William E. Cobb, a meteorologist with ERL's Atmospheric Physics and Chemistry Laboratory in Boulder.

Cobb says: "A large increase in the number of small foreign particles suspended in the atmosphere will significantly modify the atmosphere's electrical conductivity. Our conductivity measurements, made at oceanic locations that represent global conditions, yielded information on the amount of particulate matter suspended in the atmosphere."

Particulates, or aerosols as they are sometimes called, are dust-like pollutants that hang suspended in the atmosphere. Such particles change the reflectivity of the atmosphere, affecting the amount of sunlight reaching the earth's surface.

"The consequences of an increasing global particulate concentration are not well known or understood," Cobb explains. "There is, for example, a widely accepted hypothesis that claims an increase in particulates will lead to an increase in non-precipitating clouds and a probable decrease in rainfall over maritime areas. Since washout by precipitation is the major process of particulate removal, these two processes normally complement each other. An increase

in particles may cause a decrease in rainfall and, in turn, particles will increase further as there will be less rain to remove them."

Another long-term effect of increased particulate pollution is suggested by Dr. Earl W. Barrett of the same Laboratory, who says: "Fifty million tons of particulate added to the atmosphere and retained there could cause the average surface temperature over the earth to dip from its present 60 degrees Fahrenheit to about 40 degrees Fahrenheit. Most forms of plant life could not survive in such an icy world."

Both natural particulate sources, such as volcanoes, and man's pollution continually inject many tons of this finely divided matter into the atmosphere, but most of it settles out or is washed out by precipitation within a few weeks. Barrett's concern is with the small fraction that remains suspended longer, maintaining a background level of airborne particulate. He estimates that the 50 million additional tons that could start us irrevocably toward the next ice age is only 10 to 20 times greater than the present background of particulate in the atmosphere.

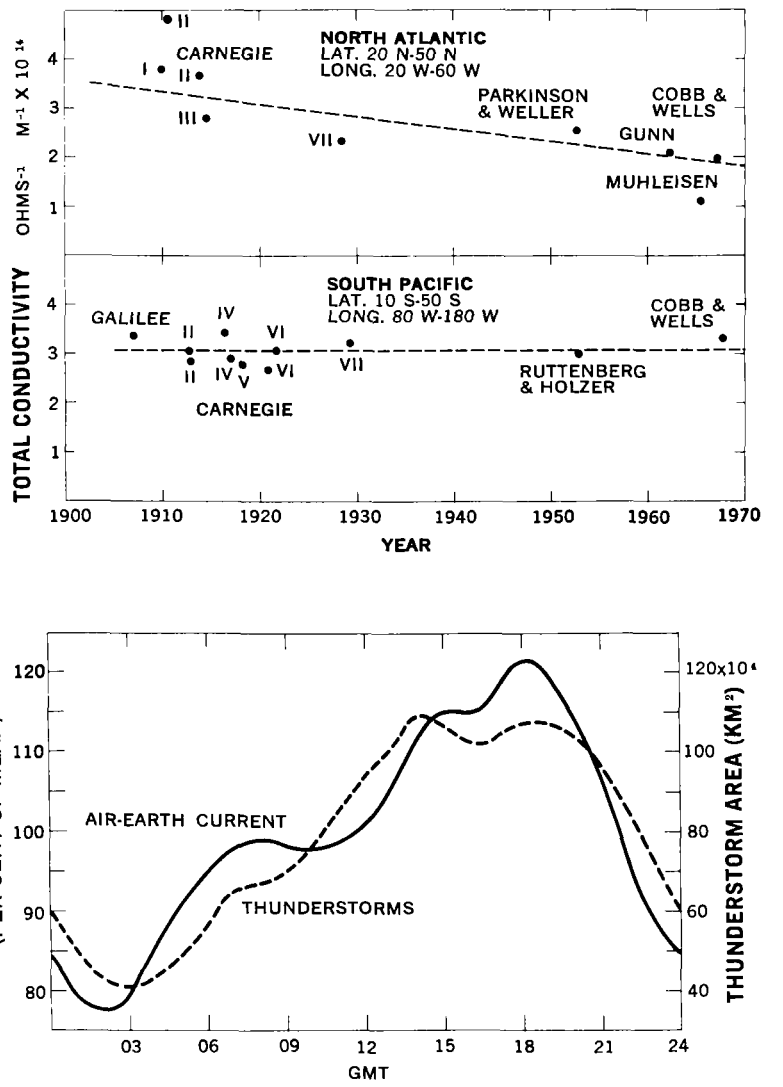
In the last decade, the Atmospheric Physics and Chemistry Laboratory has investigated conductivity and other atmospheric electrical parameters at several sites which are remotely isolated from sources of atmospheric pollution. In addition to the work done during the global cruise of the OCEANOGRAPHER, similar measurements have been made in the polar regions and at Mauna Loa Observatory atop Mauna Loa on the island of Hawaii.

Sixty years ago, scientists of the Carnegie Institution of Washington recognized the importance of monitoring the electrical properties of oceanic air. Their classic measurements, made aboard the sailing vessel CARNEGIE, and it predecessor GALILEE during the period 1909 to 1929, established an invaluable atmospheric benchmark in the era preceding both the atomic age and most of the great increase in atmospheric pollution sources. On November 18, 1929, at the island of Samoa, a tragic fire and explosions ended the CARNEGIE's career. Although methods of detecting and recording atmospheric conductivity have improved greatly since the CARNEGIE measurements, their data provided today's scientists with a unique opportunity to investigate secular changes in the electric climate of the global atmosphere over the past half century.

According to Cobb, "Some doubt will always exist as to the absolute value and comparability of measurements that span more than 50 years. However carefully made, the instantaneous manual observations of the CARNEGIE crew obviously have some scatter. But, even allowing for errors, the CARNEGIE evidence is sufficiently reliable to state that there has been a true downward secular trend in atmospheric conductivity in this century. The possible climatic effects of this aerosol increase in the North Atlantic region are sufficiently important that any evidence pro or con must be closely studied."

The Laboratory's conductivity measurements provided the first global quantiative estimate of the increase in particulates in the last 50 years. Of particular interest are comparisons of the 1910 CARNEGIE and the OCEANOGRAPHER data at two latitudes—35 degrees South and 35 degrees North. In the Southern Hemisphere, conductivity was found to be the same on the two voyages, separated by more than a half-century. At the same latitude in the Northern Hemisphere, conductivity observed by the OCEANOGRAPHER was 40 percent less than at 35 South and at least 20 percent less than that previously measured by the CARNEGIE crews in the same mid-North Atlantic waters.

"The lower conductivity over the North Atlantic," Cobb explains, "is an indication that the suspended amount of aerosols has increased in this region. The increase can be correlated with the far greater amount of manmade pollution produced in the Northern Hemisphere. Many particulates persist for about one month before they are washed out by rain or the normal sinking action of parts of

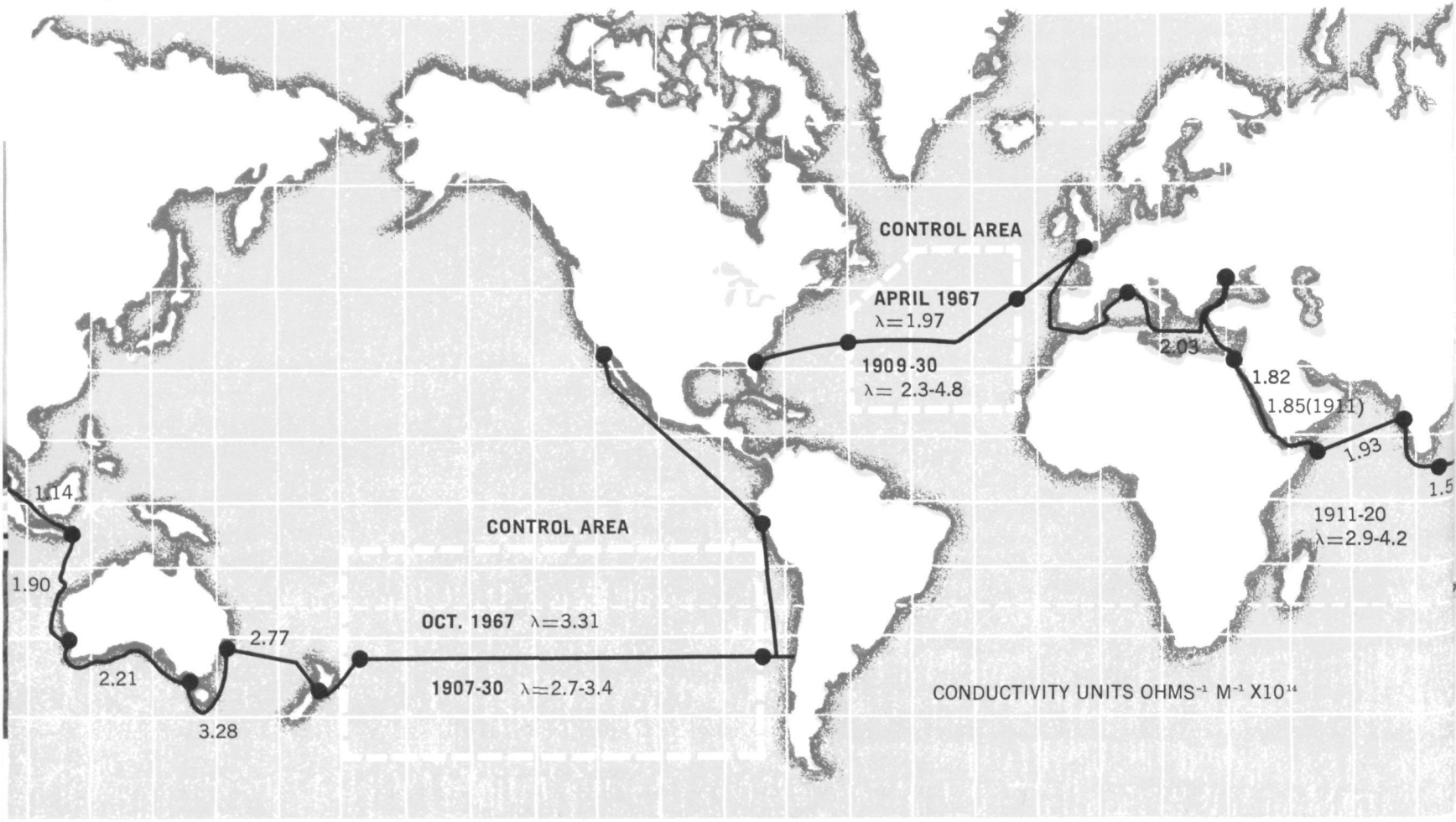


(Top) Comparison of atmospheric conductivity measurements made in 1967 with those taken early in the century reveals the downward trend in the North Atlantic. (Bottom) The ionosphere-to-earth flow of electrical current recorded at Mauna Loa varies depending on how much of the earth is covered by thunderstorms.

the atmosphere. Thus, for the most part, they are injected, transported, and washed out in the same hemisphere."

Cobb attributes the clean air of the South Pacific to several factors. First, the vast oceanic regions and limited land masses of the Southern Hemisphere have not witnessed the enormous increase of sources of manmade pollution experienced by the Northern Hemisphere. Second, the atmospheric circulation effectively inhibits the exchange of air and transport of aerosols between the hemispheres. And, third, the atmosphere around 35 degrees South is a region of natural subsidence where sinking air is part of the general circulation. This is one of nature's major cleansing basins. *continued*

Readings of the average total conductivity of the atmosphere, taken in 1967 on the OCEANOGRAPHER, are shown for points along the route. Outlined areas are those for which the long-term changes have been computed.



In another region—the Indian Ocean several hundred miles from land—the comparative study indicated that pollution had at least doubled since the CARNEGIE's voyages. These conductivity measurements were affected by airborne pollution from southeast Asia, Cobb believes.

"We found generally low values of the conductivity in the Indian Ocean region but the readings fluctuated widely. Since lower conductivity indicates increased pollution, it is reasonable to assume that pollution from southeast Asia is finding its way into the Indian Ocean and even south of the Equator. The monsoon circulation of this region provides a possible mechanism for transporting aerosol pollution from the Northern to the Southern Hemisphere and is an exception to the effectiveness of the equatorial barrier."

Detection of secular changes in atmospheric conductivity has been complicated since 1945 by manmade radioactive aerosols. Although nuclear atmospheric testing throughout the world was reduced by 1963, it was not completely stopped and the net effect of radioactive contamination is to make the atmosphere more conductive. This was another point checked by the APCL researchers, and Cobb concluded that "radioactive contamination of the free atmosphere has returned to a reasonably normal level which is not detectable as a secular increase in the electrical conductivity."

Stressing the continuing need for long-term or secular measurements of change in our environment, Cobb says: "We know we are changing the atmosphere. We must know how and at what rate we are changing it. So far, nature has always been able to take care of her own pollution—even such cataclysmic events as the eruption of Krakatoa have upset the aerosol balance for not more than a few years, causing some minor temperature fluctuations. It is essential that we keep a close watch on her attempts to handle man's continuous polluting to which nature's reaction could be more drastic. It may not be the amount of pollution so much as its duration that may eventually cause a fundamental climatic change.

"Hopefully, the increased aerosol pollution found in the North Atlantic may as yet be confined to the band of prevailing westerly winds extending from North America to Europe. Recent measurements, for example, at Mauna Loa, NOAA's high altitude observatory in Hawaii, indicate little or no change in aerosol pollution since 1959. This region is climatologically similar to the South Pacific where the OCEANOGRAPHER found the environment unchanged since the earlier 1900's."

The Atmospheric Electricity Ten Year Program, begun in 1969 by the Joint Committee on Atmospheric Electricity of the International Union of Geodesy and Geophysics, may include a repeat of one of the CARNEGIE cruises.

Such secular measurements and continued monitoring of atmospheric processes and changes are part of the mission of APCL. The Laboratory conducts research in deliberate attempts to change and control the weather, as well as in the side effects of man's activity that may inadvertently change the earth's climate. □

A university study probes the minds of those who heard but did not heed the warnings of Camille's approach.

THE SURVIVORS SPEAK

BY EDWIN P. WEIGEL
National Weather Service

A GREAT HURRICANE is like a great battle. Long after it is over, people look back on it again and again to see what lessons can be learned before the next arduous encounter.

So it has been with Hurricane Camille—one of the most powerful storms ever to strike the U.S. coastline.

The latest chapter in the saga of Camille—which roared ashore on the night of August 17, 1969—might be entitled: "Why didn't everyone heed the hurricane warnings?"

A study of individual responses to the warnings indicates that perhaps 28 percent of the people in the Gulf Coast strip which caught the hurricane's full fury chose to ignore National Weather Service pleas to evacuate.

In that area, 146 persons died and 21 others are still listed as missing. More than 75,000 people fled to safety. Most homes and businesses were damaged or destroyed.

The study, published in October 1970, was conducted by Dr. Kenneth P. Wilkinson and Peggy J. Ross of the Mississippi State University Social Science Research Center. It was jointly funded by the University and the National Weather Service.

CAMILLE TARGET AREA—Focus of the sociologists' study was a 45-mile beachfront strip that marks the southern boundary of Harrison County, Miss. The hurricane's eye passed over the western portion. This strip is bounded on the north by the L&N Railroad and bisected by four-lane Highway U.S. 90. About a half-mile wide, with few stretches of open country, it has the characteristics of a strip city. Along the highway and bordering the beach is an almost continuous stretch of residences—many of them expensive, colonial style—interspersed with areas of commercial structures. Estimated population: 100,000.

Sociologists Wilkinson and Ross arranged interviews in depth of 384 heads of household in a ribbon of shoreland about one-half mile wide and 45 miles long, where Camille did her worst. The strip is the southern boundary of Harrison County, Miss., and contains an estimated 100,000 people. Included are Biloxi, Gulfport, Long Beach, and Pass Christian.

Scientific sampling techniques were used to get as representative a group as possible, although the storm's catastrophic effect made this difficult. Interviews were conducted in October and November 1969.

Overall, there was widespread agreement among the interviewees that official actions for warning and protection were timely and effective, undoubtedly saving many thousands of lives.

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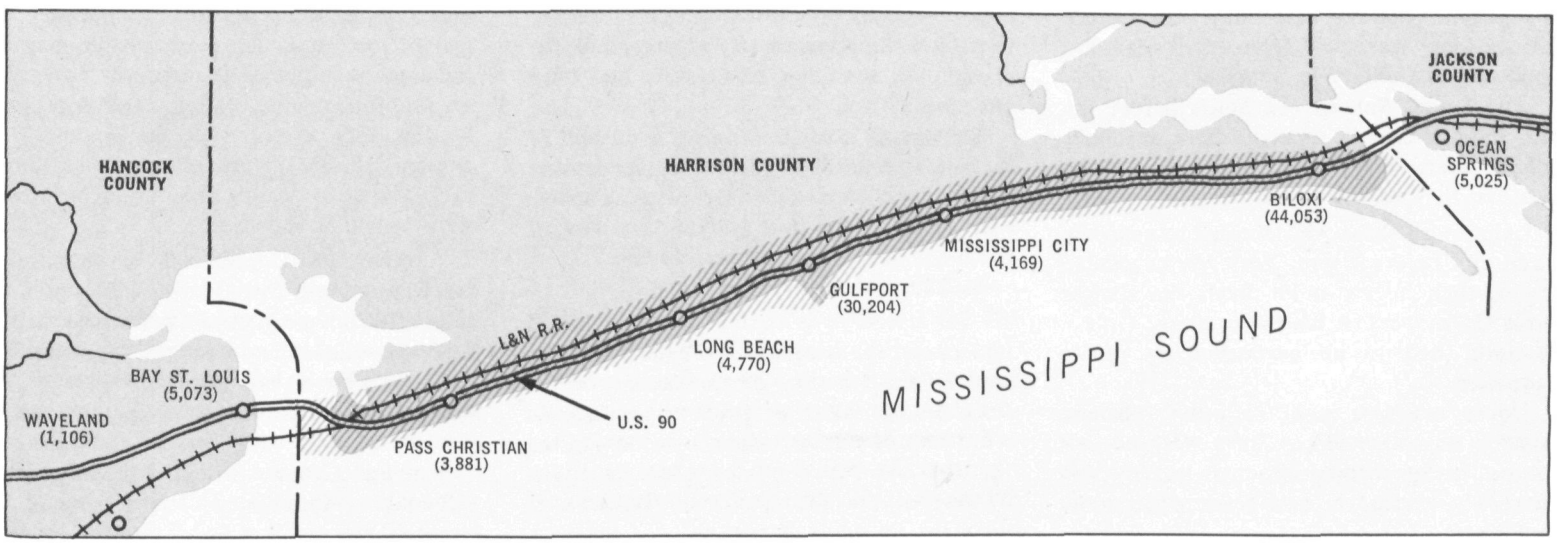


Most of those interviewed by the Mississippi State University team were found to have been well-schooled in hurricane safety rules.

The area was saturated with official warning information during the 36 hours preceding the storm.

Warnings were broadcast from two local TV stations, from TV stations in Mobile and New Orleans, and from numerous radio stations. Television was reported to be the most-used source of information by 90 percent of the respondents.

Radio and television broadcasts were supplemented Sunday—the day the storm struck—by warnings from civil defense, police, and military personnel.

By 9 a.m. Sunday, 12 hours before the full force of Camille moved ashore, residents of southern Harrison County had been assured they would be hit.

Almost all those who decided to evacuate were out before 8 p.m. Very few evacuated more than a few miles from the danger area. Most went in their own autos. Only a handful had to be evacuated by rescue agencies.

More evacuees went to public shelters than to any other place. There were no casualties in the shelters although tragedy was narrowly averted in two cases when roofs collapsed.

The most perplexing finding to officials charged with hurricane warnings and disaster preparedness was that 107 of the 384 persons interviewed (28 percent) did not evacuate their homes even though most of them knew of warnings to do so and were aware the hurricane was predicted as "extremely dangerous" with 190-mile-an-hour winds and 20-foot tides.

Adding to the puzzle was the fact that the interviewees were generally "an older, stable upper-middle-class population" with at least a high-school education, and that the "stayers" tended to be the most experienced and best educated of the group.

Also baffling was that 85 percent of the stayers felt warnings of Camille had been effective.

The survey notes that only 2.8 percent of the stayers and 30.2 percent of the leavers believed the predicted tides would damage their houses. The fact is that very few of the homes in the sample area escaped.

Said Dr. Wilkinson:

"The evidence is that they received and understood the warnings. Perhaps many discounted the potential destructiveness of the tides on the basis of previous experience with tides of similar height, overlooking the fact that this time the tides would be driven by one of the strongest wind forces ever recorded during a hurricane."

He added that, fortunately, the broadcast of just such a message over TV at 3 p.m. on the day of the hurricane was successful in triggering a wave of evacuations.

Some of the hesitation about leaving may have been because people didn't know their homes' height above sea level and couldn't judge the danger of a 20-foot tidal surge. Even though most had lived in the area for years, less than 25 percent of the stayers and 8 percent of the leavers were able to state accurately the elevation of their homes.

When evacuation to safety a mile or so away is so easy, why take a chance by staying? One possible answer is an ill-defined fear of looting, which many people may be reluctant to admit. Although only two stayers said they themselves remained to prevent looting, 36.9 percent of the leavers and 31.8 percent of the stayers gave worries about property as a reason they thought others were reluctant to leave.

Another attitude difficult to measure is fatalism among the elderly. For some, at least, the prospect of a frantic evacuation amidst confusion and strange faces was more than they could bear. A few expressed the feeling that if the hurricane took their homes and things, they would just as soon go, too.

Among 123 deaths in Mississippi attributed to Camille, 44 were persons 66 years of age or older.

Of the 107 people interviewed by the Mississippi State team who stayed in the coastal strip despite warnings to evacuate: Eighty-four said they sat and talked or otherwise waited for the storm to pass. Eleven slept. Fourteen reported having prayed. Fifteen worked to protect themselves and their families.

One woman told of climbing into the rafters of her mother's house along with 17 other adults and 13 children to escape the rising waters. The ladder on which they climbed was later used to pull to safety two people floating past on a mattress.

A family in a beachfront house sat in their downstairs living room watching the storm until water began seeping under a door. A mop, then towels, then a rug were used to stop the flow. The husband opened the door and was swept across the room by a surging wave. As the lower floor filled with water, the family retreated upstairs where they rode out the storm.

Two people reported having been invited to an apartment building in Pass Christian by friends who were concerned for their safety. They declined, and stayed where they were. The apartment building—in a low site formerly known as the "rice field"—was destroyed, and 21 lives were lost.

A professional archaeologist completing an excavation with a group of students reported that they met Sunday afternoon and decided to stay and try to finish the dig. "We simply had no idea what such wind and water could do," he said. This reaction was a common one. Almost no one anticipated Camille's ferocity.

A beachfront resident in Gulfport recalled that the lower floor of her house suddenly filled with water and that in the next minute, as the tide slid back, she was afraid the house would explode before the water could drain out.

"Hurricane parties" evidently were not a major factor in behavior of the coastal population, although several were reported in progress. Only 36 respondents said they knew of such parties. One said about 60 people were involved in a party in the Richelieu apartments, where a number of persons died. A man in Gulfport reported that a party in a trailer near his home broke up when one of the walls caved in. Several respondents referred to a man who had built a "hurricane-proof house" and had been planning a party since Betsy hit in 1965. He and his wife perished.

Most respondents—87 percent—agreed that people in the area would be much better prepared for future storms. Said one who had stayed: "This place will clear out immediately next time evacuation is recommended." □

PROPERTY DAMAGE—The Mississippi State researchers reported that about 5,000 homes were destroyed by Camille and 12,000 suffered major damage. One thousand house trailers, 500 small businesses and numerous boats also were destroyed or damaged. Nearly 100 vessels were sunk or grounded in the Mississippi River. There were extensive losses in crops, timber, tung and pecan groves, and in cattle drowned. About 320 square miles of Mississippi coastland were inundated. Cleanup cost was estimated at $18 million.

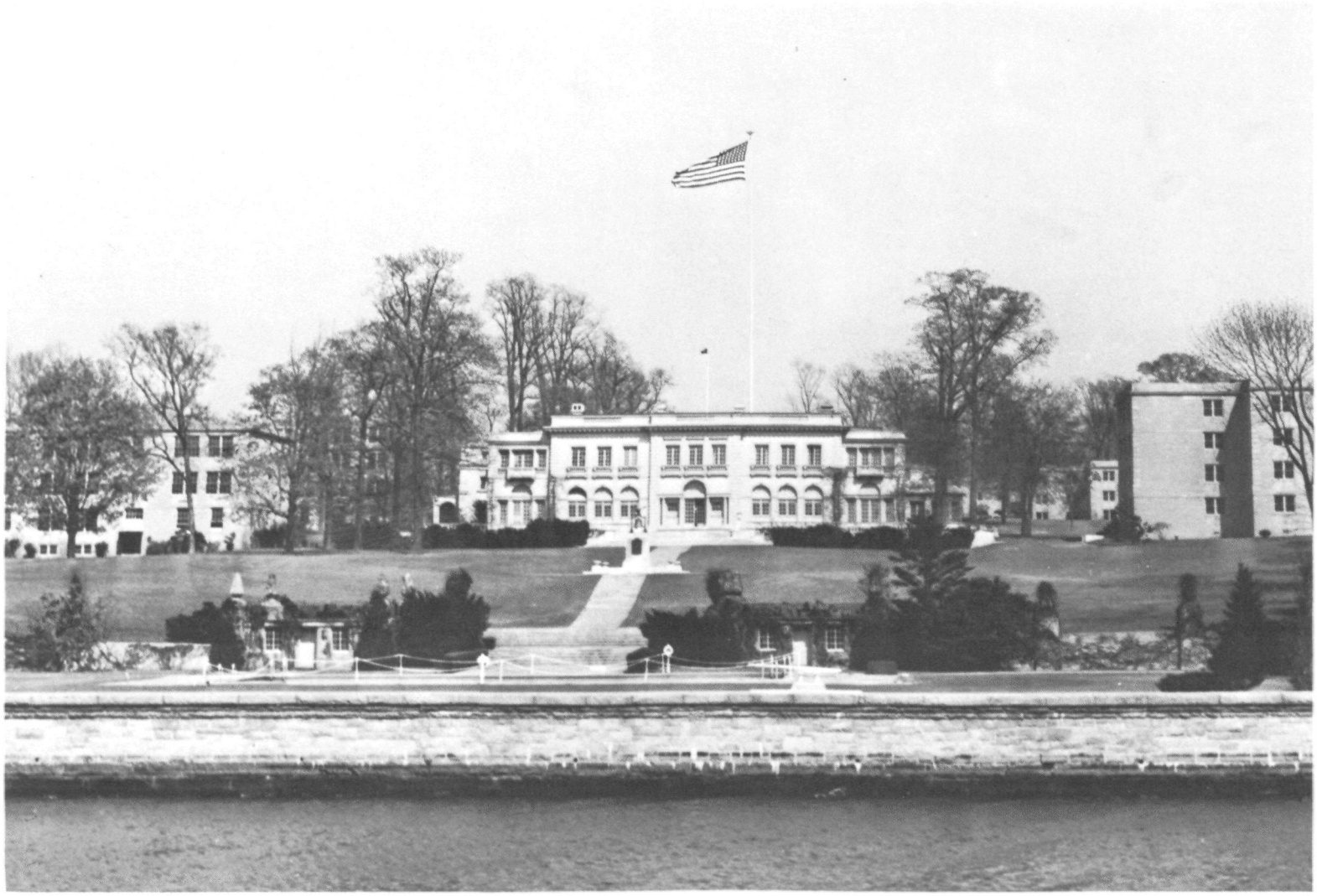
a Campus for the Corps

NOAA's officer training program has a new home at the Merchant Marine Academy

THERE'S A NEW BREED of Kings Pointers at the U.S. Merchant Marine Academy . . . the commissioned officers of the National Oceanic and Atmospheric Administration.

For the first time since the formation of the commissioned corps in 1917 (as part of the former Coast and Geodetic Survey), the elite group of uniformed officers is receiving its initial training on a college campus.

The trainees' home is now a beautiful campus at Kings Point, N.Y., site of the Merchant Marine Academy, about 20 miles from New York City. The campus, once the estate of motor magnate Walter P. Chrysler, is bounded by the green waters of Long Island Sound and the lush estates of some of America's most affluent citizens. The academy is operated by the Department of Commerce and is one of the nation's five federal academies. Its physical plant consists of 40 buildings and marine facilities on 68 acres of tree-shaded lawns.



The flag flies over Wiley Hall, the Academy's Administration Building. Formerly the summer residence of Walter Chrysler, the site is some 20 miles from New York City.

The NOAA Corps is composed of a relatively small number of men, approximately 330. All are college graduates, versed in engineering and the scientific disciplines. Few come into the corps with a nautical background, so a program was begun in 1960 to equip them to serve as officers aboard ship, as well as to conduct scientific and research activities.

The first trainees were instructed aboard the Coast and Geodetic Survey Ship EXPLORER and in Washington, D.C. The classes were transferred in 1962 to the Atlantic Marine Center in Norfolk, Va., where they continued until October 1970, when the 35th class convened at the academy. The classes have varied in size according to the needs of the time, the 35th class consisting of 13 officers.

Lt. Cdr. Joseph W. Dropp became the first Training Officer In Charge at the academy, assisted by Lt. (jg) William R. Daniels and Lt. Donald E. Nortrup.

Life at Kings Point is a considerable improvement over that at Norfolk, where officers had to find their own housing and make their own arrangements for meals. Facilities for training are much better at Kings Point. Here the NOAA officers live on campus, instead of being widely dispersed in private accommodations and brought together only during class instruction.

At Kings Point, they are part of a major educational institution, one which has been building a tradition of service to the nation since it opened its doors in 1942. President Franklin D. Roosevelt pinpointed the academy's place at its dedication 29 years ago when he said: "This academy serves the merchant marine as West Point serves the Army and Annapolis serves the Navy." To this roster have been added the Air Force at Colorado Springs and the Coast Guard at New London, Conn.

The NOAA officers make up only a small fraction of the one thousand students at the academy, but they are an integral part of the educational, cultural, and social life of the institution.

In one respect, NOAA officers occupy a unique position on the campus. Being commissioned officers (generally ensigns), they outrank the cadets at the academy who will not receive their commissions (as ensigns in the Naval Reserve) until they graduate. Since the NOAA Corps is not a military unit (except when called into service in time of war), they are, while at the academy, faced

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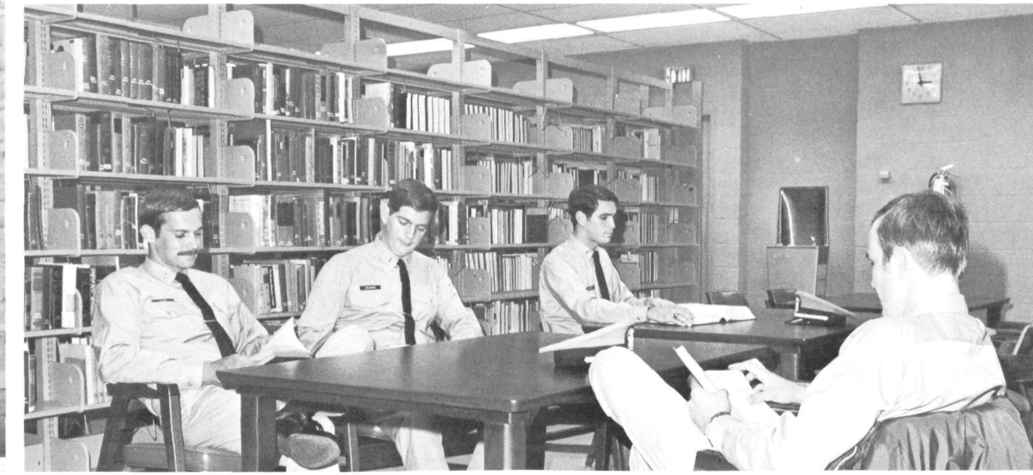


(Above) Lieutenant (jg) William R. Daniels, one of the three training officers, instructs Ensign Coon in navigation and chart reading. (Above right) Furuseth Hall houses NOAA classrooms and offices, as well as the nuclear simulator laboratory. (Right) Lt. Daniels gives some pointers in the use of the sextant to Ensign Franklin.

(Above) NOAA officers have full use of the Merchant Marine Academy's new library. From left, Ensigns Coon, Yeager, Beaupre, and Turnacliff. (Left) Safety at sea is a vital part of mariners' training. From left, Ensigns Beaupre, Yeager, and Turnacliff take a close look at the inner workings of an emergency life raft.

with the responsibility of conducting themselves with a certain amount of discipline they would not otherwise experience in a civilian organization.

Commander Dropp felt this was very important. "It helps build up an esprit de corps," he said, "right from the beginning. Our trainees are civilians, most of them fresh out of a college or university where they were just one of many civilians seeking an education. But for our officers, the life they lead henceforth will be different, because many of them will carry out duties aboard ship which in some instances may give them life or death control over others. Aboard ship, whether civilian or military, a certain amount of discipline is necessary if the hazards of the sea are to be coped with successfully. Here at the academy, the officers get their first insight into that discipline which is so essential at sea."

Facilities available to the NOAA officers include the use of two vessels, the KINGS POINTER, a 120-foot former Coast Guard cutter, and a 65-foot former Army Transportation Corps ship. Actual training aboard ship at Norfolk was limited to a 25-foot survey launch, with occasional sessions aboard a Coast and Geodetic Survey vessel when it happened to be in port.

The officers are taught the mechanics of ship handling and navigation aboard the two ships, first at the dock and then under way. They become adept in placing ships' lifeboats and survey launches in the water, a function essential to good seamanship and safety at sea.

Modern radar and navigational equipment serve to train the NOAA officers in the skills necessary to determine accurate positions at sea. In the Electronics Laboratory at Bowditch Hall are LORAN, OMEGA, and DECCA navigational systems and radar simulators. The latter create displays on a radar screen similar to those an officer would observe at sea. If he fails to take correct action, the simulator indicates the results of his error.

"The only thing missing from a lifelike simulation of what occurs at sea," said Dropp, "is the absence of the adrenalin that starts running through your body when you're at sea and an object is bearing down at you and you know you have to do something. Outside of that, it's very realistic."

Another important facility available to the NOAA officers is the navigation laboratory in Samuels Hall, equipped with a chart work area and the latest in navigational equipment, including three-dimensional training aids.

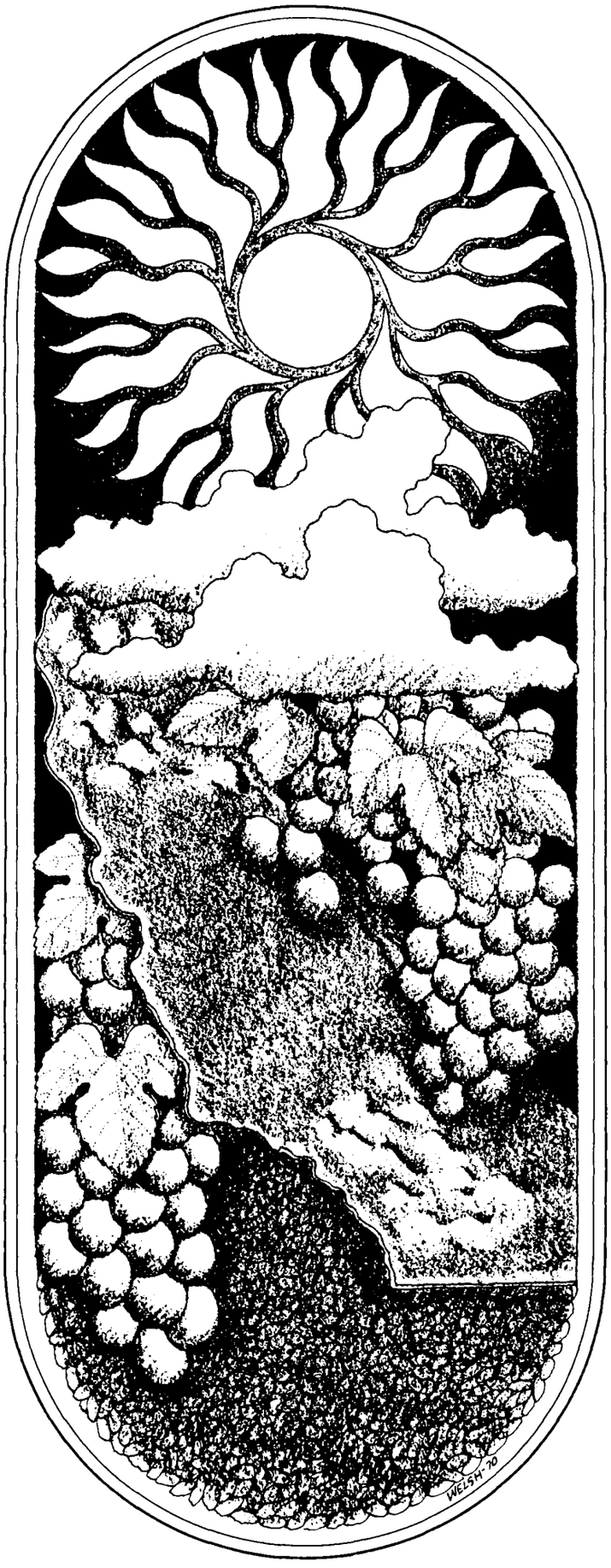
Plans for transferring the class to the academy began some years ago and Rear Adm. Harley Nygren, Acting Director of the NOAA Corps, was instrumental in having this done. Nygren said he was "very pleased with the spirit of cooperation the Maritime Administration has shown in bringing this about" and said he looked for "continued improvement in the coordination of NOAA and the Maritime Administration."

"Our men should benefit greatly from being at Kings Point," added the NOAA official. "The facilities and atmosphere are superb for our purposes. But this is a two-way street. We hope to benefit the academy also. We recruit about 80 officers a year for our ships. With the American merchant marine declining, the NOAA fleet offers graduates of the academy the added opportunity of shipping aboard our vessels, which have been augmented by the formation of NOAA."

"There is still another way in which NOAA can benefit the academy," Nygren continued. "Our men are more generally ocean-oriented than academy graduates, whose instruction is largely in the managing of merchant ships. The presence of our officers at the academy may assist the academy in broadening its horizons to cover the entire world ocean and the opportunities and problems it poses for the human race. What we do with the ocean may go far toward determining how well we make out in the future."

The NOAA training class is centered in Furuseth Hall, just inside the main Vickery Gate to the academy. The hall is also the home of the academy's Nuclear Study Center, which includes a multi-colored Nuclear Simulator Laboratory. The simulator is almost an exact duplicate of the control console of the Nuclear Ship SAVANNAH, the world's first nuclear commercial vessel. Here, merchant marine officers learn to operate nuclear-powered commercial ships.

Upon completion of their stay at the academy, the NOAA officers are assigned to various positions in the organization. The initial assignment for most of them is aboard a NOAA ship, where they put to use the training they received at the academy. □



The Fresno weather office provides forecast services for an entire national crop.

WEATHERMEN IN RAISINLAND

BY THOMAS R. CROSSAN
Fresno, Calif., Weather Service Office

In the month of September, a one-hundred-million-dollar crop hangs in the balance, its success or failure riding on the weather and the National Weather Service's forecasts.

The crop is raisins, and the place is the San Joaquin Valley of California. This mountain-ringed valley—just 50 miles wide and 240 miles long—produces America's entire raisin crop, its output nearly always exceeding the combined production of the rest of the world.

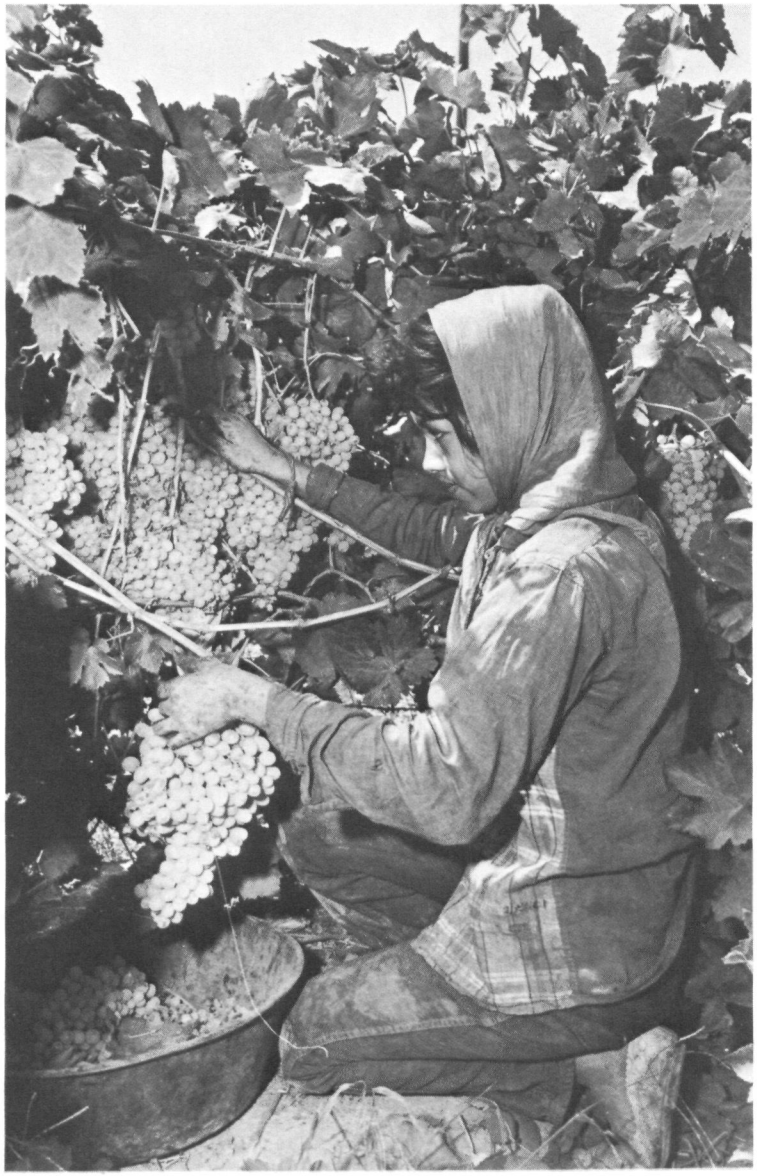
Each year, more than a million tons of California grapes are converted to raisins by exposure to the sun. When the grapes are severed from the vines, they contain about 20 percent solids or sugar. They are then placed on paper trays to dehydrate in the hot sun. After two to four weeks, the grapes have lost 80 percent of their weight, and their sugar content has risen to 70 percent. They have become raisins.

But if rain occurs during this drying period and protective measures are not taken, the fruit of a year's labor may be damaged or destroyed. Drying grapes will mold rapidly if they remain wet for more than a few hours. Rains of .10 inch usually cause some damage; amounts exceeding .25 inch can cause widespread damage.

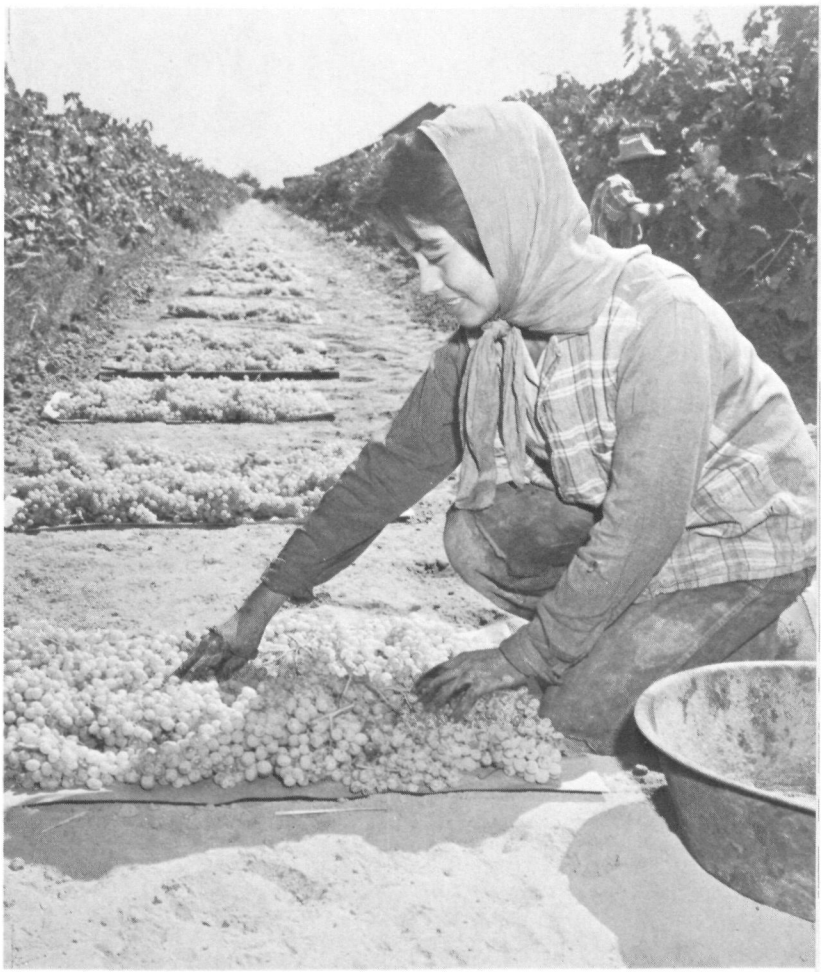
While the crop lies exposed to the elements, San Joaquin's raisin growers are attentive listeners to the morning weather broadcast from the Weather Service Office at Fresno, in the heart of the valley. The appearance of any clouds—even cirrus—doubles or quadruples the telephone load at the Fresno office. The forecaster's assurance of no significant rain is almost as important to the growers as a rain forecast.

Grapes for raisins are harvested between August 20 and September 20, and the length of the drying process extends the critical period through the latter part of October. Ordinarily, weather conditions are excellent until mid-September. Thereafter, the days grow shorter, temperatures drop, and the probability of damaging rain increases.

When rain threatens, the paper trays of drying grapes are rolled up by field crews, before the paper is even slightly dampened. If the raisins are only partially cured, the paper trays are rolled like a home-made cigarette, with the ends open. The "cigarette roll" sheds water and allows some air circulation. If the raisins are almost completely cured, both edges of the paper are folded



Using a curved knife strapped to her wrist, this worker cuts a bunch of Thompson Seedless grapes, which she will place on a paper tray between the rows of vines to dry. A skilled worker can pick two-and-a-half tons of grapes a day.



A row of grape-laden trays stretches between rows of vines as the drying process begins. Each tray holds 22 pounds of grapes which will become 5 pounds of raisins. This is the most anxious time for growers as rain can ruin the fruit.

over once before the tray is rolled, producing a tight package called a "biscuit roll." The rolls are then placed under the vines on a slight slant to shed water; the vines afford some added protection from the rain. Each time the trays are rolled and unrolled, the cost is between five and ten percent of the grower's gross return. But a grower who does not take this precaution risks the loss of his entire crop.

Either way, the stakes are high, and an early and accurate forecast of the probability of rain and the amount is vital. The forecast must be issued long enough before the rain to give the vineyardist time to carry out his precautionary measures. Without the advice of the weather forecaster, raisin drying would be a hit-or-miss operation, especially near the end of the drying season when damaging rains are not uncommon.

The National Weather Service follows the movement of Pacific storms across the northern storm track with sufficient accuracy to be able to predict their effect on the San Joaquin Valley. During the drying season, the main forecast problem is the formation and movement of the 500-mb. lows that break off from deep migratory troughs moving onto the west coast. The "cut-off" lows drift toward the south and southwest for a period of time until they again approach the coast. Over subtropical waters, these

continued

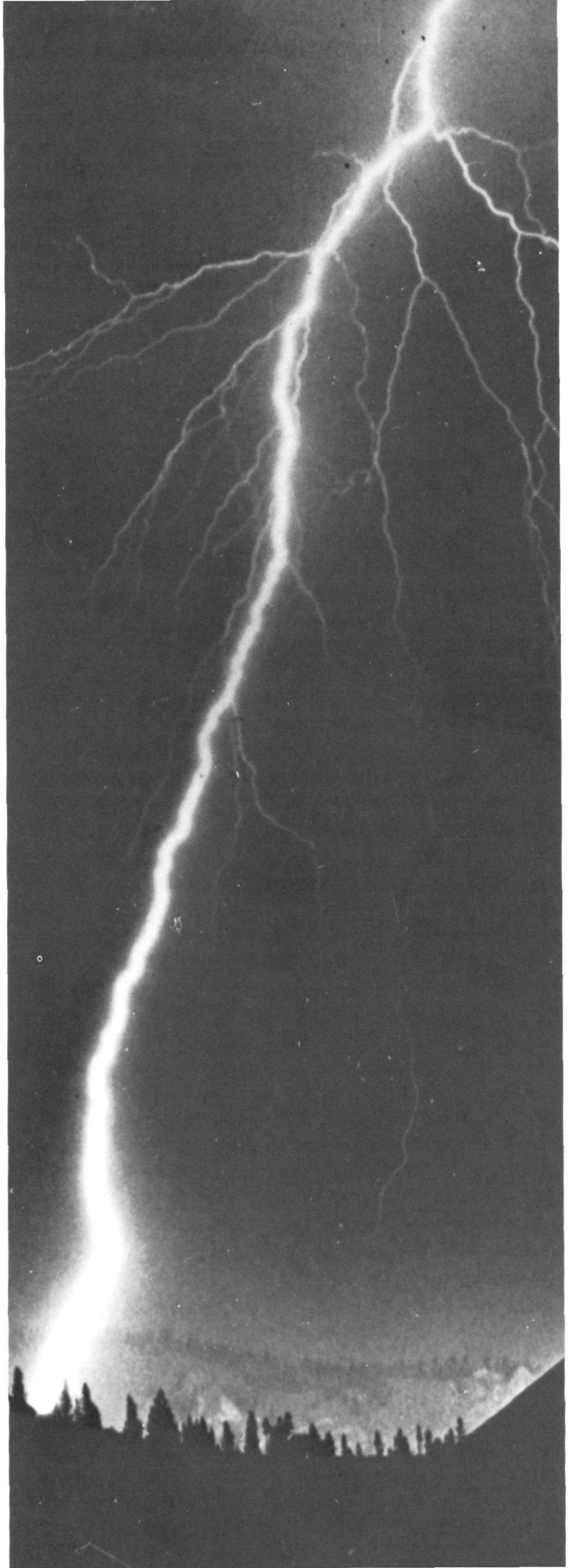
The most worrying time is over, and the grapes have dried without interference from rainshowers. This worker prepares the raisins for boxing and shipment by bundling them, in their paper tray, into a "biscuit roll."

The Weather Service forecasts have been for fair skies and one side of the bunches is now dried. Two men work at the back-breaking job of flipping the raisins over from one paper tray to another. Fast workers can turn 8,000 trays a day.

systems gather up additional moisture. The forecaster's dilemma is to predict the timing of the movement of these intensified systems, and their water content. It is expected that operational availability of photographs from the Applications Technology Satellite and nighttime photographs from the ITOS spacecraft will do much to improve the forecaster's solution.

Raisins are one of man's oldest foods. The Persians and Egyptians grew grapes 2000 years before the birth of Christ. By 1000 B.C., the Israelites were using raisins to pay their taxes to King David. Today, raisin production is important in Australia, Turkey, Iran, and the Union of South Africa, but America's raisin industry is the biggest in the world. In the San Joaquin Valley, it began just 85 years ago.

Weather forecasting for raisin drying in the Valley goes back to August 1887, when the Signal Corps observer at Fresno, Sgt. J. R. Williams, began a system of rain warnings by displaying flags by day and a lantern by night on the cupola of the county courthouse. Since that time, it has been probably the most important specialized forecast issued from the Fresno Weather Service Office. The current warning system has been expanded to a special fruit-drying forecast issued by the San Francisco Weather Service Forecast Office for most of California's fruit-growing counties. But the raisinman still bases his daily operational decisions on the morning weather broadcast from Fresno. □



A team of ERL scientists has deliberately triggered lightning for the first time in history.

LIGHTNING TO ORDER

Firing rocket-borne steel balls into thunderclouds, scientists of the Environmental Research Laboratories have successfully triggered lightning.

The experimental rockets, fired from a 10,700-foot-high mountaintop in the Magdelena Peaks west of Socorro, New Mexico, ignited lightning nine separate times.

"We weren't sure it would work even though we knew it was theoretically possible," said Dr. Heinz W. Kasemir, project director for the Atmospheric Physics and Chemistry Laboratory in Boulder, Colorado.

"These mountaintop studies were part of our effort to make rocket launches safer," Kasemir explained. "Launching a rocket or flying an airplane through thunder or rainclouds can be hazardous, not so much because the vehicle will be hit by natural lightning, but rather because it may trigger a lightning stroke from the storm.

"We undertook the New Mexico tests to see if lightning could be triggered by small rockets as a possible means of preventing lightning discharges during major rocket launches. Most of us foresaw considerable difficulty in making it work, maybe one chance in four. After all, this had never been deliberately done before. Benjamin Franklin may have triggered a cloud-to-ground lightning stroke by providing a long-wire conducting path to the ground along his kite string, but we were attempting to initiate intracloud lightning with short rockets—an entirely different proposition."

Kasemir and his seven-man team are working under a National Aeronautics and Space Administration contract to predict lightning hazards and to protect moon-bound rockets from reoccurrences of the Apollo 12 lightning strike.

Apollo 12's Saturn rocket encountered two lightning discharges in its first minute of

continued

(Above) A ball-tipped rocket is loaded into the launcher for the lightning experiments at Socorro, New Mexico. The rockets ignited lightning seven different times. (Right) NOAA instrumented a NASA aircraft to locate electrical charge centers in thunderstorms. Physicist James Holitza, shown checking a field mill atop the aircraft, relayed information on charge centers to ground crews that fired the rockets.

flight. The first, about a half-minute after launch, occurred when the rocket and its exhaust plume triggered a bolt which reached the ground. The second discharge, triggered higher up in the cloud, did not strike the ground; however, such an intracloud discharge can be as hazardous as its more spectacular cousin, the cloud-to-ground stroke.

"Since we were encouraged beyond expectations in the Socorro tests, it may now be feasible to protect the Apollo spacecraft by inducing discharges with small rockets before the principal launch," according to Kasemir. "What we have to do is exhaust the cloud by several triggered lightning strokes just before liftoff."

Lightning is an electrical discharge between two oppositely charged regions in a cloud. If the two charge centers are located in the base of the storm, the lightning may stretch from the cloud all the way to the ground. If the charge centers are higher in the cloud, the lightning will be more or less confined to an area inside the cloud and become a cloud discharge. The electric field necessary to start a natural lightning discharge is about 500,000 volts per meter.

Introducing a large metallic object such as the Saturn-Apollo rocket into the cloud changes the whole picture. A lightning discharge can then be triggered in a much weaker electric field. Calculations based on the theoretical considerations indicate that fields as low as about 30,000 volts per meter are capable of producing lightning if a rocket penetrates the cloud. Thus, a seemingly safe cloud harboring an electric field only one-tenth that required for natural lightning can produce a lightning bolt when a rocket vehicle enters the field.

Kasemir hoped that the small test rockets would be large enough to successfully trigger lightning. Corona discharge—a steady, weak discharge incapable of initiating lightning—could have been a problem since objects with pointed ends tend to encourage corona discharge. By fitting stainless steel spheres to the rocket noses, Kasemir managed to suppress the corona effect and generate the desired long spark instead. This induced long spark ignited a lightning bolt which discharged the cloud's electric field.

The Socorro area was chosen for initial tests because thunderstorms usually form in the afternoon over the Magdelena Peaks. The NOAA-instrumented NASA aircraft was used to locate electrical charge centers in the storm. During these aircraft passes under the storm, NOAA physicist James Holitza relayed information on the strength of the fields to the ground crew headed by Kasemir. This information, together with the location of the charge centers, enabled the ground crew to adjust the azimuth and elevation angles of the rocket launcher.

When the electric fields became sufficiently large, Kasemir sent word to the plane to "clear the area" and the rockets were fired until the repeated lightnings dissipated the cloud.

The NASA twin Beechcraft returned to monitor electric field changes in the cloud where the rockets had passed. Meteorologist William E. Cobb, also aboard the Beechcraft, reported: "We nearly always found reduced electrical fields in the clouds after the rocket had ignited a lightning strike."

Fifteen rockets were fired into thunderstorms at Socorro. Of these, nine successfully triggered lightning. Another three were launched toward areas of the storm where researchers thought the electric field was too low to produce lightning. These three failed to trigger a stroke, substantiating the scientists' judgment.

On August 8, three rockets were fired along the same path into a storm within 16 minutes. The first rocket triggered a ground discharge, the second and third did not. This led Kasemir to conclude that "the part of the cloud where lightning was triggered remained discharged for at least 16 minutes."

Later the same day, a more active storm arose and five-and-one-half-minute series of four rockets were launched. The first three launches touched off lightning strokes, discharging the more dynamic storm cloud sufficiently so that the last rocket, fired two minutes and seven seconds after the third rocket, did not trigger a stroke.

Since the lightning was hidden by clouds and was not visible from ground observing stations, there was some question as to whether the second rocket actually triggered lightning or whether it passed through a natural lightning strike. "If our rocket did trigger this strike," Kasemir says, "it did so on its upward pass unlike our other successful launches which triggered lightning as they descended. To check our assumption that lightning was really triggered, we carried out another test on August 14. Here, we waited until the storm was dissipating and natural lightning was occurring only about once every three minutes. We fired two series of three rockets each—the first series into the charge center of the cloud, the second series to a region away from the charge center. The first three shots all triggered lightning—61.0, 59.5, and 60.5 seconds after the respective launches. The second series did not create lightning. The close agreement of time from launch to lightning leaves practically no doubt that the lightning discharges were, in fact, caused by the rockets penetrating the charge center.

"After this encouraging beginning at Socorro, our full-scale tests at Cape Kennedy should be able to give us a lot more information on triggering lightning and perhaps providing Apollo a safe path through storm clouds."

After the rocket firings, the NASA twin Beechcraft returned to monitor electric field changes where the rockets had passed. Technician Billy R. Caldwell keeps watch on the recording instrumentation inside the plane.

After the shakedown tests at Socorro, the scientists moved to Cape Kennedy in early September, where they began a series of test launches called Project Mighty Mouse. Plans call for as many as 175 launches of a modified 2.75-inch-diameter military aircraft rocket with foldable fins. The rockets range in length from 54 to 63 inches. After the aircraft has sampled the electric fields, a rocket with a device to measure electric fields is launched first. This is followed by a rocket with the steel ball tip to trigger lightning. After the lightning, a second rocket of the sensing type is launched toward the cloud to measure the on-the-spot electric field after the triggered lightning. The Mighty Mouse rockets can reach altitudes of about 16,000 feet on their 70-second flight.

The Mighty Mouse launches at Cape Kennedy are continuing as the NOAA researchers gather more and more information on triggered lightning—information that may soon reduce lightning hazards to rocket launches. □

ODYSSEY OF THE GLOMAR CHALLENGER

On a seagoing drill platform weathermen aid the search for clues to the earth's origin.

BY CHARLES G. THOMAS
National Weather Service

In New England one can still occasionally hear a sailing vessel referred to as "yare" if she is particularly easy to handle or maneuverable.

"She's a yare craft," they'll say, and you can almost picture a sleek-hulled schooner cutting through the water with white sails billowing.

This is *not* a picture of the Glomar Challenger, and yet a more "yare" vessel would be hard to find. The 400-foot drilling ship can spin around in her own length or even move sidewise, crab-fashion. This maneuverability was built into her for a good reason . . . to make her a stable platform for drilling into the ocean's floor several miles below the surface.

But even with her incredible "station-keeping" ability, the Glomar Challenger can operate only under well-defined sea and weather conditions, and she never sets sail on one of her deep-sea drilling missions without an experienced marine weather observer-briefer on board.

As is usually the case when weather support services are needed in an exotic setting—be it a Panamanian jungle or the South Pole—the National Weather Service's Overseas Operations Division is on the job. In this case, they're helping the National Science Foundation solve a 140-million-year-old mystery.

To appreciate the importance of timely and accurate weather information to the Glomar Challenger, it is necessary to know a little about the ship itself and her mission.

In 1968, the Challenger began an 18-month program of investigating the deep ocean basins, their age, and their history of formation and modification. This marked the first field operations of a National Science Foundation program known as the Deep Sea Drilling Project. Scripps Institution of Oceanography of the University of California at San Diego manages the project under contract to the NSF. The initial 18-month program has been extended 30 months—to June 1973.

Quite simply, the Challenger's mission is to drill and obtain sample cores of sediments in the deep ocean basins. These sediments contain a relatively undisturbed record of oceanic processes for more than a hundred million years.

In order to obtain these core samples, the Challenger has drilled in water depths greater than three miles and into almost 3,300 feet of sediment at the ocean's bottom.

An obvious problem when the bit of your drill is 20,000 feet from its source of power is how to keep everything reasonably in line. The Challenger does it by an ingenious system known as "dynamic positioning."

When the ocean-bottom site to be drilled has been located by sounding techniques, sonar (from SOund NAvigation Ranging) beacons are dropped to the sea floor. Six hydrophones are located in the ship's hull. These underwater listening devices continually "home" on the sonar beacons, and the information is fed into computers which, in turn, can control the ship's diesel electric motors.

The Glomar Challenger can spin on her axis or move sidewise because she has "tunnel thrusters"—propellers set in four tunnels which run *across* the ship, two in the bow and two in the stern.

With her regular twin screws to move her forward or backward and her tunnel thrusters to move her sideways, the Challenger is able to maintain her position over the drilling hole with remarkable precision—actually within a drift radius of 60 feet. That is, even with the drill bit down 20,000 feet, the top of the drill can be maintained within a 120-foot circle around the drill hole—well within the limits of the 90-foot sections of pipe which, screwed together, form the flexible shaft of the drill.

The Challenger also has a gyroscopically controlled tank stabilizer which "dampens" her roll to six degrees in a rough sea, while other vessels may roll as much as 30 degrees.

In spite of the Challenger's stability as a drilling platform, there are times when adverse weather and sea conditions bring operations to a standstill. While there is no way in which these conditions can be controlled, foreknowledge of heavy swells or high winds permits the crew and science party to avoid costly delays, possible loss of equipment, and even personal danger.

The observer-briefer on the Challenger is the only weatherman aboard, but he gets plenty of meteorological assistance. He is "connected" to shore by the most modern communications equipment, which brings him radio facsimile charts and marine forecasts issued by area forecast centers. Also on board is an APT receiver to bring in pictures from weather satellites equipped with Automatic Picture Transmission systems. Naturally, there are instruments on the Challenger for making on-the-spot observations of wind, temperature, pressure, and so forth. The observations are transmitted to various forecast units on shore to improve their guidance forecasts for his area.

Each observer spends about two months with the ship before being relieved by his alternate. During the Challenger's initial 18-month program, meteorological chores were shared between two Weather Service marine specialists from the Pacific Weather Project based in San Francisco—Charles A. Green and Robert W. Bowman. Green now

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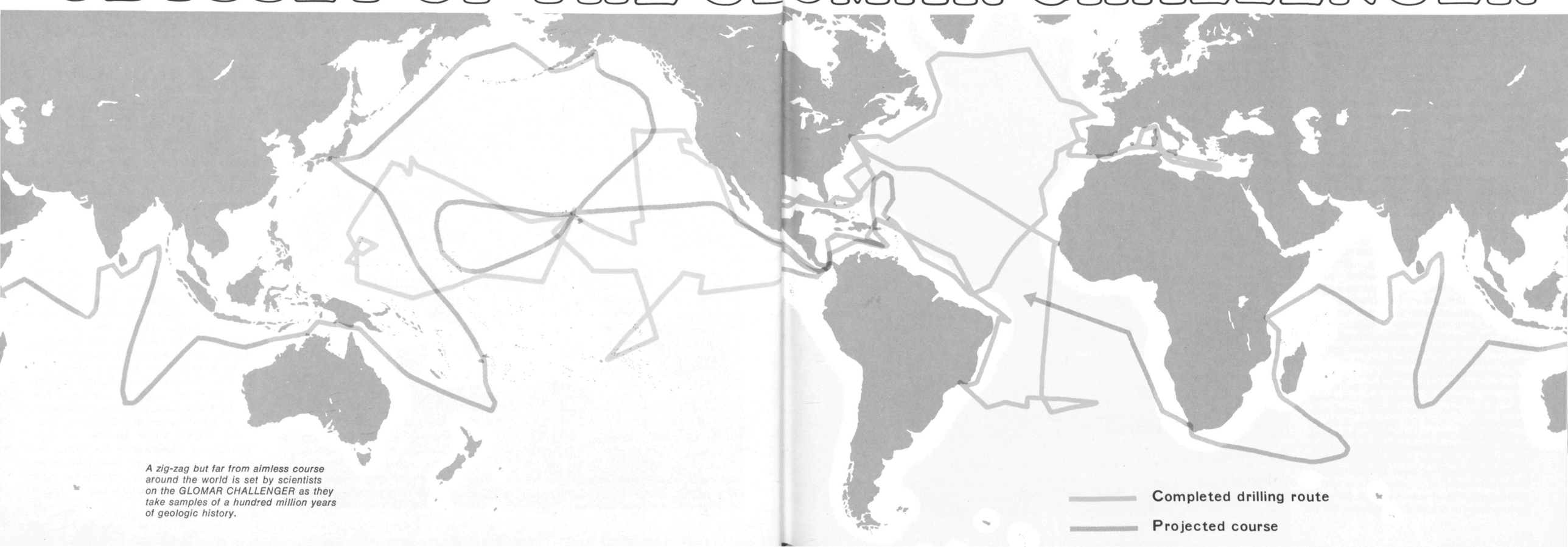
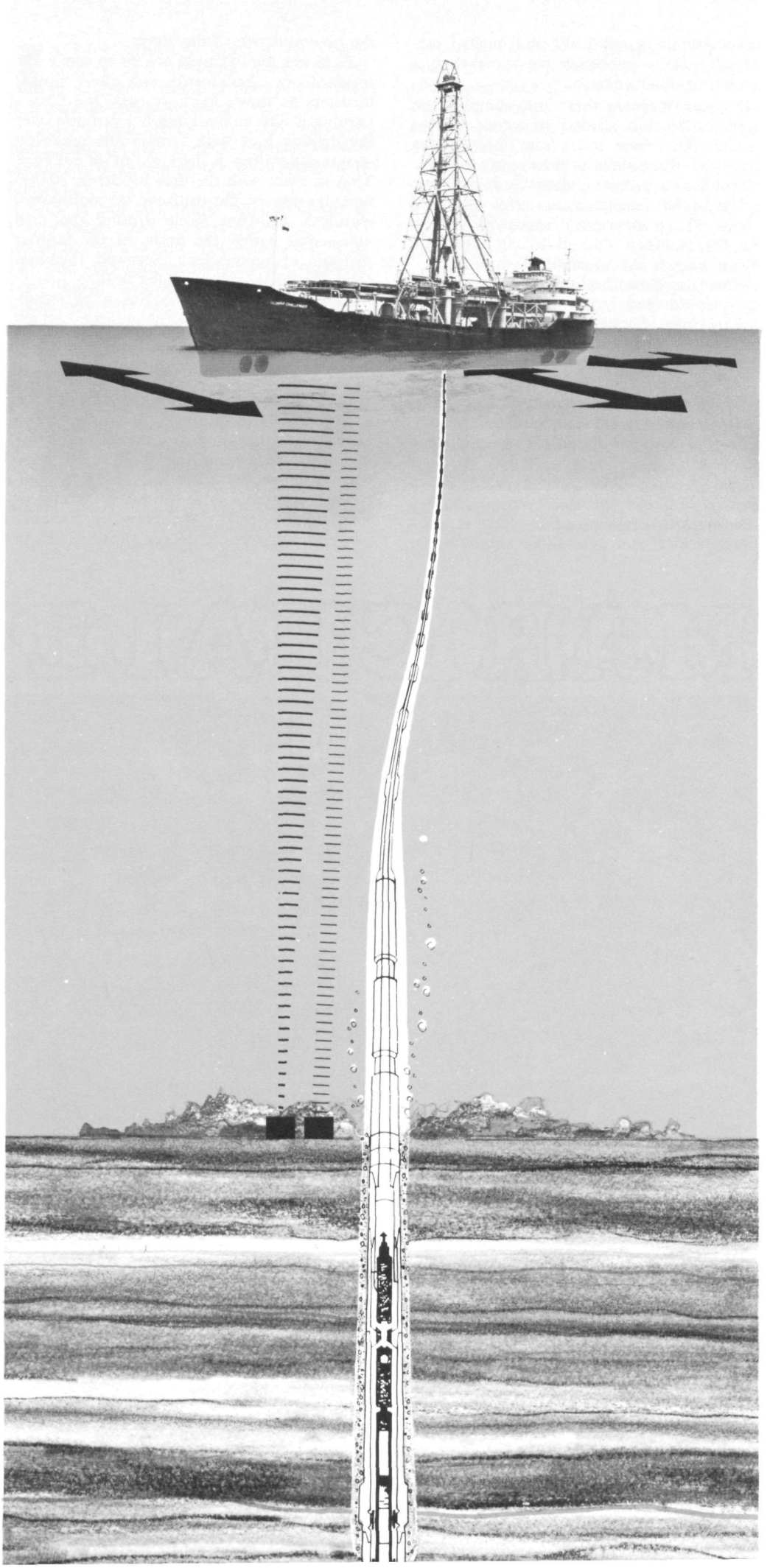


A zig-zag but far from aimless course around the world is set by scientists on the GLOMAR CHALLENGER as they take samples of a hundred million years of geologic history.

The GLOMAR CHALLENGER's "dynamic positioning" system enables the ship to stay over a drill hole with remarkable precision. Signals from the sonar beacons near the drill hole are "read" by a computer which controls the ship's various propellers. The heavy arrows indicate the several directions in which thrust may be applied.



alternates with Melvin L. Fields, another Pacific Weather Project employee.

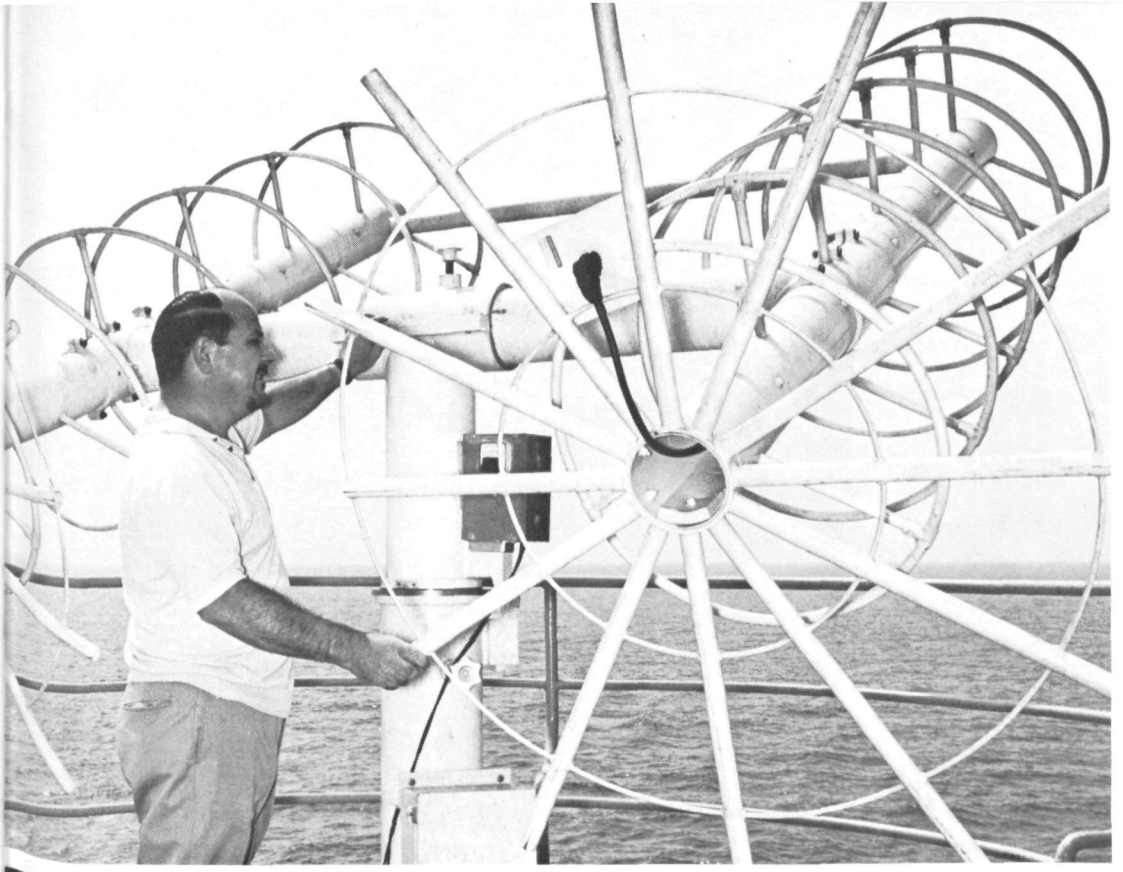
During the early cruises, the weathermen were asked to keep diary-like logs of daily happenings, successes and failures with shipboard equipment, communications problems, and the like. Excerpts from these diaries provide revealing glimpses into the day-to-day living of the Weather Service observer-briefers aboard the CHALLENGER.

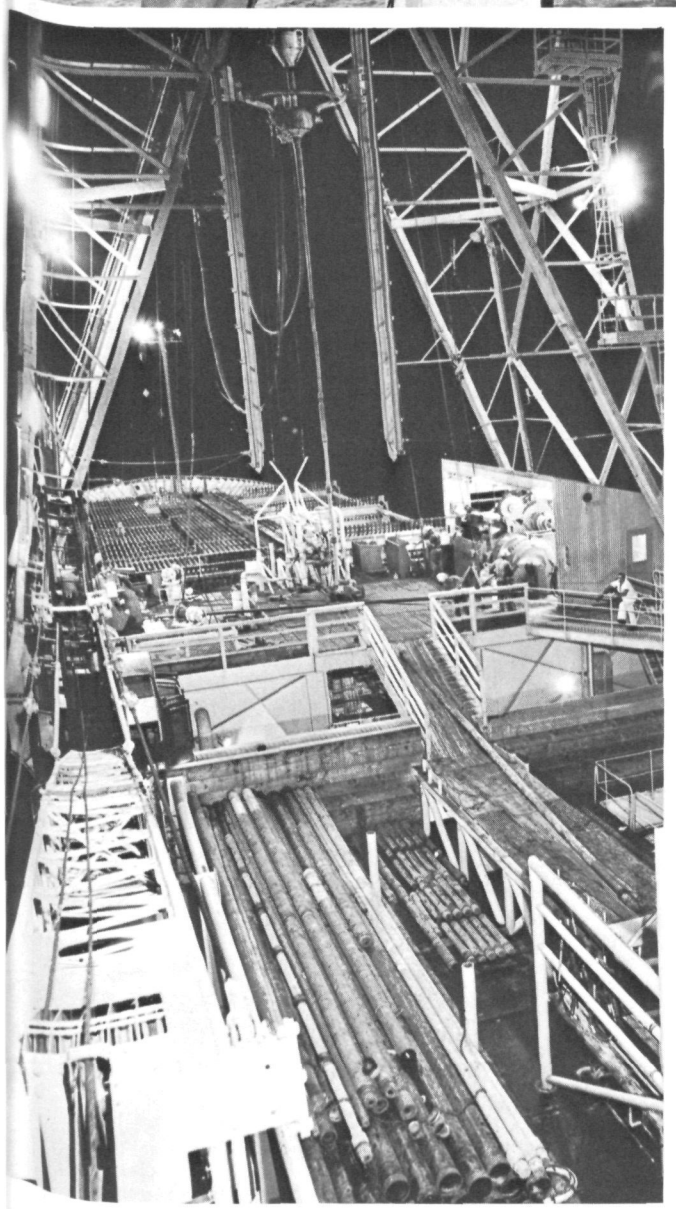
On the food: "Shrimp gumbo tonight and was excellent."—"Prime rib for lunch and New York cut steaks for dinner, wonder what the poor people are eating today."—"Lobster and crab salad tonight."

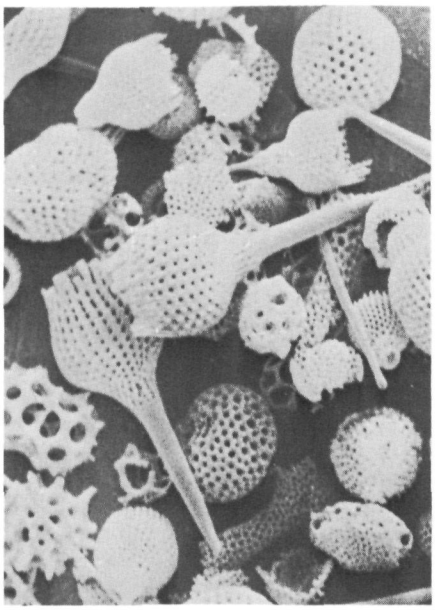
On the ship's maneuverability: "After passing through the first set of [Panama Canal] locks, the captain brought the Canal pilot down, and I explained the weather satellite system to him and gave him a couple of the APT pictures. Like most visitors, he was amazed at the amount and different sorts of equipment the GLOMAR CHALLENGER carries. . . . Later on the captain turned the ship around in a 360-degree circle in her own length in front of one of the locks, just to show the pilot it could be done. The whole circle took about two to three minutes, and was done in view of about six other ships. A lot of seafaring people probably wished they had a ship that could maneuver that way."

On one problem of deep-ocean drilling: "They had some trouble getting started on this hole. The first set of beacons broke apart, and they lost the positioning signal. Then, after they successfully dropped the second set and had lowered about 500 feet of [drill] pipe, they found the current so strong that they started drifting off position. Then, in order to get back, they had to turn over the screws [propellers] so much that the noise they made drowned out the peep-peep from the beacon. So they pulled up the pipe, ran back above the site, then drifted back over it and started down with the pipe again. Now it's touch and go to see if the ship can hold in this current. It's almost like holding station in a river." [The CHALLENGER retrieved some cores from this site, but cut its stay short because of the heavy current.]

On staying fit at sea: "Got in 200 laps on foredeck (or 5 miles) for exercise."







(Upper left) The National Weather Service observer, Charles L. Green, inspects the satellite receiving antenna on the CHALLENGER's stern. (Above) Magnified 100 times in an electron microscope picture, these tiny skeletons of various forms of radiolaria were found in core samples taken in the Pacific. (Left) The ship's rigging stands out starkly during night operations. The drill string, suspended between two guide rails, extends down through the decking and out of the bottom of the hull.

On a break in ship's routine: "Amazing things happen! They found a stowaway last night. Young fellow about 25 or so. Hidden out among the mud sacks. . . . They decided to put him to work doing the ship's laundry. Have to give a guy credit for trying a stunt like that. First ship I've been on where someone has tried to stow away."

On some bad weather: "7/21/69—Arrived on location site 55 at 1700. Position is 9.3 degrees North, 142.5 East. Puts us in intertropical convergence zone [a narrow zone where air masses of the two hemispheres converge giving rise to general upward motion and disturbed weather]. Had one squall with heavy rain shower and wind gusting to 40 knots. 7/22/69, 10 a.m.—Tropical depression forming right on top of us. Our pressure dropped 4 millibars in 3 hours. I informed Captain, showed him the ESSA 8 [satellite] picture which clearly shows it on top of us. . . . Our winds now steady 30 knots with gusts to 40. Seas up to about 8 feet. I hope it moves to the west soon. . . . Getting storm or gale warnings from JMG Japan teletype. According to recon flight, the center of the depression is at 8.2 degrees N. and 143.5 degrees E. We are only about 60 miles away. . . . [A little later that day] They pulled the pipe up and we are running. Wind steady 40 knots, gusts to 50. Seas up to about 12 to 15 feet. From recon information, we figure the center passed anywhere from right over us to 30 miles away at the most. Forecasts are it will be typhoon force in another 24 hours." [The storm which formed over the GLOMAR CHALLENGER became supertyphoon Viola with 150-mile-an-hour winds which killed 20 persons in Taiwan and the Philippines.]

And, finally, on a sailor's two favorite subjects, liberty and food again: "The island of Hawaii was in sight from daybreak until afternoon. Due in at pilot station at 6 a.m. It has been a very nice trip. We had steak and lobster again for dinner."

The CHALLENGER is now drilling in the Caribbean along a course which will take her through the Panama Canal and into the Pacific. In the months and years to come, the ship's scheduled ports of call indicate a zig-zag, round-the-world cruise with stops at Honolulu, Hawaii; Kodiak, Alaska; Yokohama, Japan; Suva, Fiji; Darwin, Australia; Colombo, Ceylon; Dar es Salaam, Tanzania; and Durban, South Africa, before her oceanic odyssey ends.

Summing up the CHALLENGER's first two years of operation, Dr. Melvin N. A. Peterson, Chief Scientist of the Deep Sea Drilling Project, has said: "We have all seen the obvious evidence of motions in the outermost layer of the earth—the cloud patterns in the atmosphere. Somewhat slower, but also very large motions occur in the water masses of the oceans. Now it has also been demonstrated that even slower, but equally profound, large-scale motions take place in the outer part of the solid earth."

The GLOMAR CHALLENGER, with its 142-foot derrick, is even now bringing up secrets of the ocean deeps from which man may draw the clues which will solve the mystery of the earth's origin. □

SALMON AND FLOUNDER–

FISH OF THE YEAR

For commercial fishermen, 1970 will be remembered as the year of the salmon and the flounder. The deep icy waters of the North Pacific yielded the biggest salmon catch in 30 years, and the available supply of flounder was double that of the previous year. Much of this record production has been canned or frozen and is now in the supermarkets, providing an economical source of high-quality protein and other nutrients.

Salmon has nourished the human race since ancient times. Pliny, the Roman scholar, wrote in 77 A.D. that "the river salmon is preferred to all fish that swim the sea." Salmon remains a favorite today. The fact that canned salmon is 100 percent edible, easy to store and use, as well as being high in nutritional values, makes it one of the most convenient food items on the market.

The National Marine Fisheries Service and state conservation agencies are working together to enhance salmon resources and protect them from dams, pollution, overfishing, and other threats. Research on salmon behavior patterns and the influence of the environment provides an understanding of the fluctuations in abundance of salmon stocks. Other research is aimed at providing safe passage for migratory fishes at water-use projects, such as hydroelectric and flood-control dams and irrigation systems. The basic goal of all fishery research is to ensure the wise use of a renewable resource.

In contrast to the stately salmon, flounder are often called the clowns of the sea, because of their bizarre appearance. Born with normally placed eyes, a young flounder soon finds its skull beginning to twist and one eye moving toward the other side. At the same time, the fish begins to tilt. Within a short time, both eyes peer from the same side, and the fish swims with its eyeless side down. As the head and eyes twist, the mouth becomes distorted and the flounder ever after wears a crooked, pained look.

Rippling and gliding through the water, flounder resemble flying saucers. Part of nature's camouflage is the way they glide to the bottom and then flip sand over their backs, becoming almost invisible except for their protruding eyes. When it spots a small fish or other prey, the flounder gives a squirt of water from its underside gill to jet propel itself from the bottom in hot pursuit. The white belly side blends with the light filtering down through the water, protecting it from enemies below. The darker top side usually resembles the color of the bottom on which the flounder lives.

Flounder are found along almost every coastline of the United States. Most live along the continental shelf and slope, but some come into shoal waters and are found in bays and inshore along the coast.

To aid the fishing industry in marketing the last year's abundant catches of salmon and flounder, the National Marketing Services Office of the National Marine Fisheries Service has prepared and published a number of new recipes. □

Sea Fare

RED AND WHITE SEAFOOD ROLL-UPS

2 pounds flounder fillets or other thin fillets, fresh or frozen
½ teaspoon salt
Salmon Stuffing
1 can (10-½ ounces) cream of celery soup
1 cup white wine
Dash Worcestershire sauce
⅓ cup grated cheddar cheese
Minced parsley
Pimiento strips

Thaw frozen fillets. Skin fillets. Cut into 12 portions. Place fish, skinned side up, on a cutting board. Sprinkle fish with salt. Divide salmon stuffing into 12 portions, about 1 tablespoon each. Place stuffing on fish. Roll fish around stuffing. Skewer or tie. Place fish rolls, stuffing side up, in a well-greased baking dish, 13 by 9 by 2 inches. Combine soup, wine, and Worcestershire sauce. Pour sauce over fish rolls. Bake in a moderate oven, 350° F., for 20 minutes. Baste with sauce in pan. Sprinkle with cheese. Bake 5 to 10 minutes longer or until cheese melts and fish flake easily when tested with a fork. Garnish with parsley and pimiento. Makes 6 servings.

SALMON STUFFING

1 can (7¾ ounces) salmon
1 egg, beaten
1 teaspoon chopped parsley
½ teaspoon liquid hot pepper sauce
½ teaspoon onion powder
¼ teaspoon paprika

Drain and flake salmon. Combine all ingredients. Makes approximately ¾ cup stuffing.

BAKED SALMON STEAKS

2 pounds salmon steaks, fresh or frozen
2 eggs, beaten
2 tablespoons milk
1 tablespoon lemon juice
1 teaspoon salt
1½ cups toasted dry bread crumbs
⅓ cup butter or margarine, melted
Lemon wedges

Thaw frozen steaks. Combine egg, milk, lemon juice, and salt. Dip fish in egg mixture and roll in crumbs. Shake off extra crumbs. Dip fish in egg mixture, and roll in crumbs again. Place fish in a single layer in a well-greased baking dish, 13 by 9 by 2 inches. Pour butter over fish. Bake in a moderate oven, 350° F., for 20 to 25 minutes or until fish flake easily when tested with a fork. Makes 6 servings.

APPLE-SALMON MOUSSE

2 packages (3 ounces each) orange flavor gelatin
1½ cups boiling water
1½ cups cold water
3 apples*
1 can (1 pound) salmon, drained
½ cup chopped green pepper
2 tablespoons chopped ripe olives
¾ cup mayonnaise or salad dressing
½ teaspoon salt
¼ teaspoon paprika
1 tablespoon vinegar
Salad greens
Lemon-water mixture
*Preferred variety—Golden Delicious

Dissolve gelatin in boiling water. Stir in cold water; mix thoroughly. Chill until partially thickened. Pare, core, and dice 2 apples to measure approximately 1½ cups. Drain salmon and break apart. Reserve a few pieces of salmon for garnish. Break remaining salmon into small pieces and combine with diced apples, chopped pepper and olives, mayonnaise, salt, paprika, and vinegar. Fold salmon-apple mixture into thickened gelatin. Pour into a 6-cup mold. Chill until firm. Unmold on serving plate lined with salad greens. Slice remaining apple and dip into lemon-water bath. Drain; garnish Apple-Salmon Mousse with apple slices and salmon pieces. Makes 6 to 8 servings.

BROILED FLOUNDER WITH WINE SAUCE

6 pan-dressed flounder or other pan-dressed fish, fresh or frozen
Wine Sauce

Thaw frozen fish. Clean, wash, and dry fish. Place fish in a single layer in well-greased, hinged, wire grills. Brush fish with sauce. Cook about 4 inches from moderately hot coals for 8 to 10 minutes. Baste with sauce. Turn. Cook 8 to 10 minutes longer or until fish flake easily when tested with a fork. Serve remaining Wine Sauce with the fish. Makes 6 servings.

WINE SAUCE

½ cup tomato juice
½ cup dry white wine
¼ cup butter or margarine
¼ cup chopped onion
2 tablespoons cider vinegar
1 tablespoon brown sugar
1 teaspoon salt
½ teaspoon paprika
½ teaspoon Worcestershire sauce
¼ teaspoon chopped garlic
¼ teaspoon pepper

Combine all ingredients in a 1-quart saucepan. Simmer 10 minutes. Makes approximately 1½ cups sauce.

SALMON PEARADISE

1 can (29 ounces) Bartlett pear halves
1 can (16 ounces) salmon
2 cups cooked rice
⅓ cup slivered green pepper
⅓ cup coarsely chopped walnuts or toasted slivered almonds
¼ cup chopped chutney
⅓ to ½ cup tart French dressing
Parsley or salad greens for garnish

Chill pear halves. Drain salmon and flake coarsely. Combine salmon with rice, green pepper, walnuts, and chutney. Toss with French dressing to coat lightly. Drain pears. Line salad bowl with pears, placing pointed ends of pear halves up. Mound salmon-rice mixture in center of pear-lined bowl. Garnish with parsley or salad greens. Makes 6 servings.

NEW ORLEANS FLOUNDER ROLLS WITH DILL SAUCE

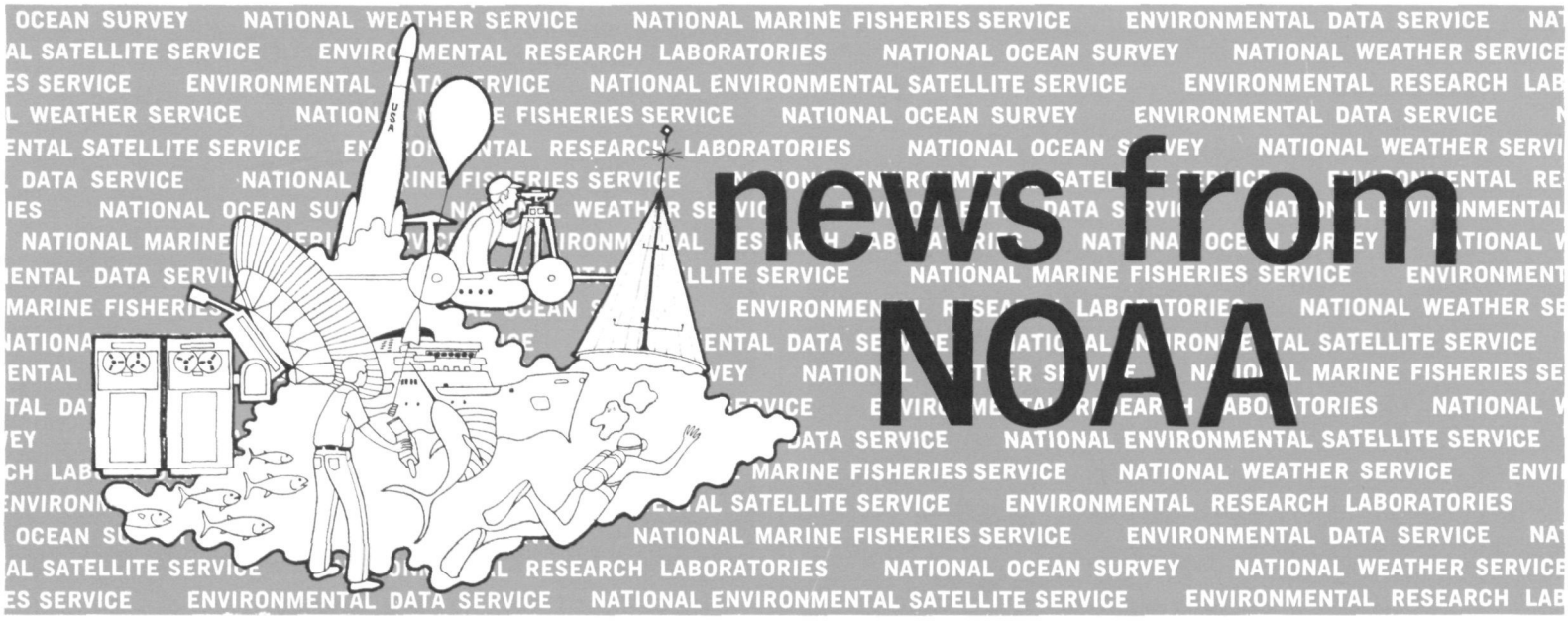
2 pounds flounder fillets, fresh or frozen
1 teaspoon salt
¼ cup butter or margarine, melted
2 tablespoons lemon juice
¼ teaspoon dill weed
Dill Sauce

Thaw frozen fillets. Sprinkle salt evenly over both sides of fillets. Roll fillets up, skin side out, starting at tail end. Arrange rolls in greased baking dish, 12 by 8 by 2 inches. Combine butter or margarine, lemon juice and dill weed; mix and drizzle over fillets. Bake in moderate oven (350° F.) 20 minutes or until fish flakes easily when tested with a fork. Baste occasionally with pan drippings. Serve with Dill Sauce. Makes 6 to 8 servings.

DILL SAUCE

2 tablespoons butter or margarine
2 tablespoons flour
1 teaspoon salt
1 teaspoon sugar
⅛ teaspoon white pepper
1½ cups milk
1 egg yolk, beaten
1 tablespoon lemon juice
1 teaspoon dill weed
1 teaspoon prepared mustard

Melt butter or margarine. Blend in flour, salt, sugar, and pepper. Add milk; cook until thickened, stirring constantly. Add a small amount of hot mixture to egg yolk, stirring constantly. Stir egg yolk mixture into hot sauce. Add remaining ingredients; heat and serve over fish. Makes 1½ cups sauce.



NOAA-1 Environmental Satellite Is New Administration's First

NOAA's first Improved TIROS Operational Satellite was launched December 11 from NASA's Western Test Range, Lompoc, California. After successfully entering orbit, approximately 900 statute miles above the earth, the ITOS spacecraft was designated NOAA-1.

The omnibus ITOS spacecraft contains four camera systems —two for global picture coverage of the earth's weather and two for immediate transmission of cloud photographs directly to receiving stations around the world. These Advanced Vidicon Camera Systems (AVCS) and Automatic Picture Transmission (APT) systems proved their reliability and effectiveness in the ESSA spacecraft of the earlier TIROS Operational Satellite system.

Instrumentation of the new ITOS includes scanning radiometer systems that provide data in both visible and infrared channels. The visible channel is an alternate source of daytime cloud pictures. The infrared channel affords cloud pictures at night as well as during the day.

Nighttime satellite observations now are available to National Weather Service forecast offices throughout the nation for use in preparing early morning forecasts. With the spacecraft's ability to photograph the dark side of the earth, the entire globe is observed twice each day by both stored and direct readout systems, doubling the coverage formerly provided by operational weather satellites.

The scanning radiometer also measures surface temperatures in cloud-free areas. NOAA's Satellite Service has developed a technique for preparing global maps of sea-surface temperatures from satellite infrared measurements, and expects to begin issuing such maps on a routine operational basis this year.

Unlike previous operational vehicles, ITOS is large enough to house additional environmental sensors. The first NOAA spacecraft contains a flat plate radiometer to provide data on the earth's heat balance and a solar proton monitor to detect the arrival of energetic solar protons in the vicinity of the earth. Solar proton measurements are processed by the National Environmental Satellite Service and transmitted to NOAA's Space Disturbances Laboratory at Boulder, Colo., for use in issuing warnings of solar storms.

The operational satellite system, established by ESSA in 1966, has provided a routine service of weather observations over the entire earth every day. Photographs transmitted by the Automatic Picture Transmission system are received by more than 500 specially equipped ground stations around the world, for use in issuing local forecasts and warnings for the public and for aviation, marine, agricultural and other interests. Pictures taken by the Advanced Vidicon Camera System are stored for readout by NOAA's Command and Data Acquisition stations at Fairbanks, Alaska, and Wallops Station, Virginia, and transmission to National Environmental Satellite Service headquarters at Suitland, Md. NMC also makes extensive use of satellite data.

INSTRUMENT LADEN C-130B JOINS RESEARCH FACILITY AIR FLEET

A WC-130B was turned over to NOAA's Research Flight Facility by the Air Force early in October.

Replacing the C-54 formerly operated by the RFF, the WC-130B has joined the Facility's two DC-6's and WB-57 in environmental research projects.

The new aircraft has a range of 3000 nautical miles, a normal cruising altitude of 18,000 feet, and a maximum operating altitude of 35,000 feet. Its equipment includes dual dropsonde systems, a Johnson-Williams liquid water probe, foil air sampler, infrared hygrometer, and vortex temperature probe.

A reconnaissance system now being developed by the Air Force will be added to the instrumentation later, and a sophisticated research package including an inertial platform, gust probes, and refractometers is being designed by the Environmental Research Laboratories for installation on the aircraft in Fiscal Year 1972.

Commerce Honors 31 From NOAA With Gold, Silver Medal Awards

Seven Gold Medals and twenty-four Silver Medals were awarded to NOAA employees at the Department of Commerce's 22nd Annual Honor Awards Program, October 21.

Secretary of Commerce Maurice H. Stans presented Gold Medals, the highest honor given by the Department, to:

Harold A. Bedient, Chief, Data Automation Division, National Meteorological Center, National Weather Service, for his role in the development of automatic weather analysis, data processing, graphics, and communications. Mr. Bedient was commended for his contributions to the technology of automatic data processing, the development of practical automatic recognition, and editing of meteorological data which were never designed for such purposes.

Stuart G. Bigler, Chief, Sounding Systems Branch, National Weather Service, and newly appointed Director of the Alaska Region, for his outstanding leadership in establishing the nation's weather radar network. He played a leading part in establishing the Weather Service's western radar network, which uses Federal Aviation Administration Air Route Traffic Control radars for weather observation when air traffic loads permit. Mr. Bigler also has provided leadership in the development of improved techniques in radar data acquisition, including remoting and the use of commercial telephone lines to provide radar displays from distant sites.

Guy H. Dorsey, Acting Chief, NOAA Personnel Division, for outstanding work as one of the Department's top personnel officers. Mr. Dorsey has served continuously in the Commerce Department since 1935, with the exception of a tour of duty with the Navy from 1943 to 1946. In recent years, his expertise in personnel matters has proved extremely valuable in a major reorganization of the former Weather Bureau and, in 1965, the creation of the Environmental Science Services Administration.

R. Cecil Gentry, Director of the National Hurricane Research Laboratory, Miami, Fla., and of Project Stormfury, and for outstanding scientific ability and program leadership as Director of Project Stormfury during the 1969 hurricane season. The results of this joint project of the Departments of Commerce and Defense in seeding Hurricane Debbie in August 1969 strongly suggest that man is on the threshold of being able to moderate the intensity of these destructive storms.

Harold L. Frost, Meteorologist in Charge, Weather Service Office, Lubbock, Texas, for his leadership in the administration of the weather warning program at Lubbock, where he has developed and maintained an extraordinarily competent severe-weather warning service. Outstanding skill and action were displayed by the Lubbock Weather Service Office in issuing warnings more than one hour in advance of a tornado which roared through the downtown area of Lubbock on May 11, 1970.

Stanley L. Rosenthal, Chief, Theoretical Studies, National Hurricane Research Laboratory, Miami, Fla., for outstanding work in hurricane modeling. Dr. Rosenthal has produced the first numerical model of a hurricane that has many of the characteristics observed in nature's storms and can be used to simulate hurricane modification experiments. His model has been used in conjunction with field experiments, as well as for the design of new experiments and techniques for Project Stormfury.

Kirk Bryan and Syukuro Manabe, Research Meteorologists, Geophysical Fluid Dynamics Laboratory, Princeton, N.J., for an outstanding contribution to the problem of mathematically modeling the joint atmosphere-ocean system. The research of Dr. Manabe and Dr. Bryan in simulating joint large-scale circulations of the atmosphere and ocean marks a significant milestone in the history of attempts to model the earth's fluid envelope. Their achievement provides the necessary framework for future studies of natural climatic change and of climate modification caused by human activities.

Silver Medals were awarded to:

Glenn Ball, Chief, Instrument Approach Procedure Chart Branch, National Ocean Survey.

Philip Brandis and Charles Carpenter, Data Automation Division, National Weather Service's National Meteorological Center.

Max M. Chesy, NOAA Visual Services Branch.

Hilmer A. Crumrine, National Severe Storms Forecast Center, National Weather Service, Kansas City, Mo.

Spellman J. Diez, Systems Manager, Distribution Division, National Ocean Survey.

Agnes B. Erkens, Budget Analyst, Budget Division.

Earl W. Estelle, Executive Assistant to the Associate Director for Meteorological Operations of the National Weather Service.

Dale Gough, Chief, Personnel Services, Environmental Research Laboratories, Boulder, Colorado.

Arthur Gustafson, Meteorologist in Charge, Weather Service Forecast Center, San Francisco, California.

Commander Richard Houlder, Chief, Photogrammetry Division, National Ocean Survey.

Marvin N. Hunter, retired Aviation Forecaster at the Weather Service Forecast Office, Washington, D.C.

Lieutenant (j.g.) Robert C. Husted, Jr., NOAA Commissioned Corps.

Frank Lewis, Systems Development Office, National Weather Service.

Stephen Lichtblau, retired Meteorologist in Charge, Weather Service Forecast Office, New Orleans, La.

Grady F. McKay, Chief, Data Reduction Branch, National Climatic Center, Environmental Data Service, Asheville, N.C.

Howard J. Mason, Jr., Chief, Research Flight Facility, Environmental Research Laboratories, Miami, Fla.

Herbert W. Rahmlow, Special Assistant to the Chief of the National Weather Service's Engineering Division.

Gerald L. Shak, Regional User Services Representative, Weather Service Eastern Region Headquarters, Garden City, N.Y.

John J. Smiles, Chief, NOAA Visual Services Branch.

Mirco Snidero, Chief, NOAA Computer Division.

Wilmer L. Thompson, retired Director of the Weather Service's Southern Region.

Harry W. Waldheuser, Principal Assistant, Weather Service Office, St. Louis, Mo.

Chalmers C. Wooden, Meteorologist in Charge, Weather Service Office, Montgomery, Ala.

William L. Woodley, Research Meteorologist, Experimental Meteorology Laboratory, Miami, Fla.

Francis J. Balint, Chief of the Management and Planning Branch, NOAA Computer Division, won the Secretary's Suggestion Award for the outstanding suggestion by a Department employee during the past year. Mr. Balint's suggestion proposed converting government-owned 024 and 026 card punch machines and 056 verifying machines from 48-character-set equipment to 64-character-set equipment. This will prolong the useful life of government-owned card punch machines by permitting their use in computer systems of modern, sophisticated design.

Medal winners, with Dr. Robert M. White, Acting Administrator. Seated, left to right: S. Rosenthal, H. Bedient, S. Manabe, K. Bryan, Dr. White, A. Erkens, G. Dorsey, H. Frost, R. Gentry. Standing, left to right: D. Gough, G. McKay, W. L. Woodley, H. J. Mason, S. Diez, W. Thompson, G. Shak, S. Bigler, F. Lewis, E. Estelle, A. Gustafson, C. Wooden, H. Crumrine, R. Houlder, S. Lichtblau, G. Ball, M. Snidero, J. Smiles, H. Rahmlow, M. Chesy, C. Carpenter, P. Brandis, H. Waldheuser, M. Hunter, D. Crombie, R. Husted.

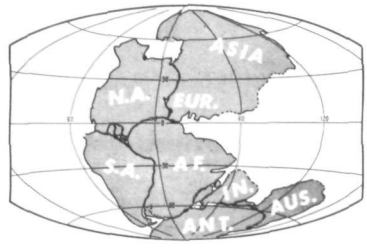
Maps Plot Continents' Slow Drift

Dr. Robert S. Dietz and John C. Holden, marine geologists at the Atlantic Oceanographic and Meteorological Laboratories, Miami, have worked out a sequence of five maps that, for the first time, identify the tracks of a 200-million-year journey the continents have made across the face of the earth. The scientists have also picked their way backwards in time to piece together the first geographically precise reconstruction of what is thought to be the universal mother of continents.

Basing the reconstruction on the relatively new concept of sea-floor spreading and global plate tectonics, the NOAA scientists used continental margins, oceanic ridges, and ancient geomagnetic-pole positions to control the placement of landmasses in orderly geological progression.

In the beginning there was Pangaea, a supercontinent that existed unbroken 225 million years ago. Twenty-five million years later, the continent split into two large masses—Laurasia, which was ultimately to become North America, Europe, and Asia, and Gondwana, that was to break into Africa, South America, Australia, Antarctica, and India. This separation created the proto-Atlantic Ocean as a kind of offshoot of the Pacific lying at east-west points along the Equator. Africa and South America split away from eastern Gondwana, while another rift lifted India off Antarctica. By the end of the next period 135 million years ago, known as Jurassic, sea-floor spreading had further opened the North Atlantic and Indian Oceans. A new rift began splitting South America away from Africa. The North Atlantic rift continued to grow northward in the Cretaceous period, which ended 65 million years ago, extending the North American/European split. Australia tore away from Antarctica. Africa drifted northward and India moved all the way to the Equator.

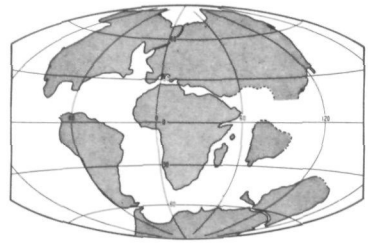
During the present geologic period known as Cenozoic, the two Americas have continued to drift westward and the Atlantic has continued opening, splitting Laurasia up through the Arctic Ocean. Australia and India have moved northward, the scientists say, at a rate of about four inches per year, or ten times faster than North America, which has drifted westward. India's journey ended early in the Cenozoic period crunching under southern Asia and uplifting the Himalayan Mountains. Africa has continued moving northward, nudging Eurasia and undergoing a split in its northeastern bulge, establishing the Arabian peninsula and the Red Sea. During the entire history of the Pangaea breakup, continental movements appear to have been chiefly northward and westward. Antarctica and Eurasia have remained relatively fixed, except for some rotation.



PERMIAN - 225 million years ago

TRIASSIC - 200 million years ago

JURASSIC - 135 million years ago



CRETACEOUS - 65 million years ago

CENOZOIC - Present

This series of maps shows the universal continent (Pangaea), subsequent breakup, drift dispersion, and present positions of the world's landmasses, as envisioned by Dr. Robert S. Dietz and John C. Holden of the Environmental Research Laboratories. The outlines are based on the 6,000-foot-deep sea-floor contours of the continents.

NOIC Gets Versatile New Test Tank

The National Oceanographic Instrumentation Center has acquired a versatile new test tank. This is the twelfth in a series of unique oceanographic test facilities which have given NOIC a worldwide reputation for leadership in testing and evaluating oceanographic instruments and related equipment.

The new tank allows instruments to be immersed and tested in either distilled water, tap water, artificial sea water, natural sea water or a solution of ethylene-glycol and tap water. Working fluids with salinity up to 60 parts per thousand can be used in the tank without corrosive effect on the pumps or other components of the piping and heat exchange system. Temperature in the tank can be varied. Jet circulators provide for uniform fluid flow by introducing circulating fluid either at the bottom or the top of the bath. The cylindrical bath provides an unobstructed interior work volume of approximately 17 cubic feet or a work area that is 2 feet in diameter and 5½ feet high.

Major Sea Grants Awarded Schools In Texas, Calif.

The Office of Sea Grant announced several major grants recently.

A $763,800 Sea Grant went to the University of California, San Diego, for an extensive program of education, training, research, and advisory services related to improved use of ocean resources. The grant included $200,000 for San Diego State College, which is cooperating in the multi-faceted study. Also cooperating in the study is the NOAA National Marine Fisheries Service Fishery-Oceanography Center at La Jolla, Calif. A large part of the Sea Grant work is being conducted at the University of California's Scripps Institution of Oceanography.

Grants totaling $2.5 million went to Texas A &M University for operation of the institution's Sea Grant Program. The grants included $1,166,000 for academic year 1970-1971 and $1,400,000 in 1971-1972 for development of marine resources in Texas. In addition to the work conducted by Texas A & M, the funds provide partial support for marine work at six other Texas schools and at Dow Chemical Company.

"Hot Line" Links Washington, Tokyo Weather Services

Forging a new link in the system of global telecommunications for the World Weather Watch, a high-speed "hot line" recently went into 24-hour-a-day operation between Tokyo, Japan, and Washington, D.C.

The new circuit is the first of the overseas links in the global system to operate at the speed of 3,000 words a minute, which is to become standard for the entire network by 1972.

It replaces a 100-word-a-minute circuit installed in December 1969 as the Weather Service's first direct line to Tokyo, and carries almost three times as much data as the WWW circuit to Europe, operating at 1,050 words per minute.

Another first for the Washington-Tokyo line is that it is the first circuit operating at this high speed to be geared for error control, so that U.S. and Japanese weathermen can correct mistakes before flashing data halfway around the world.

The massive volume of information transmitted in this manner is far too fast for human eye and hand and brain. Computers process the material, sort it, and deliver the various components to the proper parties.

NMFS Device Speeds Crabmeat Processing

Dr. Wayne Tretsven of the National Marine Fisheries Service in Seattle, Washington, examines crab leg in the study of a new process for separating meat from shells.

For commercial crab processors, the necessity of hand-picking crabs has long meant that too much meat was left in the shells.

Until recently, the problem has defied solution. Now, however, scientists with the National Marine Fisheries Service have developed a machine which uses a centrifuge to separate shell from meat, and which increases the yield of crabmeat by 50 percent.

Dr. Wayne Tretsven, industrial scientist with the NMFS technological laboratory at Seattle, Wash., says that prime sections, such as large leg sections, are still more easily separated by hand. However, hard-to-pick sections, such as the tips of legs, can be picked by machine.

The shell pieces are chopped into three-quarter-inch sections, fed into the machine, and the difference between the density of the meat and the density of the shell in brine permits separation.

Research on the process is continuing, both at the Seattle laboratory and at the NMFS technological laboratory at Gloucester, Mass.

Successful tests have been run with Dungeness crab, snow crab, blue crab, Jonah crab, and lobster. Although some breaking of the meat was reported, the scientists said it was only slightly more than the breakage that occurs during handpicking.

Lake Survey Offers New Chart Editions, Historical Matter

New editions of three Lake Survey Charts of the Minnesota-Ontario Border Lakes, Charts 818, 820, and 822, are now available. Together, the charts, designed and prepared especially for use in the small, shallow-draft boats that cruise these waters, cover all of Lakes Namakan and Kabetogama. Chart 818 shows the eastern part of Lake Namakan; Chart 820 covers western Lake Namakan; and Chart 822 shows the western end of Lake Kabetogama. This is the first time they have been updated since 1963-64. Excluding hydrography, they include the islands in the area, rivers flowing into the Lakes, and other features of interest to recreational boaters.

The Lake Survey Center also has some interesting bits of American history available to the public in the form of early charts and field drawings. The earliest chart is a "Plan Topographique du Detroit—Lac Erie Avec Le Lac St. Clair," made in 1796 under General George Henry Victor Collot, an officer in the army of Napoleon. The chart is in French, but a brief note in English explains its origin. Two small sketches show the "town of Detroit" and "Fort Erie." Black and white copies sell for $1.00 each.

Another is the "Map of Hydrographic Basin of the Upper Mississippi River, 1843," prepared from astronomic and barometric observations, 1836-1840, under the direction of J. N. Nicollet. It shows parts of the States of Illinois and Missouri, the Iowa and Wisconsin Territories, and the general location of various Indian countries, such as Winnebago, Kikapoo, Pawnee, Omaha, and others. A black and white print is available for 65 cents.

Civil War enthusiasts will appreciate the 1865 map which shows the "Marches of the Union Army under Major General W. T. Sherman, 1863-65." The map covers an area from Washington, D. C., to below Brunswick, Ga., and from the Atlantic Ocean to the Mississippi River. Copies in sepiatone are made from the original copper engraving discovered in 1965. The cost is 75 cents a copy.

For a free catalog showing the charts and publications available, as well as a list of sales agents, write to the Lake Survey Center, 630 Federal Bldg., Detroit, Mich. 48226.

Data Buoy Project Units Move to Gulf Facility

The National Data Buoy Project Office estimates that the relocation of its operating divisions from Coast Guard headquarters in Washington to the NASA Mississippi Test Facility (MTF) at Bay St. Louis will be completed by the end of this month.

Captain V. W. Rinehart, USCG, and a small staff of special assistants will remain at NOAA's Washington headquarters.

There are presently ten Coast Guard and two NOAA civilian personnel working at MTF for the Data Buoy Project Office. The Coast Guard personnel are serving with NOAA under a Memorandum of Understanding so as not to lose the expertise developed by the Coast Guard since the Project Office's formation in January 1968. Additional civilian personnel are being hired and will bring the total personnel level at MTF to 40 or more during FY 1971.

NASA at MTF provides support services ranging from supplying furniture to letting contracts. An additional building at MTF may be used to assemble the Engineering Experimental Phase Buoys. From there, the buoys can be towed through a canal system to the Mississippi Sound.

The Mississippi Test Facility was built by NASA during the 1960's for static test firing of the Saturn rocket motors used in the Apollo Program. Since the end of the test program, NASA has encouraged other government agencies to use the excellent physical plant and support facilities available.

The MTF is also being used by NOAA's National Marine Fisheries Service and National Weather Service.

The NMFS is using the facility's sophisticated technical equipment and expertise in studies of the location and abundance of fishing resources. Initial aerospace sensing studies involve sighting with light amplifiers, laser, aerial photographs, and other equipment designed to help detect schools of fish and to study sea surface conditions from high altitudes. NASA's extensive engineering and management skills also are being used to help develop additional sensing equipment, and to provide test and evaluation.

Heading the NMFS staff of six at MTF is William H. Stevenson, formerly assigned as Fishery Administrator in Washington, D.C. The program will employ 11 by the end of FY 1971.

When the National Weather Service's upper-air sounding station at Boothville, La., was damaged by the winds and water of hurricane Camille in 1969, NASA agreed to house the operation at MTF. NASA is currently providing ground tracking equipment, while the Weather Service provides personnel and expendables, such as balloons and radiosondes for the soundings. The unit is expected to return to the Boothville station shortly.

Intensive Study Underway in Caribbean Area

NOAA ocean scientists are participating in an intensive international study of the Caribbean Sea and the Gulf of Mexico known as CICAR (for Cooperative Investigation of the Caribbean and Adjacent Regions).

The program involves, in addition to the United States, the Soviet Union, Mexico, Cuba, Colombia, Venezuela, England, the Netherlands, and possibly other nations to join later. CICAR will study all phases of oceanography in the Caribbean and Gulf, including their currents and geology and their fishing and biological problems.

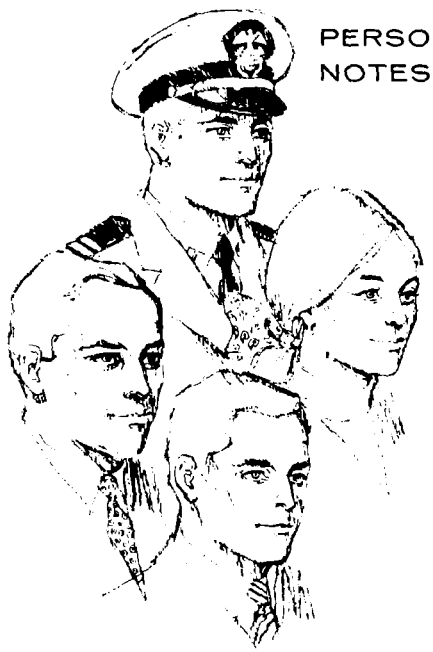
In September, the NOAA Ship DISCOVERER used her electronic sonar equipment to probe the bottom and subbottom of the Caribbean around Barbados to trace the extension of structural features found during previous studies. The one-week cruise was an attempt to gather evidence that would determine whether the Caribbean is tied into the South American landmass or is a separate crustal plate.

During another phase of CICAR carried out over a five-week period in October and November, 30 oceanographers from the Miami-based Atlantic Oceanographic and Meteorological Laboratories boarded the NOAA Ships DISCOVERER and PEIRCE to conduct a concentrated study of tides and currents in the Caribbean and Gulf, including the determination of their chemical properties and their distribution, their water temperature and salt content, and other marine aspects.

Also involved in CICAR is the National Oceanographic Data Center which sponsored the preparation of the first volume of CICAR Bibliography on Meteorology, Climatology, and Physical Chemical Oceanography. The volume, prepared by the American Meteorological Society, contains more than 3,000 references (2,000 with abstracts) on the title subjects in the Caribbean Sea, Gulf of Mexico, Greater and Lesser Antilles Regions, and the adjacent coastal areas of North Central and South America.

all in the family

PERSONNEL NOTES



W. Clyde Conner has been appointed meteorologist in charge of the Weather Service Forecast Office at New Orleans, La. Mr. Conner joined the Weather Service in 1942 at Washington, D.C. In 1943, he was assigned to a special military support project at Brownsville, Tex. He joined the New Orleans staff in 1946. Mr. Conner holds degrees from UCLA and the University of Chicago. He has been awarded Commerce Department Silver and Gold Medals for his outstanding work in coastal weather warnings and hurricane forecasting.

John S. Gottschalk, formerly Director of the Bureau of Sport Fisheries and Wildlife, Department of the Interior, has been appointed Senior Scientist and Assistant to the National Marine Fisheries Service Director, Philip M. Roedel. Mr. Gottschalk will assist the Director in defining and developing the role of the NMFS within NOAA.

Jeter A. Pruett has been named meteorologist in charge of the Fort Worth Weather Service Forecast Office. Mr. Pruett joined the Weather Service in 1946 at Fort Worth after serving in the Army during World War II. He was also assigned to weather facilities in Pittsburgh, Pa.; St. Louis, Mo.; Shreveport, La.; and Oklahoma City, Okla., before returning to Fort Worth.

Richard Maestas has been selected as technician in charge of the Weather Service's programs on the floating Arctic ice island, T-3. Mr. Maestas' most recent assignment was at Las Nicolas Island, Calif., where he was a specialist in upper-air soundings.

Lt. Cdr. Darrell W. Crawford has been named Executive Officer of the NOAA Ship DAVIDSON. Lt. Commander Crawford joined the Ocean Survey in 1961. He served prior to his current assignment as Operations Chief at the Mid-Continent Field Office in Kansas City, Mo.

Brantley B. Christian has been named to head the National Weather Service Office in Palm Beach, Fla. A weather observer for the Air Force from 1953 to 1957, Mr. Christian joined the Weather Service at Atlanta, Ga., in 1959. He also served at Jacksonville and Miami, Fla., and at Caribbean stations before reporting to Nashville, Tenn., his last station, in 1966.

Don H. Halligan, Chief of the Synoptic Climatology Branch of the EDS's National Climatic Center since 1965, has been named meteorologist in charge of the National Weather Service's Rapid City, South Dak., office.

John T. Murray has been named head of the Williamsport, Pa., Weather Service Office. Mr. Murray entered the Weather Service in 1941. In 1943, he joined the Air Force Air Weather Service. He returned to the civilian weather service in 1946 at Philipsburg, Pa. The station moved to Williamsport, Pa., two years later, and Mr. Murray was assigned there until his transfer to Harrisburg, Pa., his last station, where he was named official in charge.

Nelson C. Ross, Jr., has been appointed to head the National Oceanographic Data Center's West Coast Liaison Office. His chief mission in this newly created post is to facilitate NODC's data acquisition from West Coast laboratories. He will also assist the laboratories in making use of NODC's products.

George T. Gregg has been appointed meteorologist in charge of the Weather Service Forecast Office in Albuquerque, N. Mex. He had been the station's principal assistant since 1968. Mr. Gregg began his Weather Service career at Amarillo, Tex., in 1940 and has held assignments in Los Angeles and San Francisco, Calif., before moving to Albuquerque in 1946.

Edwin P. Weigel has been appointed Public Information Officer for the National Weather Service. A science reporter for the news magazine, *U.S. News and World Report*, from 1957 to 1969, he covered news of meteorology, oceanography, and space.

Cdr. George M. Poor is the new Projects Officer of the Ocean Survey's Atlantic Marine Center in Norfolk, Va. From 1966 until 1969, he was Projects Officer at the Pacific Marine Center in Seattle, Wash. Cdr. Poor, who joined the Ocean Survey in 1958, was formerly in charge of the Commissioned Officer Training Program at Norfolk, Va.

Lloyd G. Heavner has been appointed meteorologist in charge of the Weather Service Office in Billings, Mont. Mr. Heavner entered the Weather Service at Pendleton, Oreg., in 1960, after service in the Air Force Air Weather Service. He also served as MIC at Pocatello, Idaho, principal assistant at the Pendleton, Oreg., Weather Service station, and fire-weather forecaster at Billings, Mont.

Dr. Donald J. Williams, formerly of the NASA Goddard Space Flight Center, has been appointed Director of the Space Disturbances Laboratory at the Environmental Research Laboratories, Boulder, Colo. Dr. Williams graduated magna cum laude from Yale in 1955 with a bachelor of science degree in physics. In 1957 he was chosen as a Silliman-Sloan fellow. After receiving a master's degree in 1958, he held a Bell Telephone Laboratories Fellowship in 1959 and a National Science Foundation Fellowship in 1960. In 1962, he earned his Ph.D in nuclear physics from Yale. From 1961 to 1965, Dr. Williams was a senior staff physicist at Johns Hopkins University. He joined NASA in 1965.

Earl W. Estelle has been named Deputy Chief of the Analysis and Forecast Division at the Weather Service's National Meteorological Center in Suitland, Md. He was formerly assistant to the Weather Service's Associate Director for Meteorological Operations. Mr. Estelle joined the Weather Service in 1958 after serving in the Air Force.

Dr. Lester Machta, Director of the ERL's Air Resources Laboratory in Washington, received a Department of Commerce Special Achievement Award in August. The award cited Dr. Machta for his outstanding leadership and assistance to the Federal Aviation Administration on problems dealing with the Boeing 747 and Supersonic Transport programs.

Jack L. Hummel, former meteorologist in charge of the Williamsport, Pa., Weather Service Office, has been named to head the Syracuse, N.Y., WSO. Mr. Hummel joined the Weather Service in 1955 at Burlington, Vt., after graduating from Pennsylvania State University.

Capt. John B. Watkins has been appointed Director of the Ocean Survey's Honolulu office. Capt. Watkins has been commanding officer of the NOAA Ship FAIRWEATHER for about three years. Capt. Watkins joined the Ocean Survey in 1950 after graduating from the University of Arizona.

James G. George has been appointed meteorologist in charge of the Lakeland, Fla., Weather Service Office. Mr. George was principal assistant at the Lakeland station since 1960. He joined the Weather Service at Pittsburgh, Pa., in 1946 and later transferred to Puerto Rico. He moved to the Lakeland office in 1951.

Robert G. Fish, Jr., is the new chief of the Electronic Data Processing Branch at the Ocean Survey's Atlantic Marine Center in Norfolk, Va. Mr. Fish, a computer specialist, joined the National Ocean Survey three years ago.

Harold M. Gibson has been appointed meteorologist in charge of the Weather Service Office in Des Moines, Iowa. Mr. Gibson also served the Weather Service at Kansas City, Mo.; Salt Lake City, Utah; and Anchorage, Alaska. He holds a master's degree in meteorology from Pennsylvania State University.

Kelly F. Anderson has been named official in charge of the National Weather Service facility in Peoria, Ill. Mr. Anderson formerly served at LaCrosse, Wisc.; Rochester and International Falls, Minn.; Goodland, Kans.; and Duluth, Minn. During World War II, he served in the Air Force.

Morris R. Jones has been named chief of the Distribution Division in the Ocean Survey's Office of Aeronautical Charting and Cartography. A World War II veteran and 1947 graduate of South Dakota State University, Mr. Jones has been with the Geological Survey for 23 years, entering on duty as a topographic engineer and serving for the last 12 years as Distribution Officer. During parts of 1949, 1950, 1951 and 1957, he did archeological mapping in Central America for the Carnegie Institution and for the University of Pennsylvania Museum.

Robert E. Cardinal has been named official in charge of the Green Bay, Wisc., Weather Service Office. An Air Force veteran of World War II, Mr. Cardinal also served the Weather Service at Duluth, Minn.; St. Joseph, Mo.; Sault Ste. Marie, Mich.; and Klamath Falls, Oreg.

A. Glenn Jean has been named Deputy Director of the Space Disturbances Laboratory of the Environmental Research Laboratories in Boulder, Colo. Mr. Jean has served as the laboratory's acting director since December 1968. A graduate of Vanderbilt University, Mr. Jean served in the Army during World War II and taught at Vanderbilt until he joined the Commerce Department in 1948. He received a Department of Commerce Silver Medal Award for meritorious service in 1959.

Richard H. Hagemeyer has been named chief of the National Weather Service's Resources Management Staff, a new position created to provide staff assistance to the NWS Director. Mr. Hagemeyer joined the Weather Service in 1950 in Washington. He then served for six years at various stations in the Pacific before returning to Washington. Mr. Hagemeyer holds a degree from George Washington University.

Stuart G. Bigler New Director Of NWS in Alaska

Stuart G. Bigler has been named director of the National Weather Service's Alaska Region. In his new job at the Region's Anchorage headquarters, he supervises the activities of 29 Weather Service stations scattered throughout the state.

For the past 11 years, Mr. Bigler has been in the Data Acquisition Division of the Weather Service's headquarters. His last post was as chief of the sounding systems branch.

Mr. Bigler has had 25 years' experience in meteorology. He served in the Navy as a weather observer from 1945 to 1948 serving on the islands of Peleliu and Guam, aboard three weather ships, and on the aircraft carrier BAIROKO. He took part in the atomic bomb testing at Eniwetok in June 1948.

Mr. Bigler holds a bachelor's degree in meteorology from Pennsylvania State College, and a master's degree in meteorology and physics from Texas A&M College. He taught meteorology for several years at Texas A&M before beginning his weather service career in 1959.

An internationally recognized authority on radar meteorology, Mr. Bigler has played a leading role in the development and management of the Weather Service's radar network.

NMFS Scientists Scout Resources With German Ship

Two National Marine Fisheries Service scientists recently participated in an exploratory fishing cruise conducted by the West German research vessel WALTER HERWIG off the Atlantic Coast. Scouting for commercially exploitable herring stocks on Georges Bank was the first priority. The results were radioed to a German mothership for relay to other West German trawlers on the Bank. In the Gulf of Maine, the WALTER HERWIG took herring samples for biological research. The West German Fisheries Research Board is in the process of evaluating biological, hydrographical, freezing, and salting tests made during this cruise. The results will be shared with the United States. During future cruises, the West German Board plans to explore the effects of nutrients on herring stocks in waters off the East Coast of the United States through plankton catches.

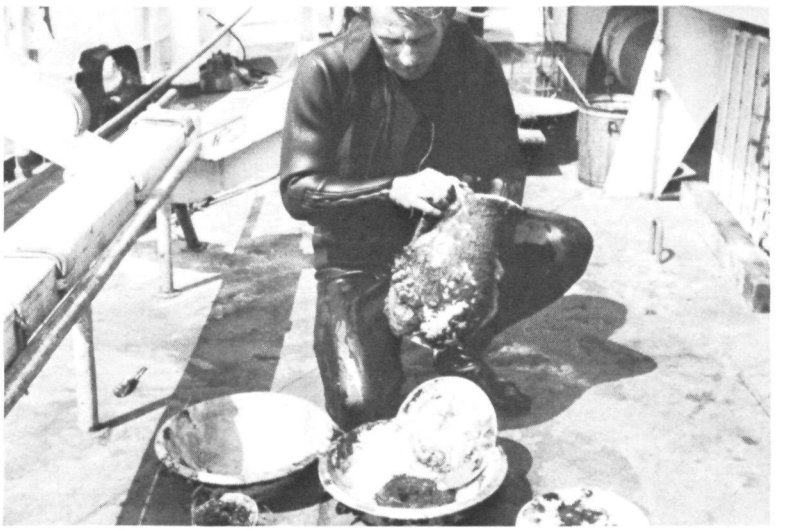
Delaware Bay Survey Turns Up Wreck's Cargo

The unmarked wreck of a 19th century ship, possibly a British cargo vessel, has been discovered in Delaware Bay between Lewes, Del., and Cape May, N.J.

The wreck was found by the NOAA Ships RUDE and HECK, while dragging the bay for submerged navigational hazards.

Lt. Cdr. Merritt N. Walter, of Martin, Mich., commanding officer of the two wire drag vessels, said the wreck lay in 39 feet of water, about 15 miles from Lewes, 7½ miles south of Cape May and 12 miles east-northeast of Cape Henlopen, Del.

Scuba divers aboard the wire drag ships found nothing remaining of the wreck's superstructure. Portions of the hull protruded from the bottom, and more was apparently imbedded in the mud. Walter said he found the wreck laid open on the bottom with part of its cargo, consisting of thousands of pieces of neatly packed British-made chinaware, exposed. The remainder of the cargo was imbedded in the bottom and covered with coral and silt.



On the basis of an examination of the chinaware by Jefferson Miller, curator of ceramic history at the Smithsonian Institution's National Museum of History and Technology, it was concluded that the wreck postdated 1876.

The wreck's anchor was also hoisted to the surface. Of woodstock type, it weighed around 3500 pounds and measured approximately six feet across the flukes and eight feet along the shank. Walter said the size and weight of the anchor made it clear that the wreck was that of a seagoing vessel.

The Coast Guard was notified of the wreck's location, which will appear later on a nautical chart to warn ships of the underwater hazard.

Weather Service Honors Volunteer Observers For Long and Outstanding Service to Nation

Thirty volunteer weather observers across the nation won the 1970 Thomas Jefferson and John Campanius Holm Awards, given by the National Weather Service for excellence and cooperation in recording the widely divergent weather conditions of the United States.

The recipients were selected from over 12,000 volunteer weather observers who make and record daily observations throughout the U.S. This information is processed and published by the Environmental Data Service, and is a valuable contribution to climatic study.

Five observers received Thomas Jefferson Awards for unusual and outstanding accomplishment in the field of meteorological observations. This award is named in honor of Jefferson because the statesman-scientist took an almost unbroken series of weather observations from 1776 to 1816.

The volunteer weather observers honored with Thomas Jefferson Awards for 1970 were:

Howard R. Allard of Willows, Calif., where weather observing has been an Allard family project for more than 44 years;

Gilman W. Ford of West Burke, Vermont, who has maintained an outstanding chronicle of the weather in the Caledonia County area since 1930, including 40 icy winters of that rugged region of Vermont;

Douglas F. Manning of Alexandria Bay, New York, who traveled a considerable distance daily even in the most severe weather to make the weather and rainfall observations at Alexandria Bay since 1932;

Charlie McCornack, Jr., of Cloud Chief, Oklahoma, who has served as volunteer weather observer for 34 years, continuing a record of the sometimes-extreme climate begun by his father-in-law in the same location in 1907;

Walter Ormsby of Sabino Canyon, Arizona, a physical science teacher, who has been a Weather Service volunteer observer in the Pima County community since 1941;

The John Campanius Holm Award for continued excellence commemorates the first known systematic weather observer in the American colonies. In 1644 and 1645, the Reverend Holm made records of the climate, without the use of instruments, near the present site of Wilmington, Delaware.

Volunteer weather observers receiving the 1970 John Campanius Holm Awards are:

Jerome Akin, Farmington, Minn.; William H. Alison, Catheys Valley, Calif.; Leslie J. Anderson, Manti, Utah; W. P. Cater, Cerro, New Mexico; Parker N. Chick, Walpole, Mass.; Stanley W. Coon, Duncan, Ariz.; Harold Del Ponte, Klamath, Calif.; Merton T. Goodrich, Keene, N.H.; Mrs. Mary F. Harker, Heron, Mont.; Dr. Walter S. Hough, Winchester, Va.; John Koepl, Nez Perce, Idaho; Gust Lofgren, Homer, Alaska; Oscar C. Lofgren, Wallin, Iowa; William Marsteller, Uniontown, Pa.; Frank Mascari, Sr., Ironton, Ohio; Ross R. McKenna, Kaycee, Wyo.; Nello Moroni, Advance, Mo.; Mrs. Gertrude Peters, Jiggs, Nev.; Charles A. Roberts, Kent City, Mich.; Mrs. Vieva E. Saltmarsh, Buncom, Oreg.; Daniel Smiley, Mohonk Lake, N.Y.; Paul C. Sorenson, Rockport, Tex.; Gust Steinmann, Ashton, Idaho; John Swaine, Jr., Royal Oak, Md.; Oscar T. Yoder, Phillips, Wyo.

US, USSR and Canada In Joint Herring Study

The United States, the Soviet Union, and Canada are cooperating in a study along the North Atlantic Coast which fishery scientists hope will lead eventually to accurate spawning estimates for the herring of Georges Bank, a world famous fishing area.

The National Marine Fisheries Service research vessel ALBATROSS IV, the Soviet vessel KVANT and a Canadian two-man submarine weighing seven tons are participating in the research.

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