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OCTOBER 1972

NOAA

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

In this issue:

Report From Stockholm

An Environmental Game

Disarming the Thunderstorm

VOLUME 2
NUMBER 4

National Oceanic and Atmospheric Administration

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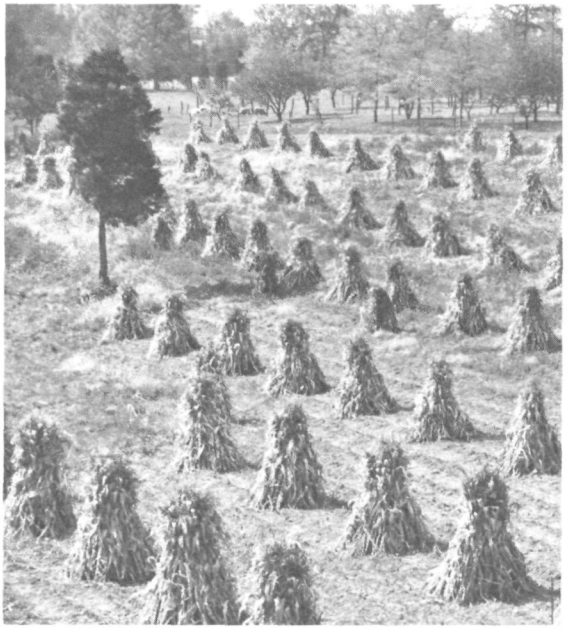

COVER
Autumn, and harvest time, come again.

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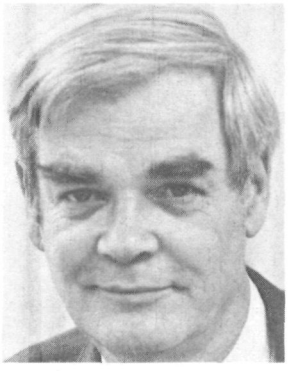
ENDEXING THE ENVIRONMENT



THOMAS S. AUSTIN
DIRECTOR, ENVIRONMENTAL DATA SERVICE

"...index-learning turns no student pale, yet holds the eel of science by the tail."

—ALEXANDER POPE

Though Mr. Pope's words may seem quaint, his point is infinitely more valid today than when he penned it; "index-learning" is still the key to organizing scientific intelligence. For in science, as in all other areas of human knowledge, it is not necessarily what you know, but rather whether you know where you can find out.

Recognizing this truism, the recent 114-nation UN Conference on the Human Environment held in Stockholm urged the "establishment of an international Referral Service for efficient . . . exchange of information on environmental problems and solutions. . . ." The Referral Service would make it possible for the world's developing nations, among others, to find out what data and information are already available, where they are located, and how to gain access to them. It would save them from wasting precious time and resources collecting environmental intelligence already available.

The need for environmental referral services is no less crucial at the national regional, or local level. Consider, for example, the many cooperative coastal zone studies now being contemplated; the various Federal, State, local, and private organizations involved cannot intelligently plan their projects without a thorough knowledge of pertinent available data and information. And certainly they will not want to duplicate existing data files through their own collection efforts.

To meet such user needs, NOAA's Environmental Data Service has, since 1969, been building the Environmental Data Index or "ENDEX." When fully operational (target date, 1978), ENDEX will provide convenient, rapid referral to existing NOAA, national, and global environmental science data files and sources, as well as documentation concerning their quality, quantity, and character. A complementary, literature-based system, OASIS (Oceanic and Atmospheric Scientific Information System), will provide a parallel subject-author-abstract referral service. A telephone call to an EDS specialist at any EDS data or information center will allow a user to "plug into" this interdisciplinary NOAA data dialog machine.

Since EDS data holdings contain only a portion of the total body of data and information necessary to develop ENDEX, EDS will seek out and document collections scattered nationally and internationally; obtain available inventory and reference materials; and integrate these into the ENDEX system. The approach will be a step at a time, beginning with collections easily accessible and particularly pertinent to the solution of contemporary national and international environmental problems.

By 1978, ENDEX will provide us with a firm grip on the eel of environmental science.

REPORT FROM STOCKHOLM

BY ROBERT M. WHITE

Representatives from 113 nations convened in Stockholm last June for the United Nations Conference on the Human Environment. It was an historic event which provided a focus for world attention on environmental problems.

An ambitious agenda which had occasioned many months of preparation by every nation involved was addressed. Debate among delegates was spirited because of the widely varying ideas on how to achieve the common purpose symbolized by the conference insignia, a man in a circle surrounded by olive leaves, with the legend: "Only One Earth."

What emerged? What are the implications for our organization?

The Conference did what it set out to do. It was a singular success. Entirely apart from the individual actions taken there, President Nixon has said: "I believe that the deepest significance of the Conference lies in the fact that for the first time in history, the nations of the world sat down together to seek better understanding of each other's environmental problems and to explore opportunities for positive action, individually and collectively."

And the specifics are impressive:

—A Declaration on the Human Environment was negotiated which, for the first time, sets forth the rights and obligations of nations on environmental matters.

—More than 100 recommendations addressing the widest spectrum of problems of the human environment were adopted.

—An action plan to guide their implementation was agreed.

—A UN organizational mechanism to coordinate and support international efforts in carrying out the plan and an International Environmental Fund to provide the necessary financing were created.

The Declaration represents the first international political consensus on ways of preserving and improving man's habitat. The action plan contains the concept of a global Earthwatch to monitor and assess the atmosphere, oceans, land, and human health, along with programs for environmental management. Institutional arrangements, divided until now among a multitude of specialized bodies, will provide for unified coordination within the UN system.

The Conference carried major implications for NOAA's activities in the oceans, atmosphere, and solid earth. It encouraged new international efforts, in which we will participate, and endorsed many existing ones.

In the preparatory phases of the Conference, at the request of the State Department, NOAA organized the efforts of all Federal agencies in the formulation of the U.S. propoasls for a global environmental monitoring program. Seventeen governmental and other organizations were involved in preparation of the U.S. basic paper on Monitoring of the Global Environment, which called for monitoring of the oceans, atmosphere, solid earth, and human health, for prediction of disasters and of the effects of pollution on the environment. This paper was influential in the inclusion in the UN action plan of the "Earthwatch" concept, of which more will follow. In conjunction with other Federal agencies, NOAA was

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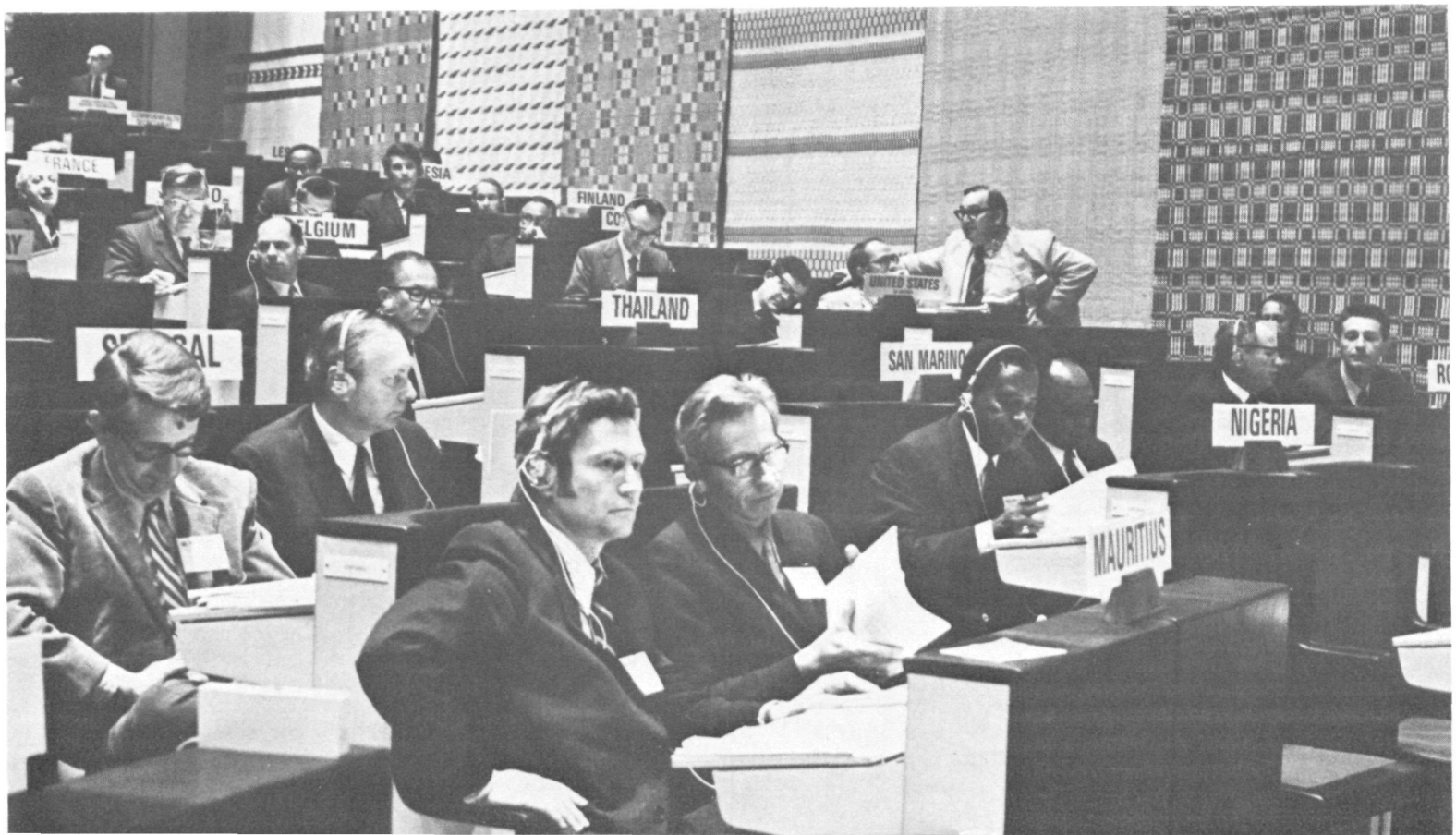
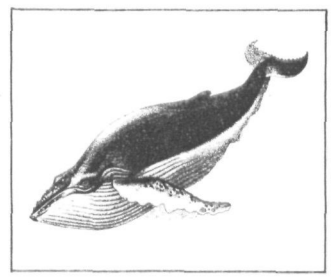
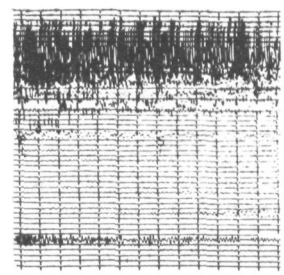
Dr. White, NOAA Administrator, was a U.S. representative to the Stockholm Conference.



also asked to prepare the basic U.S. positions on many of the elements of Earthwatch and on the whaling and other fisheries issues. These led to a resolution which called for the International Whaling Commission to consider a moratorium on all commercial whaling and support for greatly strengthening the IWC. The series of recommendations on fisheries calls for cooperation and coordination among UN specialized agencies, development agencies, regional and international fishery organizations, international cooperative programs, and governments.

The U.S. delegation was led by Russell Train, Chairman, Council on Environmental Quality, with Christian A. Herter, Jr., Special Assistant to the Secretary of State for Environmental Matters, as Vice-Chairman. Its membership encompassed a broad cross-section of national leaders in various fields. Conservationists, scientists, Congressmen, Senators, industrialists, and government leaders brought a wide range of experience and competence to the effort. The vast range of topics and items covered are symbolized by the many that NOAA is involved in, and even these are but a small sample.





With the recent typhoon disasters in Bangladesh and the Philippines, and earthquake disasters in Turkey, Iran, and South America fresh in memory, the Conference, in its discussions of environmental aspects of human settlements, adopted far-reaching recommendations on global disaster, warning, and prediction systems.

Some elements of such a system already exist and NOAA plays a key role in them. The World Weather Watch, for example, is the world system for observing, processing, and communicating weather data to serve the needs of all nations in warning of weather disasters. It is coordinated by the UN's World Meteorological Organization. NOAA plays a major role in this program through its Environmental Satellite Service which provides satellite weather data; through its World Meteorological Center which provides global weather analyses and forecasts; and through the operation of major elements of the global telecommunications network.

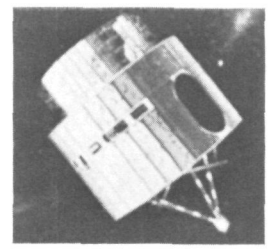
We also provide assistance to developing nations so they can participate in and benefit from the World Weather Watch. Using funds provided by the Department of State, NOAA administers U.S. participation in the WMO's Voluntary Assistance Program, which provides such financial assistance.

NOAA provides the U.S. participation in the International Tsunami Warning System in the Pacific. This disaster warning system is coordinated by the Intergovernmental Oceanographic Commission of UNESCO. Our warning center in Hawaii is responsible for the dissemination of tsunami warning to all nations, based on an international network of seismic and tide stations throughout the Pacific Basin.

NOAA, in cooperation with the National Science Foundation, also operates the World-Wide Standardized Seismic Network—120 stations in 60 nations. It provides information vital to earthquake hazard reduction. In addition, the data are used extensively by NOAA for engineering seismology and earthquake prediction studies, and by universities and industry for various purposes.

The recommendations of Stockholm call for a much improved disaster warning system. They give further substance and cogency to the programs in which we are now engaged.

A series of recommendations on fisheries and wildlife were issued by the Conference in connection with the environmental aspects of natural resource management. It called for national governments and international agencies to:

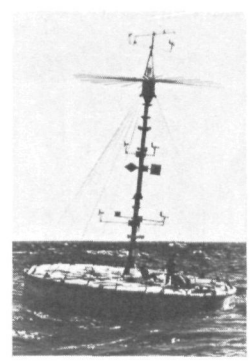


—Increase efforts in the monitoring, assessment, and management of living marine resources.

—Strengthen the international machinery for developing and managing fisheries, and to

—Cooperate internationally to prevent natural resource use by one country from harming fisheries beyond its jurisdiction.

The National Marine Fisheries Service has initiated the Marine Resources Monitoring, Assessment, and Prediction Program which focuses on the distribution and population of fisheries stocks of interest to U.S. fisheries in order to determine the maximum sustainable yield for proper management policies.



International cooperation in assessing and managing living marine resources that range beyond the jurisdiction of any one country is mandatory to enable sound management. NOAA, for example, represents U.S. interests on 13 international fisheries commissions. Agreements reached at Stockholm reflect a consensus to improve the effectiveness of these bodies.

NOAA is involved in studies to increase understanding of the marine environment and its biota and to provide for better management of living marine resources. The Marine Ecosystem Analysis Program is concerned with the structure and dynamics of selected ecosystems, such as the New York Bight area and Puget Sound, including studies of pathways and ultimate fate of pollutants in the coastal zone.

The Conference also expressed its concern over the plight of the world's whale population by calling upon the International Whaling Commission to consider a ten-year moratorium on all commercial whaling, increased whale research, and a strengthening of the Commission, which attempts to manage the exploitation of these unique creatures. The whale issue, which received global publicity, came to symbolize the environmental concern of the conference in the mind of the public.

The United States has banned the taking of all whales by its nationals and took the position that a 10-year moratorium was required to allow overfished stocks to recover. The U.S. took the lead at Stockholm in proposing such a moratorium. This recommendation was referred for consideration to the International Whaling Commission which met in London shortly after Stockholm.

The Whaling Commission, however, did not agree to a complete moratorium beyond the five species it now terms seriously depleted—the gray, right, humpback, blue, and bowhead whales, and for which a complete ban exists among IWC members. Existing commercial catch quotas were reduced for the sei and Bryde, finback, and sperm whales, and quotas were established for the first time in the Antarctic for the sperm and minke whales.

continued

Shirley Temple Black (above) and Russell E. Train, Christian A. Herter, Jr., Dr. Robert M. White, and Senator Harrison A. Williams, Jr., during deliberations of the United Nations Conference on the Human Environment.

The United States had particularly hoped to extend the current moratorium to cover the finback whale. The present population of this species is estimated at less than 100,000 individuals—about 80,000 in the Antarctic and 15,000 in the North Pacific. This is less than one-half of what scientists estimate is the total maximum sustainable yield for the finback whale which is 245,000 individuals—220,000 in the Antarctic and 25,000 in the North Pacific. Although we were unsuccessful in including the finback in the moratorium, the annual quota was reduced by 34 percent in the Antarctic and 38 percent in the North Pacific. Furthermore, the two major whaling nations—Japan and the Soviet Union—agreed to reduce the quotas substantially over the next two years.

The IWC also agreed to the necessity of strengthening its activities and appointed a committee to examine such steps as creating a permanent secretariat, establishing a scientific staff, and securing additional funding. Steps were also taken to update the cumbersome convention and schedule under which it operates.

At the core of much of the international concern about the environment is the problem of the identification and control of pollutants of broad international significance. Much was accomplished. The conference endorsed early completion of a convention to control ocean dumping of waste materials. It recommended appropriate pollution monitoring systems for ocean and atmosphere, and a host of other measures.

For NOAA's programs directed at ocean and atmosphere, the recommendations of the conference were of great importance. The Conference, recognizing the need for data to assess the trends in global and regional atmospheric pollution, proposed the establishment of a network of at least ten baseline stations remote from pollution sources, and more than 100 regional stations to determine the nature and extent of atmospheric pollution and long-term effects on the climate. The World Meteorological Organization has formulated plans for these stations as part of the World Weather Watch.

NOAA research scientists and meteorologists in its Air Resources Laboratories are now beginning to implement the U.S. part of this program. The global baseline monitoring effort will be patterned after NOAA's original Mauna Loa Observatory, in operation on the island of Hawaii since 1956. This observatory is located at 11,200 feet on Mauna Loa. This is to be the anchor of a set of our U.S. NOAA-operated observatories extending between North and South Poles. Atmospheric properties measured include carbon dioxide, fine particles, other trace materials in relatively clean air, and solar radiation attenuation. Among the sites either being established or in the planning stages are Pt. Barrow, Alaska; South Pole, Antarctica; a southwestern Pacific location, probably at American Samoa; and possibly a South American location on the Pacific coast. Other nations will establish the other monitoring stations to complete the global network.

The importance of these baseline monitoring stations is illustrated by the findings of the past at Mauna Loa Observatory. Here, scientists from Scripps Institution of Oceanography and NOAA pinpointed the creeping rise of carbon dioxide in our atmosphere. These carbon dioxide measurements have been taken continuously at Mauna Loa Observatory since the International Geophysical Year (1957-1958). The observatory's data show average yearly carbon dioxide increases of 0.7 parts per million.

To carry out the U.S. part of the regional air pollution monitoring program NOAA, in collaboration with the Environmental Protection Agency, has established ten long-term regional monitoring stations for the measurement of atmospheric turbidity, precipitation chemistry and other parameters. These stations are located at National Weather Service offices around the conterminous United States. As with the global baseline monitoring network, other nations, such as the USSR, Canada, and Sweden, have or plan to establish regional monitoring stations as part of a global network coordinated through the World Meteorological Organization.

Critical to the assessment of the consequences of various types and levels of pollutants on global weather and climate is the capability to stimulate atmospheric reactions to pollutant levels with mathematical models of atmospheric and oceanic processes. As part of the Global Atmospheric Research Program, NOAA's Geophysical Fluid Dynamics Laboratory at Princeton, N.J., has been in the forefront of this work and will soon accelerate its activities with the installation of a fifth-generation computer.

A central theme sounded at Stockholm was the concern about the pollution of the world's oceans. A wide variety of steps have been recommended to deal with the problem. Critical to this effort will be the agreement on an ocean dumping convention. A significant achievement of the Conference was to call for a conference of governments to be convened by the United Kingdom before November of this year to consummate such an agreement. The U.S. will press forward with the intention of having an acceptable international convention to control ocean dumping ready for signature by the end of this year.

Equally vital to the ultimate control of ocean pollution is the need to establish an international system for assessing the state of the ocean pollution and monitoring its changes. Not only do we need to know the extent and level of ocean pollution, but we also must know how the pollution gets there—from what sources, and through what pathways. Such fundamental information is lacking and in its absence deciding how to control such pollution is difficult. Stockholm recognized these needs and called for a set of actions that will provide the necessary data. The aspects of the conference action on ocean pollution matters that will have the greatest impact on NOAA are those which apply to our ocean monitoring efforts. The Conference singled out the Intergovernmental Oceanographic Commission (IOC) of UNESCO as the UN body to coordinate international efforts in assessing the impact of pollution in the marine environment within the framework of the Integrated Global Ocean Station System in which NOAA plays a key role.

NOAA's ocean monitoring efforts that will contribute to this effort are extensive. The Associate Administrator for Environmental Monitoring and Prediction, Dr. Richard Hallgren, has been asked to formulate a broadly based program for NOAA's full participation in the U.S. part of this ocean monitoring effort. Almost all segments of NOAA are now or will soon be involved; our National Ocean Survey, through its National Data Buoy Center and the NOAA fleet; the National Marine Fisheries Service through its MARMAP and Fish Contamination Program; the National Weather Service through its extensive ocean-related observing facilities; the National Environmental Satellite Service through the use of satellite remote sensing; our Research Laboratories through their work in understanding ocean and atmospheric processes and in developing environmental sensors; and our Environmental Data Service through its Data Centers and its responsibilities for archiving and retrieving environmental data. I have asked the National Academies of Science and Engineering to assist in the formulation of the ocean monitoring effort and initial work has begun.

The Earthwatch concept adopted at Stockholm as the framework for action in global environmental monitoring and assessment is not new to NOAAites, for it is very similar to the basic concepts within which our organization has been working since its formation. It addresses the effects of man's pollution on the environment and the effects of the environment on man, including major natural disasters. It is a total environmental concept. It is a concept that requires the bringing together of nations of the world in a truly global endeavor. It is a concept that calls for the application of our new global technological capabilities stemming from the use of satellites, aircraft, buoys, ships, and computers, backed by a scientific research and assessment program to guide and lead the effort. Just such a concept was set forth in the 1969 Stratton Commission report, "Our Nation and the Sea," which gave rise to NOAA. That report called for a National Environmental Monitoring and Prediction System to be carried out in conjunction with other nations. NOAA heartily welcomes the Earthwatch concept; it gives further strength to our prime objectives.

The Stockholm Conference gave perspective and life to other key global environmental needs. One of these was the growing need for an international system for the exchange of data and information. The Conference called for the establishment of an International Referral Service which could lead to the organization of an efficient exchange of information on environmental problems. Many environmental information and data services exist today. What is required is their linking into a network which can be responsive to the needs of nations for environmental information of all kinds.

The United States has taken an active role in data and information management. NOAA, through its Environmental Data Service, provides archiving, processing, and exchange services that parallel a number of the recommendations endorsed by the Conference. NOAA not only operates national centers for data and information on atmospheric, oceanic, and geophysical processes but also takes the lead for the United States in promoting the international exchange of many kinds of environmental data and information. NOAA's Environmental Data Service operates five World Data Centers covering 13 disciplines including oceanography, meteorology, and earth and space sciences. Just how NOAA's environmental data activities will assist in providing the kind of information referral services proposed in Stockholm is not fully defined at this time, but the implications could be substantial.

One of the important achievements of Stockholm was recognizing the need to build new global environmental institutions using the existing capabilities of the UN specialized agencies to the fullest. To coordinate and integrate the myriad environmental activities of agencies such as the WMO, FAO, and UNESCO, the conference recommended unanimously the creation in the UN of a permanent high-level environmental unit. To provide the new unit and its Executive Director with intergovernmental policy advice, a 54-nation intergovernmental commission was proposed. In addition, an Environmental Fund expected to be funded at $100 million over the first five years was established.

President Nixon first proposed the concept of a voluntary fund for the environment and pledged a U.S. contribution of up to $40 million on a matching basis. In the President's words: "This fund should help to stimulate international cooperation on environmental problems by supporting a centralized coordination point for UN activities in this field. It would also help to bring new resources to bear on the increasing number of worldwide problems through activities such as monitoring the cleanup of the oceans and atmosphere." The Environmental Fund will finance new initiatives from the Conference and will assure that the developing countries are able to participate fully in international environmental programs.

Many of us had gone to Stockholm anticipating the possibility of deeply divergent convictions. There were some, especially where environmental issues touched sensitive political views. But the conference was most noteworthy not for the differences revealed, but for the willingness of nations with widely different interests to recognize compelling environmental needs and work toward common goals. Stockholm set the stage for effective international and national action to save and improve our environment. The task, however, does not end with Stockholm—it has only begun.

We in NOAA have an important role to play. I want to see us play it vigorously. And I am confident that we shall. □

All living marine resources in waters off the United States will be evaluated in a long-term Fisheries Service program.

MARMAP-CENSUS OF THE SEA

BY ANN WEEKS

How many kinds of living marine resources are available to us? In what quantity? Where?

How much of the American diet can marine populations satisfy, now and tomorrow?

How can we protect these resources, yet increase their availability to consumers?

How can we help the fishing industry achieve peak efficiency?

How can we help assure fair distribution of food from the sea, to ourselves and other nations?

Answers to these and other questions of major importance to the nation will be sought in a new NOAA program called MARMAP—Marine Resources Monitoring, Assessment and Prediction. An integrated ocean survey of a size and scope never before atttempted, it seeks to evaluate all living marine resources off United States waters.

The giant survey went into action in July, under the direction of the National Marine Fisheries Service, with a series of Atlantic Ocean research cruises.

Starting dates for the six initial MARMAP cruises are scheduled seasonally between July 1972 and February 1973, setting forth from NMFS fisheries centers at Woods Hole, Mass., Sandy Hook, N.J., and Miami Florida. Participants aboard the NOAA fleet vessels ALBATROSS IV, DELAWARE II, and OREGON II consist of dozens of marine scientists and technicians who will travel 19,000 miles from Maine to the northern Caribbean Sea. Their mission? To explore in the most extensive detail in history samples of the countless fish eggs and larvae (ichthyoplankton) strewn through the seas in profusion—mostly to nourish other life forms, a few to survive and renew seed stocks for future generations.

The field coordinator of the cruises is Kenneth Sherman of the NMFS MARMAP Field Office at Narragansett, Rhode Island. Overall coordination comes from the NMFS Office of Resource Research under the direction of Dr. William F. Royce. Dr. J. Frank Hebard is the Acting National MARMAP program manager, awaiting the arrival of the new manager, Howard Schuck.

Progressively wider ocean areas will be examined and more complex research techniques explored during additional preparatory cruises planned for 1973, 1974, and 1975. NOAA's timetable calls for the evolution of MARMAP in the ensuing three years into one of the new realities in the nation's continually expanding program of scientific monitoring of earth's environment from outer space to the deep sea canyons.

Who will be the beneficiaries of the program? Innumerable U.S. citizens ranging from topmost government and industrial planners to Saturday anglers and freshman students, say MARMAP managers. They believe the wide spectrum of information produced will be used by an equally wide clientele. Users are expected to include national and international resource manage-

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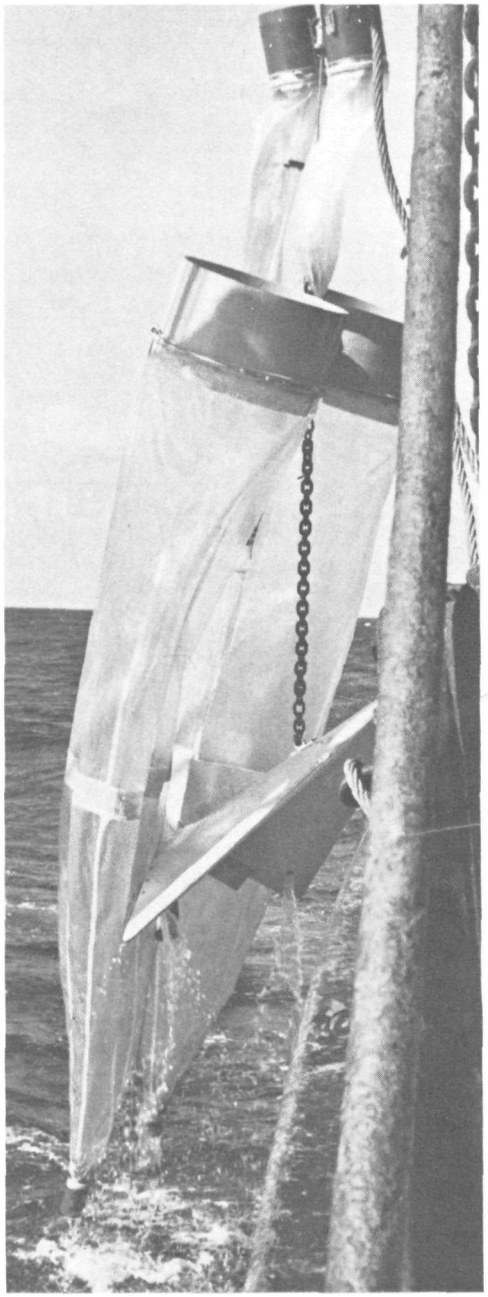
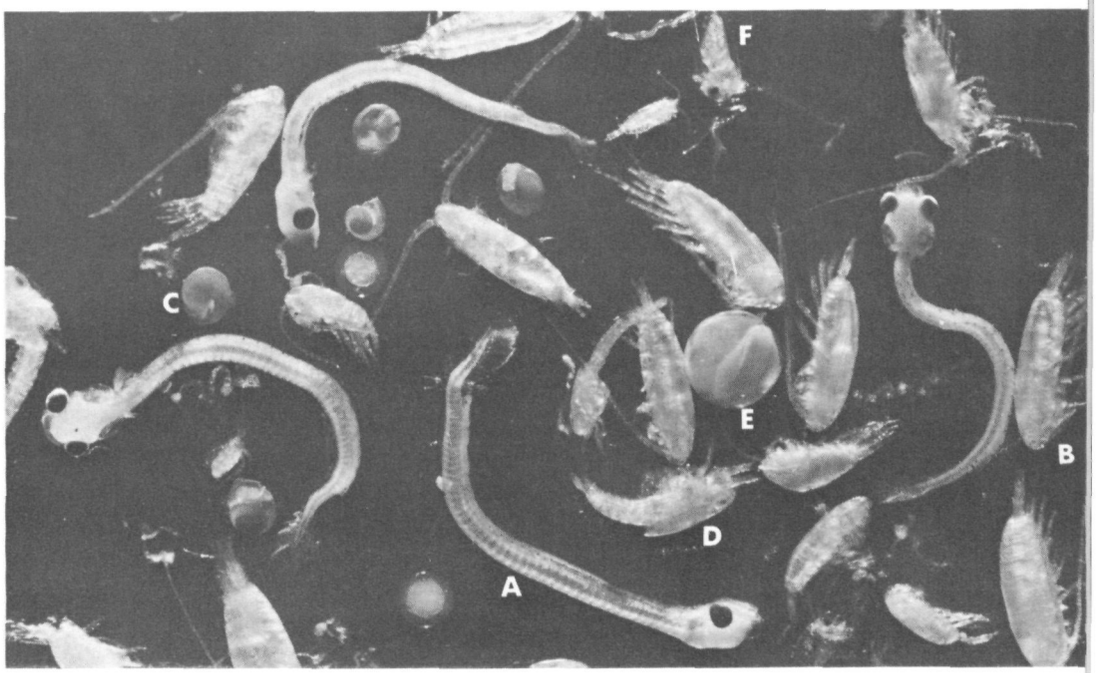
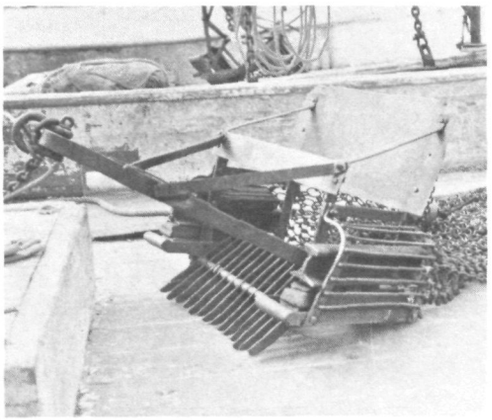
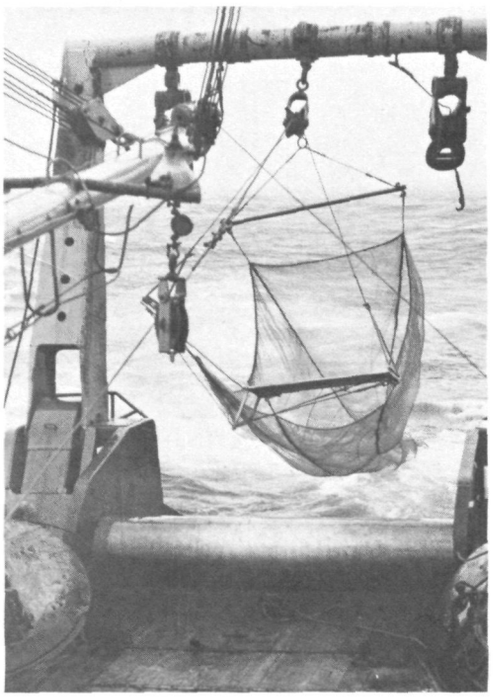


(Left) Bongo nets are efficient collectors of plankton at varying depths. (Above) After the bongo nets are retrieved, captured plankton is transferred from nets into laboratory collections. (Below) A typical collection of plankton, when magnified, reveals (A) fish larvae, (B) copepods, (C and E) fish eggs, (D and F) crustacean larvae.







In studying marine populations, the Marine Resources Monitoring, Assessment and Prediction surveys will use otter trawls (above) for sampling bottom-dwelling fish, bottom dredges (top right) for sampling marine life on or under the seafloor, and Isaacs-Kidd midwater trawls (right) for sampling fish at depths from 200 to 2000 meters, collecting many varieties of commercial and sport fish (below).

ment and conservation agencies, environmental planners, the fishing fleet, the fishing industry, sport fishermen and related businesses, and the scientific community. Eventually NOAA envisions a public-service system that disperses a regular and timely flow of marine biological and environmental information on a variety of subjects, based on MARMAP-acquired data. The service should make a significant contribution to users' long- and short-term plans of action for their business and professional lives.

Plans for MARMAP were in their formative stages when the 1970 Presidential reorganization of civilian oceanographic agencies established NOAA as a component of the Commerce Department and simultaneously expanded the responsibilities of NOAA's National Marine Fisheries Service in research directed toward the marine environment.

Because of environmental ills brought into sharp relief in the 1960's, a new approach was plainly required, to detect and solve a wide array of national problems. Marine problem areas included fisheries, both commercial and sport; pollutants as they affected food from the sea; the "property rights" of the United States in waters fished by its citizens; ecological degradation of the seas; and unpredictable fluctuations in marine stocks of economic value to this nation. In short, the national need for a far better understanding of the entire marine ecological system in all its ramifications had advanced to a "red-alert" status.

More than two years went into the preliminary planning, or "workshop" phase of MARMAP, extending from 1970—when NMFS was still the Bureau of Commercial Fisheries and under the banner of the Interior Department—until early 1972 when a blueprint was finished. Heavily involved in early planning stages was a blue-ribbon panel of marine experts from NMFS, including Harvey R. Bullis, Jr., Dr. Robert L. Edwards, Dr. Felix Favorite, Dr. Frank Hester, Dr. Robert P. Kifer, Dr. J. Lockwood Chamberlin, Walter Nelson, Kenneth Sherman, and Dr. Robert Stevenson, all scientists with NMFS. The TRW Systems group of Californa prepared the systems engineering plan under a NOAA contract.

The MARMAP concept is simple and clearcut: to create from past and future research an archive on marine resources in coastal and offshore waters of the United States, whose data has been weighed and measured against a common standard; and to convert that data into forms that can be quickly supplied to, and easily understood by, those who need such information. Translation of that concept into reality, however, is another matter, inasmuch as the master plan must take into account the yesterday, the today, and the tomorrow of marine reearch.

Volume upon volume of scientific information collected since the days of Linnaeus, the H.M.S. CHALLENGER expeditions, and Fridtjof Nansen must be re-

assessed and integrated into today's context and needs. Oceanic explorations confined to specific regions or limited in subject matter (and there have been many over the past two or three decades) must be reexamined for their relevance to the broad concept of MARMAP. Numerous biological and oceanographic findings by individuals or organizations must be considered in terms of their potential contribution to baseline information. And once all this is done, the results must be organized and standardized, then converted into selected forms to answer today's needs.

Concurrently, because time is of the essence in efforts to maintain the status quo or correct imbalances in ocean populations, new and traditional research approaches, methods, and devices must be put to the test. Can they deliver the data needed quickly, correctly, and with maximum efficiency? Are they adaptable to different climates, regions, and sea states? Can they be widely used aboard ships of various sizes? What are the best methods of delivering data to computers for rapid and accurate output? These are but some of the questions that can be answered only in field trials. MARMAP managers, therefore, designated the second phase of the operation as the 1972 to 1975 preoperational period or "dress rehearsal."

Vessel procedures finally delineated for the preparatory cruises are unprecedented in scope and magnitude, consisting of biological and physical environmental studies pursued concurrently within a single framework. The cruise program addresses itself to three broad subjects in different seasons of the year on the Continental Shelf and in oceanic areas of high biological production. Cruises will be concentrated largely in areas that have already yielded considerable data related to their biology and environment, but in which the interaction of resources and environment is not clearly understood. Sites of study will proceed from the length of the Atlantic Coast, to the Gulf of Mexico, then to the northeast sub-Arctic, finally to encompass the northeast and eastern Pacific.

Subjects of study flow into one another as work intensifies, from (1) distribution patterns of eggs and young stages of marine species which are most sensitive to environmental changes to (2) populations of bottom-dwelling fish (cod, flounders, etc.) and shellfish (scallops, crabs, shrimp, etc.) to (3) species living in the upper water layers (tunas, herrings, billfish, etc.).

Samples of marine populations are being collected by the hundreds of thousands for both on-site and laboratory analyses of the biological and environmental factors controlling distribution and abundance; collecting and sorting devices range from traditional plankton nets to newer-than-yesterday automated plankton-sorting machines that free scientific personnel from tedious, time-consuming chores; and remote-sensing optical and temperature devices are being tested to locate and enumerate resource populations.

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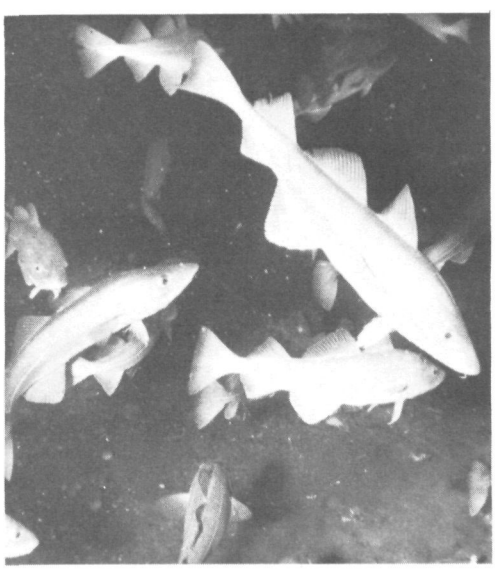
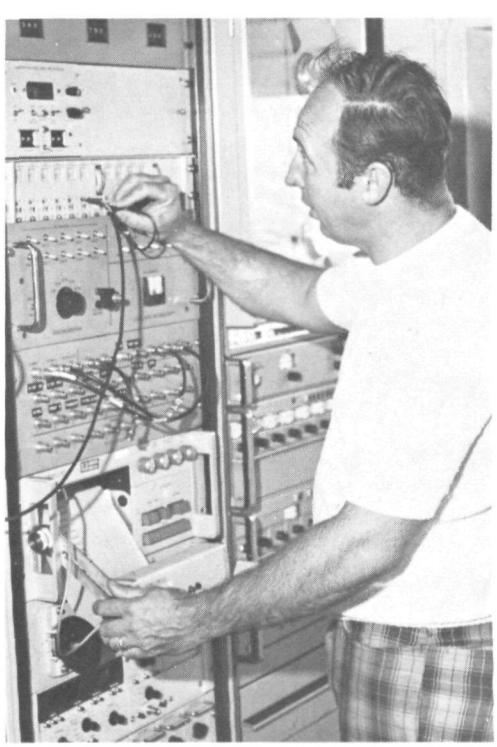
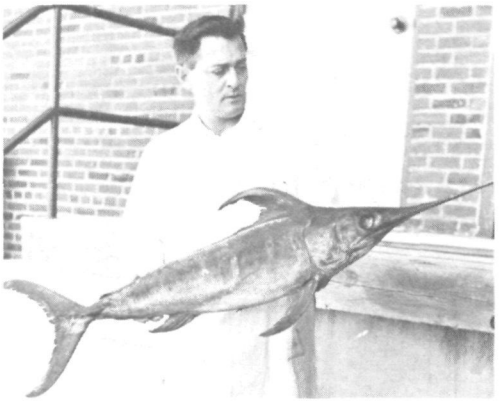
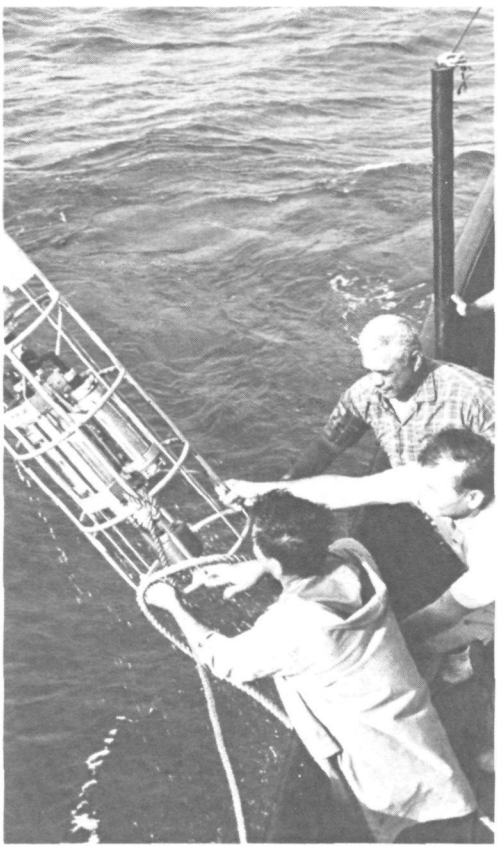




RUFAS (Remote Underwater Fishery Sensing System), controlled from shipboard, skims six feet above the seafloor, taking still photos and video tapes of bottom-dwelling species. (Left) Cod at 1200-foot depth. (Left, below) Measurements of the physical environment are automatically recorded. (Below) Tracings of submerged features play an important part in fishery investigations.





Sport fishermen seek the bluefin tuna (above) and the swordfish (top right). (Right) Salinity-temperature-depth recorders provide continuous measurements for the MARMAP surveys. (Below) NOAA fleet vessels participating in the first pre-operative stage of MARMAP include the ALBATROSS IV, from the NMFS Fisheries Center at Woods Hole, Mass.

Measurements of the physical environment are made concurrently with biological measurements at many ocean depths, and at and above the surface. Temperatures and chemical contents of seawater are recorded by sophisticated instrumentation; meteorological and weather data are collected frequently; and currents and other underwater features are studied and analyzed. Experiments will also involve satellite-generated data and automated buoys.

The preoperative cruises are designed to test under a variety of circumstances the ability of some 200 individuals, a dozen ships, and numerous data-acquisition systems to function effectively and in a coordinated manner. In effect, these advance cruises represent an intensive effort to firmly set the future pattern of MARMAP through the creation, evaluation, and standardization of a whole series of prototype procedures and systems, as well as to integrate into the master plan previously tested methods. Standardization and consistency are key words in any discussion of MARMAP. Long a problem in marine research have been the small inconsistencies that can arise when investigators working independently of one another use different equipment, approaches, and techniques to study similar factors. Even minor differences can diminish, or confuse, the outcome of a research venture. The validity of the multi-species, wide-area investigations conducted under MARMAP is heavily dependent on coordinated and mutually understood approaches to the same goal.

When preoperative cruises have been completed, a temporary halt will be called to enable MARMAP planners to assess, correct, modfiy, and finally lock into place the many elements and systems involved. Once an "all systems go" state of affairs has been reached, MARMAP will move into high gear, and the program will enter a new stage.

Plans call for the speediest possible conversion of the masses of data acquired into computer forms that can be efficiently stored in and retrieved from NOAA data banks. The target of program managers is to reach a peak of efficiency rapidly whereby data collected by whatever means is submitted for processing no more than 90 days after acquisition, and available to users 90 days thereafter. Much of the data which is to form the information base will be in comprehensive form by 1975, having been drawn not only from MARMAP cruises, but from existing literature, past ocean monitoring projects, MARMAP-related short-term studies conducted over the past two years, and past or present foreign expeditions.

As presently planned, the public information dissemination service will be divided into four categories:

"Red Flag Reports"—to provide immediate notice of real or incipient damage to marine resources because of overfishing and changes in the marine environment or in the composition of fishing stocks caused by natural or manmade changes.

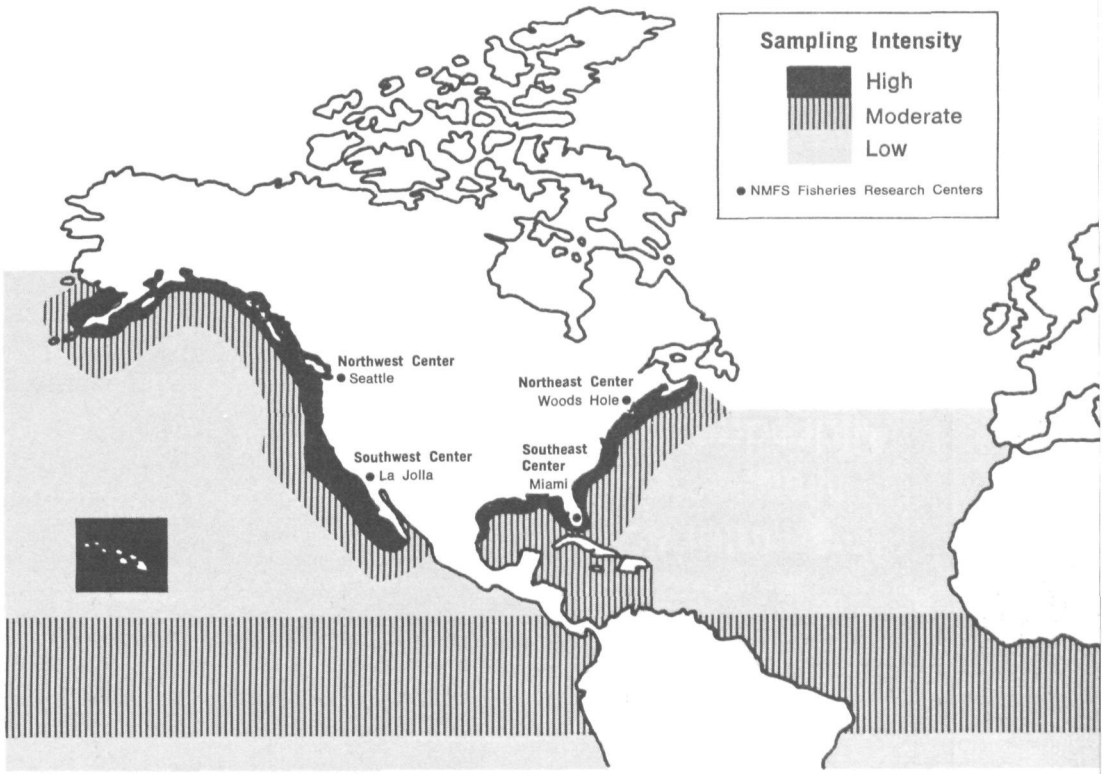
"Summary Recommendations"—to provide the scientific information in support of the need for legislation or regulations related to protection (or use) of living marine resources or for pollution controls.

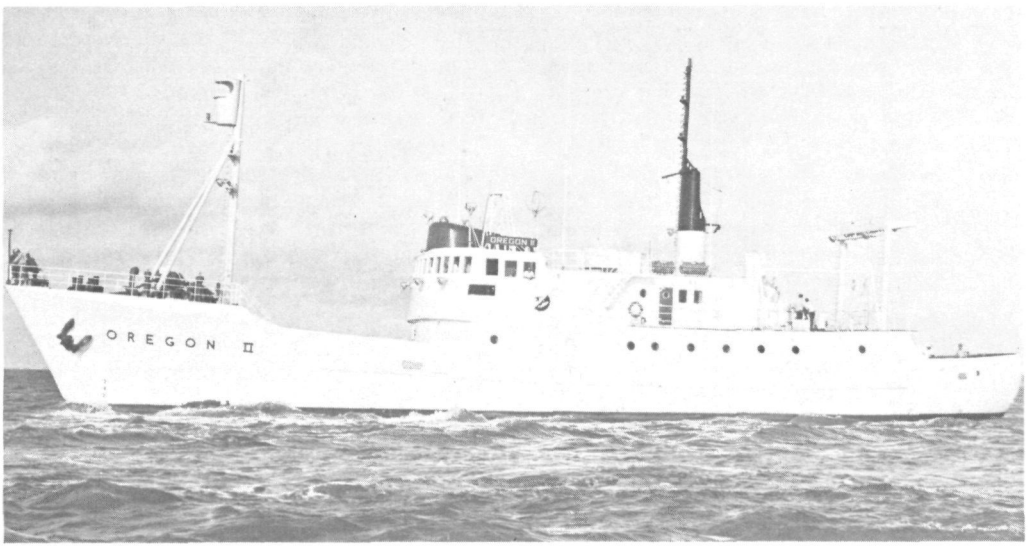
"Status of Resources Reports"—to include facts about various prevailing conditions, to disseminate maps and fact sheets, summaries, and forecasts.

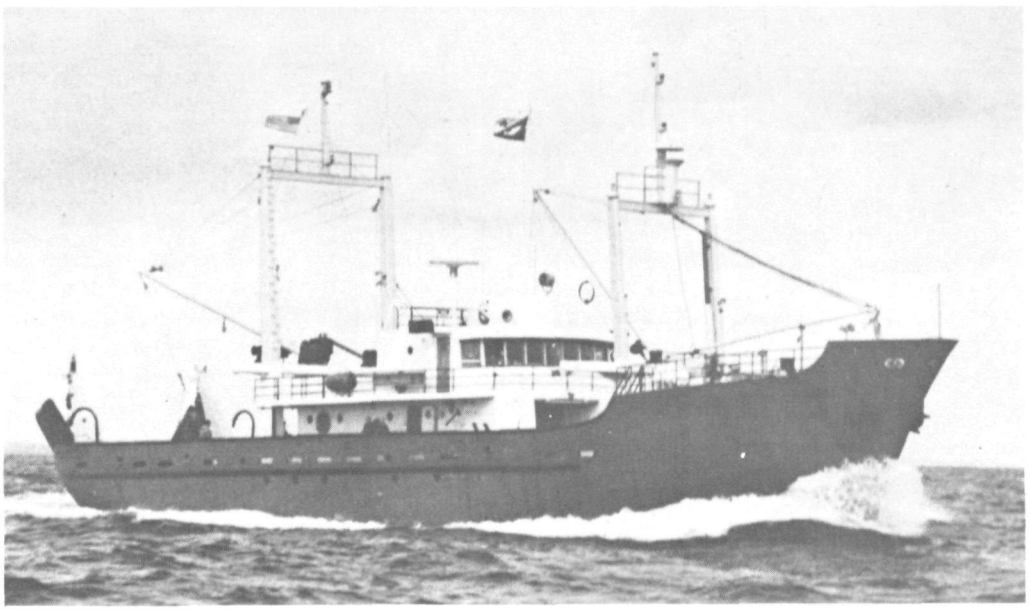
"Real Time Output"—to circulate material describing distribution and abundance of various marine species, catch data, statistics, analytical documents, and fishery advisory bulletins.

Affiliated with NMFS, and constantly adding diverse data to the MARMAP archives are many other government agencies and components of NOAA, several international organizations, almost a dozen state universities, and a number of research vessels of other nations.

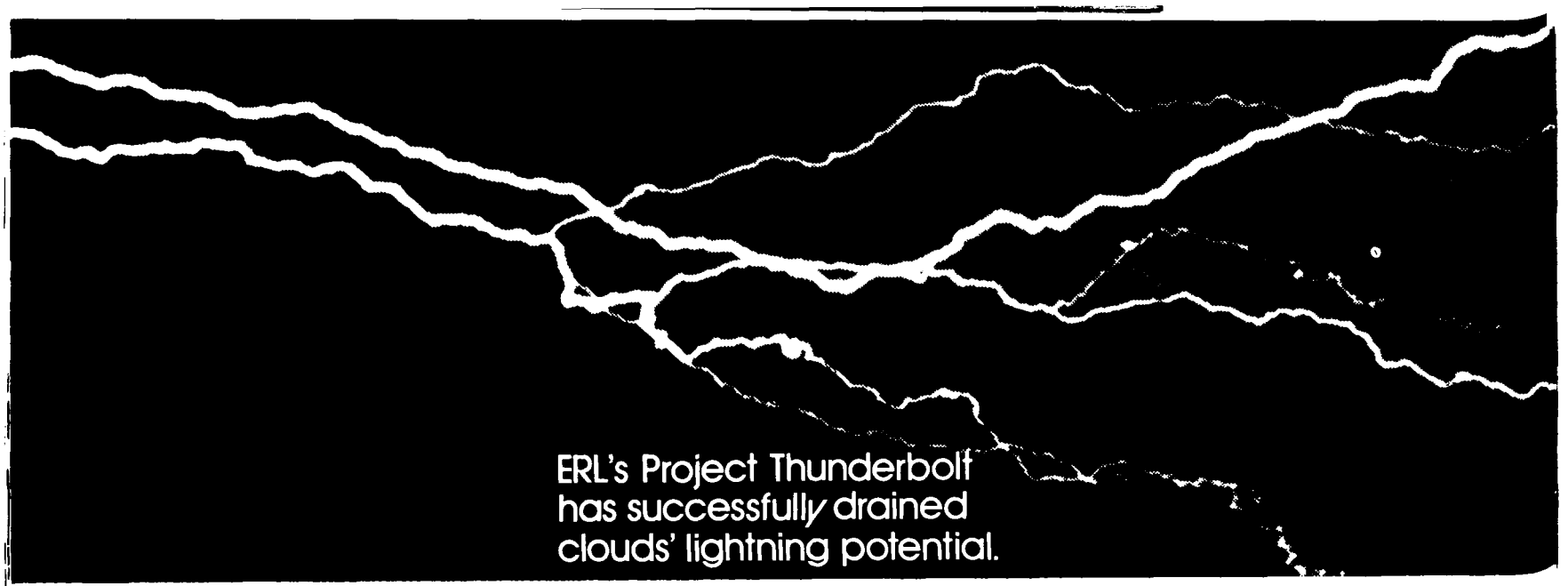
In essence, MARMAP represents a tremendous effort by NOAA scientists to produce a comprehensive body of data that will bridge the chasm between natural ocean patterns laid down eons ago and man's understanding of them in terms of the needs of the 20th century. □







(Above) The projected MARMAP survey area. The research vessel OREGON II (left) from the NMFS Fisheries Center at Miami, and the research vessel DELAWARE II (below, left) from the Fisheries Center at Sandy Hook, N.J., are also conducting pre-operational MARMAP surveys. (Below) Niskin bottles and reversing thermometers are used in sampling the ocean's physical properties.



DISARMING THE THUNDERSTORM

BY JAMES C. RUDOSKY

Tiny fibers released into thunderstorms give man the ability to suppress lightning, Environmental Research Laboratories scientists believe after testing the technique this summer.

Metallized nylon fibers—called chaff—were dispersed beneath thunderstorms in northeastern Colorado during a six-week experiment conducted by the Atmospheric Physics and Chemistry Laboratory.

The seeding consistently neutralized storm electrical fields, suggesting that the possibility of suppressing lightning for such purposes as forest-fire prevention is at hand.

This summer's effort marked the resumption of a 1966-67 lightning suppression experiment conducted near Flagstaff, Arizona, and the first phase of a two-year study to be held in Colorado. Dubbed "Project Thunderbolt," the Colorado study is aimed at further testing the feasibility of lightning suppression by chaff seeding.

Dr. Heinz Kasemir, director of the Flagstaff study and project leader of Thunderbolt, says: "Our limited previous experiment indicated that, indeed, we could suppress the lightning mechanism in thunderstorms. This summer's study has reaffirmed our belief."

The mechanism whereby thunderstorms develop tremendous electrical fields is not fully understood. "Theories are plentiful," says Kasemir, "but facts are few. It is known that generally thunderstorms are dipolar; with a positive charge on top and a negative charge on the bottom.

"One theory explains that as cloud particles collide with each other they become electrically charged. Mechanisms like gravity, wind, and electrical attraction transport the charged particles to different cloud areas where charge centers develop."

Although the source of storm electrical fields is unknown, the hypothesis is that a field of 500,000 volts per meter is necessary to initiate lightning. Since air is a poor conductor of electricity, storm electrical charges are not neutralized until the field builds enough strength to overcome the insulating effect; then a lightning bolt occurs.

Kasemir and the five other members of the project team believe they can suppress the lightning mechanism by increasing the conductivity of the atmosphere, making it impossible for storm electrical fields to develop lightning potential. To accomplish this, Thunderbolt team members utilize a phenomenon known as "corona discharge."

If an electrically conductive pointed object is introduced into a strong electrical field, like that of a thunderstorm, it will develop a positive and negative pole. Electrically charged particles, called ions, then escape from the pointed pole of the same charge.

The resulting streams of ions—negative ions traveling toward the positive field center, and positive ions traveling toward the negative field center—increase the conductivity of the atmosphere.

Using this principle, Kasemir and his co-workers disperse chaff in the region of the storm's electrical field, thereby increasing atmospheric conductivity and obviating the strong field buildup.

Since chaff disturbs radar tracking, a 200-square-mile area of northeastern Colorado farmland was chosen for the test, after consultation with the Federal Aviation Administration.

On a typical seeding flight, Kasemir and project meteorologist William Cobb board a B-26 aircraft as afternoon thunderstorms develop or move into the test area. Designed as a military bomber during World War II, the twin-engine, propeller-driven B-26 is now instrumented with electric field measuring devices (field mills) and two chaff dispensers. It was contracted for the experiment from the Sierra Research Corporation, Boulder.

As the research plane approaches the test area, Cobb scans the cloud systems for developing thunderstorms. Having located a good prospect, he communicates his observation via intercom to Kasemir, who monitors field mill measurements, and to the pilot, who flies directly toward the turbulent base of the storm.

Heated by the daylong re-radiation of solar energy from the earth, warm, moisture-laden ground air forces its way upward, driving the thunderstorm to heights of 30,000 feet above the flat farmland.

Flown through the center of the storm, the B-26 could be pelted and smashed by large hailstones and ripped by turbulence. "It is unlikely," says Cobb, "that any aircraft could survive the severe turbulence and hail in the giant storms which form over the plains in the evening.

"Even the smaller storms must be approached with caution. Several storm penetrations are usually made at cloud-base level and if in the judgment of the pilot and crew, the storm is not too large, penetrations may be made at higher levels of the storm. Past experience has shown that the highest electric fields are usually found near the freezing level, which in the Colorado summer time is near 16,000 feet."

Monitoring electric field strength, Kasemir waits until the instruments register a field greater than 30,000 volts per meter, the magnitude at which corona discharge on the chaff fibers will begin to occur. The chaff dispensers are then activated, and the hairlike fibers, four inches long, are carried into the clouds by updrafts in the storm's circulation. During the next pass through the storm, changes in the electrical field strength are recorded.

On every occasion during the July-August experiment according to Kasemir, storm electrical fields were dissipated.

Occasionally the introduction of the airplane into the storm will induce lightning at

field strengths that could normally only initiate corona discharge. Thus, when an aircraft enters a storm electrical field one-tenth the strength normally required to cause lightning, a lightning bolt may nevertheless be produced. Says Cobb: "The storm flights at times provide unexpected excitement. In 1967, the team was making thunderstorm flights in a Research Flight Facility DC-6 which was struck by lightning three times. In 1970, I was aboard a small two-engine National Aeronautics and Space Administration aircraft that was caught in the updraft beneath a relatively small thunderstorm, lifted 3000 feet into the storm and then dropped an even greater distance before exiting from the cloud. The electric field recorded on that flight peaked at 240,000 volts per meter, among the highest fields recorded from an aircraft."

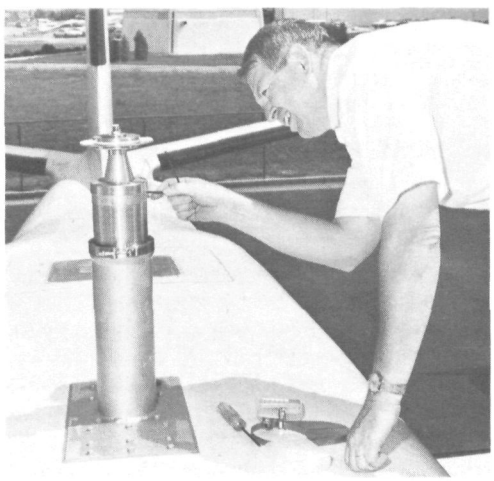
Flying in the B-26, August 22 this year, the project team was startled by a loud "bang" as lightning struck the wing of the airplane, burning a hole through the one-quarter-inch steel plating. The hole was relatively small, less than the diameter of a quarter. But, its location next to the left engine suggested to the pilot the possibility that perhaps an engine motor mount might have been severed, and the plane returned to the landing field.

Lightning suppression technology could be used to reduce the number of forest fires. According to Alan R. Taylor of the Northern Forest Fire Laboratory at Missoula, Montana, if lightning could be totally suppressed there would be 70 percent less western forest fires. However, some researchers contend that lightning and the fires it causes are necessary to maintain an ecological balance.

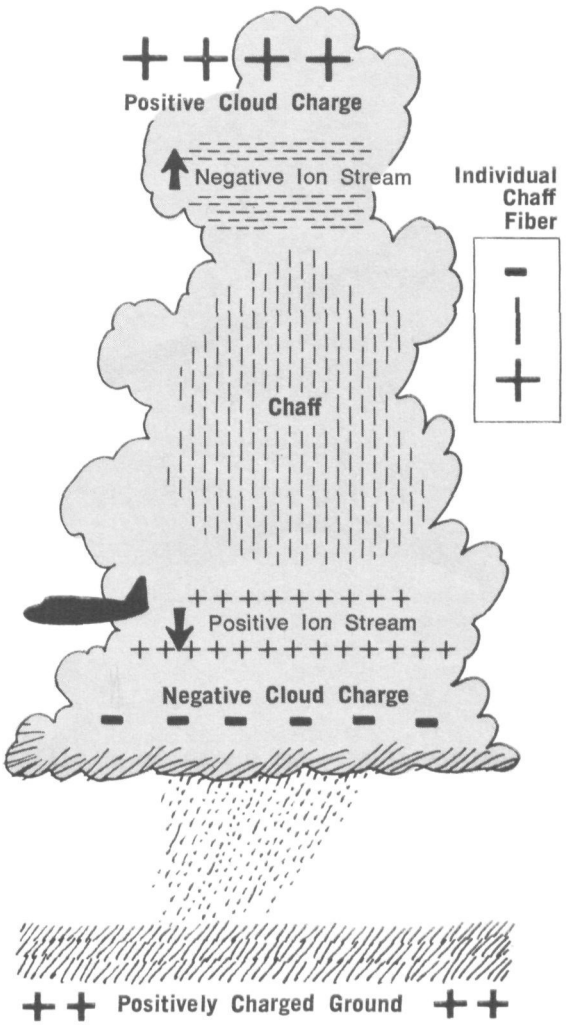
Dr. Ted L. Hanes of the National Audubon Society believes that the suppression of lightning fires may cause a reduction in the amount of atmospheric nitrogen fixed into soluble nitrate salts, decreasing forest productivity. He also points out that fires frequently swept through western forests prior to man's influence on the forest environment, and that forest vegetation adapted to these conditions. For example, the heat of light fires causes lodgepole pine cones to release their seeds, which germinate at a temperature of 113 degrees F. According to Hanes:

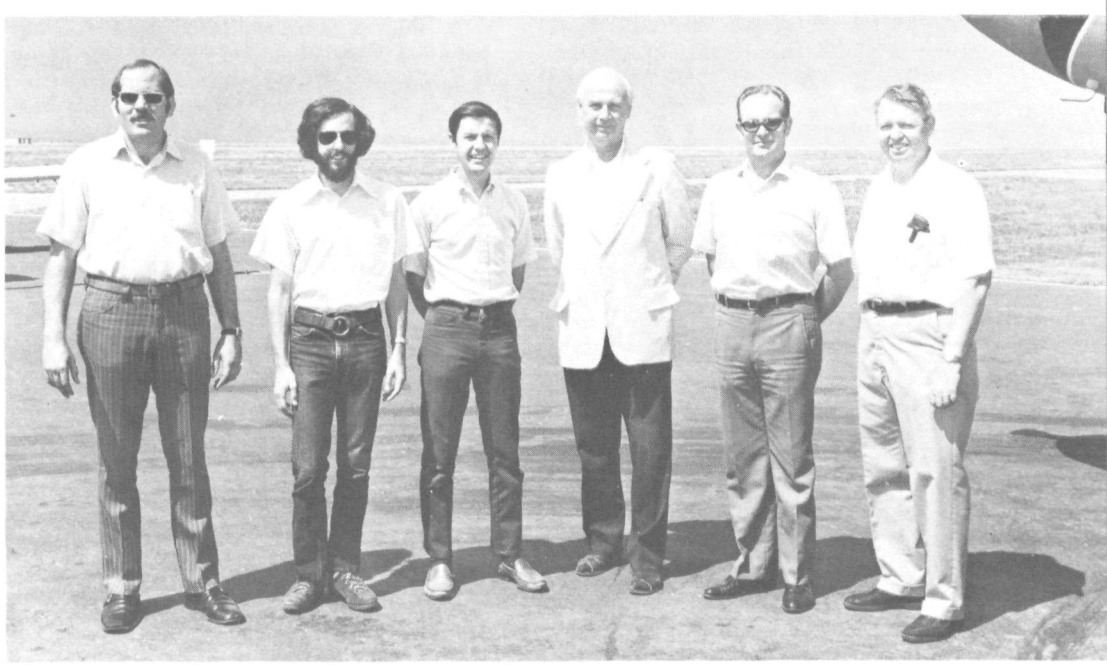
"The long-term exclusion of fire in western forests has resulted in overmature vegetation, accumulation of unusual amounts of dead plant litter, and the growth of a dense shrub underbrush which inhibits the development of forest tree seedlings. When fire ignites, it feeds upon this unnaturally large volume of fuel, producing conflagrations difficult to control and destructive to the entire forest community."

It is unlikely that lightning suppression technology would be used in a program to totally eliminate forest fires. Nevertheless, the capability of suppressing lightning may give foresters the opportunity to defer forest fires from periods of extreme hazard to periods when fires can be controlled more easily. □

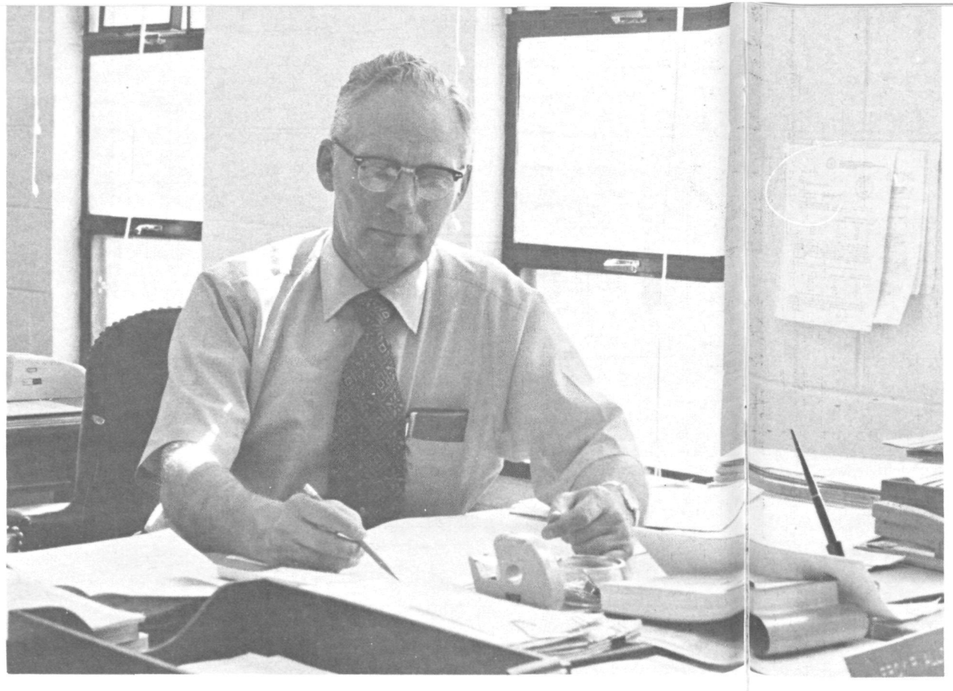


(Left) Lightning strikes wingtip of RFF aircraft. (Left, below) William Cobb adjusts electric field measuring device on aircraft. Participants in the lightning suppression test included, from left, pilot William Brodie, F.N. Gould, F.J. Holitza, project leader Kasemir, B.R. Caldwell, and W.E. Cobb. (Below) Artist's conception of the action of chaff in neutralizing a storm's electrical field.





In an interview for NOAA Magazine, Dr. Leroy R. Alldredge, Director of the Earth Sciences Laboratories, discusses



Dr. Alldredge (left), ESL Director, says the 1971 San Fernando earthquake (above) gave new impetus to seismological research.

THE NATURE OF THIS EARTH

Q. Dr. Alldredge, the solid earth does not appear in NOAA's name, but there is considerable earth sciences activity here. How would you define the province of NOAA's investigation in the earth sciences?

A. Historically, the Earth Sciences Laboratories have dealth with three solid earth science topics—geomagnetism, seismology, and, to a lesser degree, geodesy.

Q. What are some of the major service programs at ESL?

A. We have quite a number but they usually serve separate audiences, the scientific community on one hand, and the community as a whole on the other. I think our best example of a service for both types of user is in the case of seismology, where we have a global seismic network recording signals from earthquakes, cooperative stations sending in their data, and a means of making that information available—through our National Earthquake Information Center—to scientists and the general public.

Q. What about geomagnetic programs?

A. We run quite a number of geomagnetic observatories, some of them collocated with seismological observatories, that send in data on the earth's magnetic field and how it varies with the time and location. This information is useful to several kinds of people. Those working on space research are interested in time-dependent variations of the magnetic field. Other researchers have questions on the internal construction of the earth. Some of these are interested in the main field, which appears to be caused by a source in the earth's core, and others have an interest in local anomalies caused by irregular magnetization of the earth's crust. All of the observatory data is made available in the form of detailed records or in some processed form, such as world magnetic charts, for secular change and the main field itself.

Q. Does geomagnetism touch the individual American life more than it seems to?

A. The geomagnetic field has presumably never killed anybody or damaged anybody, so that you're dealing with a subject which just doesn't have the close appeal to people of some other subjects. The real basis for our geomagnetic work lies in two areas. The first is totally tied up with the scientific community. We feed a lot of information to the scientific community for space studies and also for studies of the earth's core. The only place where people use geomagnetic products in everyday life is in surveying and navigation. These still have to be serviced, but they're not terribly exciting. In the old days, when the magnetic field was the only way to get the direction of travel, one had to know the declination well. Now this method is only a backup navigation system on most aircraft and ships. NOAA still gets calls from surveyors who need to know the declination 150 years ago because they're transferring deeds to properties that were described in terms of declination then. It's shifted maybe 10 degrees since and they get the wrong piece of property if they don't know how the magnetic declination has shifted. And, of course, our work plays a part in the space environment problem, and in communications.

Carl A. Posey interviewed Dr. Alldredge for NOAA Magazine.

Q. Do you have any geodetic research programs?

A. We don't in the classical sense of geodetic survey type programs, but we do have some that specialize in measuring crustal motion in small areas, as with fault movement. One of these is a contract with the University of California at San Diego where we have a laser interferometer strainmeter under development that is quite expensive and very precise. Also I should mention the Wave Propagation Laboratory's two-wavelength Geodimeter development. Hopefully this fall it will be put out on the San Andreas Fault, and we'll see if it can measure creep along the fault.

Q. Do you interact very strongly with other ERL laboratories?

A. There are quite a few interesting cross lines through which we touch other labs. For example, ERL oceanographers measure magnetic anomalies from towed magnetometers behind ships; we in geomagnetism have a strong interest in the signals, the anomalies, since they tell us something about plate tectonics. We've had some interaction with the Space Environment Laboratory because they're interested in what happens on the sun and in the magnetosphere and ionosphere, and our records show what's happening there as time variations, so there is interaction with them in predicting solar storms.

continued

Q. With which NOAA elements do you have most interaction now?

A. Probably the National Weather Service, which has been given responsibility for final operations on tsunamis. We also have quite a bit of contact with the National Geodetic Survey of the National Ocean Survey. The geodetists there are very much interested in crustal motions like those along the San Andreas Fault, and of course we're interested because of our creep and strain work, and other earthquake research projects in California. We in ESL chair the Earthquake Research Committee for NOAA and the NOS representatives are very important to its work. We are, incidentally, adding members from the Weather Service because of the tsunami work and from the Environmental Data Service because of their geophysical data center assignment.

Q. Returning, for a moment, to the tsunami warning operation, can you explain what the National Weather Service role will be?

A. Right now, ERL is doing the whole thing, just as it has been. But we have an agreement with the Weather Service that is just being signed to the effect that within a year it will take over the final warning part. That means we will be left with the seismology input which indicates that an earthquake has occurred that could cause a tsunami. The rest of it will be up to the National Weather Service, to query tide stations to see if a tsunami has been generated, and to issue the tsunami warning if one is detected. The exceptions are for Alaska and Hawaii, where it's admitted in the agreement that it may take the Weather Service a little longer to show they can handle the regional warnings because of the quicker response-time needed. It may have to be left in the seismologists' hands in these areas for quite a long time.

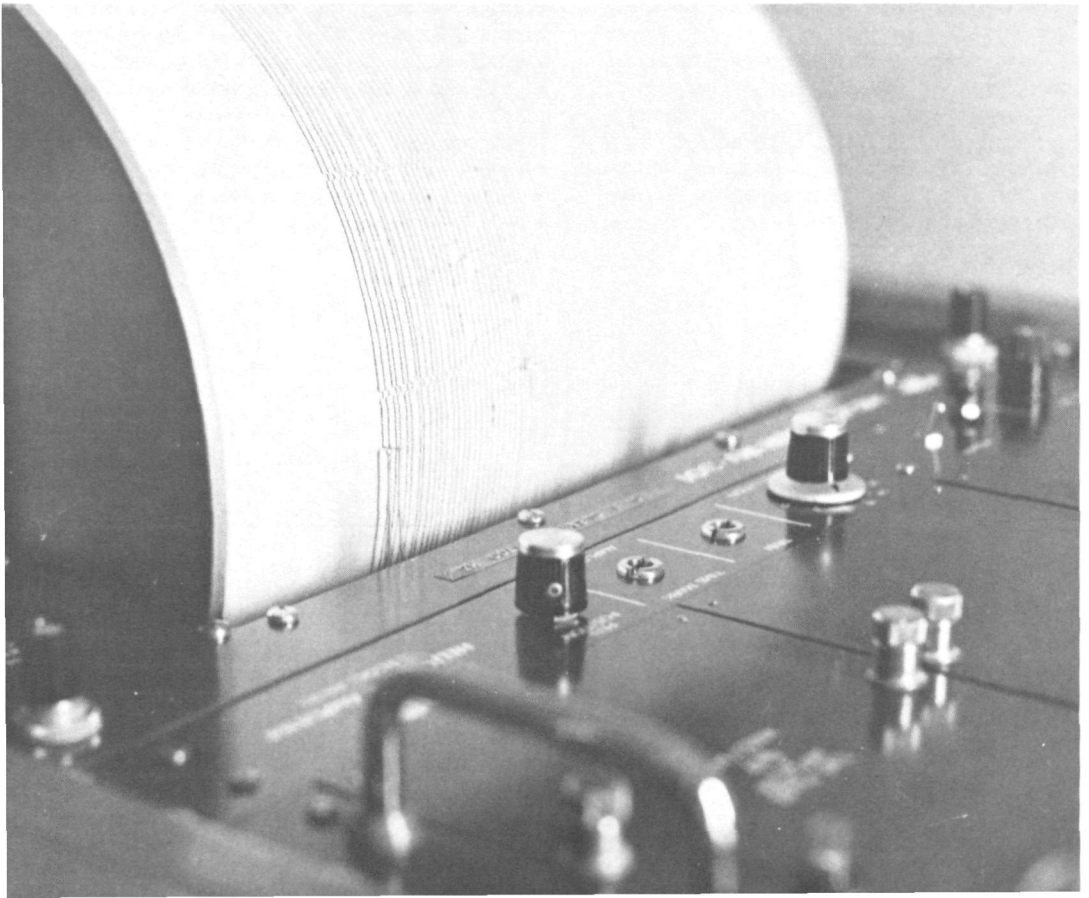
Q. Won't the GOES spacecraft and its relay capability play an important part in future tsunami warning operations?

A. Certainly. We have a project now to begin to use the GOES for transmitting some of the data. I don't think we plan to put all of our seismic information on it, but perhaps some of the final warning messages may go out that way. And they may work back and get some of the tide-gage information, or even selected seismic data.

Q. To pursue interactions a little further, do you see your research seismologists working closely with geologists and geophysicists in the marine labs?

A. They are all certainly working on the same basic problems, but usually they're able to carry their work on independently of one another. Of course they compare results as they come together in scientific meetings. The seismologists can do more or less detailed geology of where the earthquakes are occurring on downgoing slabs and so forth, whereas the oceanographers may be out there actually measuring the trench locations or the spreading centers.

A seismograph recorder at one of the stations in the global network which records and reports earthquake data.



Here again, geomagnetics is important. Data from airborne or towed surface magnetometers let us define the magnetic symmetry about the spreading centers, so that our people in magnetics also relate back to people working in the oceans.

Q. Last July, the seismological and geomagnetic operations of the National Ocean Survey—except the archival ones—were transferred to ESL. Can you tell me something about how these activities are fitting into the Boulder picture?

A. I think the thing that the move did is ensure better communications than we had before. We've had the Earthquake Research Committee for five or six years and we've attempted to bring together the people in different parts of NOAA, to know what they were all doing. I think we have less of a communications problem now because we try to make sure that what one group is doing is known to the others so that we can get a kind of scientific consensus on the best moves to make. I believe the shift is already paying large dividends in that sense.

Q. In the reorganization, archival work in seismology and geomagnetics went to the Environmental Data Service. How is that division of effort functioning?

A. I think it's working well. We still help on the research end of it, and we all have the advantage of being in the same city now. It might be worth noting that last March we had several meetings with EDS to cover things like chartmaking and what the United States policy should be regarding the new International Geomagnetic Reference Field, IGRF, which will be discussed at an IAGA meeting in September 1973. So there is every indication that although there is a split in assignment we'll continue to keep things close together.

Q. One gets the feeling, looking at your organization from the outside, that some of the elements of ESL have greater stature than they had before. Is this a mirage?

A. No, but it depends on which elements you're talking about. One major change we did make was to elevate the earthquake engineering-strong motion program to a higher-level organization reporting directly to the head of ESL. This was done because in our users conference last year it was pretty evident that they placed a very high priority on our strong-motion work. We hired a new director, Dr. "Fritz" Matthiesen, to manage this work, and he has assumed the directorship of the Seismological Field Survey. I think this is an important change.

Q. How has the routine of observatory work been assimilated into your research organization?

A. By and large the same people who were running the observatories are still running them; we haven't sent research people into the field for this. It's mainly been a matter of accommodating the work within ERL, which, incidentally, is used to running en-

vironmental monitoring programs of this type. The Space Environment Laboratory, for example, has a large monitoring operation in following and predicting "space weather."

Q. Do you see the Boulder area becoming a national focus for the earth sciences?

A. I think it already has. At least it is a bigger center than it was, and I think it has become a very substantial center with the consolidation of most of ESL here. With CIRES (Cooperative Institute for Research in Environmental Sciences, a joint effort of NOAA and the University of Colorado) deciding to make earth sciences a strong part of its program, it will of course further strengthen this concept. So in seismology and geomagnetism, Boulder is developing into an earth sciences center to be reckoned with.

Q. What do you consider the high points of your present research program in ESL?

A. There are two I would cite as the most important. One is the work on creep and strain in the San Francisco area and in the Aleutian Islands under Don Tocher. We have creep-like strain events that have been observed in the Aleutians and in the simple model they can be related to the slipping, underthrusting slabs of the lithosphere. This work has just begun and we feel it should really have a strong push on the pure research end of things.

Another area that's extremely interesting and perhaps more profitable in terms of modern social problems is the seismic risk mapping and damage surveys we are doing. Ted Algermissen and his group are trying to devise methodologies to predict damage areas in future earthquakes and to set down ways of minimizing loss of life and property. I think it will have a big payoff.

Q. What do you see as important research programs and results in the more distant future?

A. I guess one of the most controversial ones is earthquake prediction. We hesitate to use the term here to mean real-time, useful prediction of earthquakes—that is, prediction on a time scale that would be useful for taking action to minimize damage and loss of life. On the other hand, if that problem could be solved so that earthquakes were predictable in a manner similar to hurricanes along the gulf coast, the benefits would be tremendous. We feel much can be done in the research area that will have possible contributions there, and so we have prediction in the back of our mind. But we aren't tying our research to the promise that earthquake prediction is a feasible goal.

In geomagnetism there is an interesting problem, that of secular change in the earth's magnetic field. This is poorly known now, but we feel that in the next five or ten years there should be a much better understanding of it, better mapping of it, and even some kind of prediction of it, say as much as five years after a chart is issued.

Q. By secular you mean long-term?

A. Yes, long-term. Periods of 25 years to 100 years, and longer. Even tens of thousands of years if you want to try to express any periodicity.

Q. Do you feel that earth scientists have as ready access to the new technologies—satellites, computers, and the like—as their colleagues in other areas of the geophysical sciences?

A. Workers in geomagnetism and seismology are both very much up on using the new techniques. We digitize a lot of the data, we use computers for almost everything we do—even our National Earthquake Information Center's rapid determination of epicenters is computerized now. NASA has been using satellite-borne magnetometers to map the geomagnetic field for a long time. The best magnetometers, the rubidium or proton-resonance magnetometers, take advantage of nuclear and atomic processes to obtain a very fine calibration of geomagnetic field measurements.

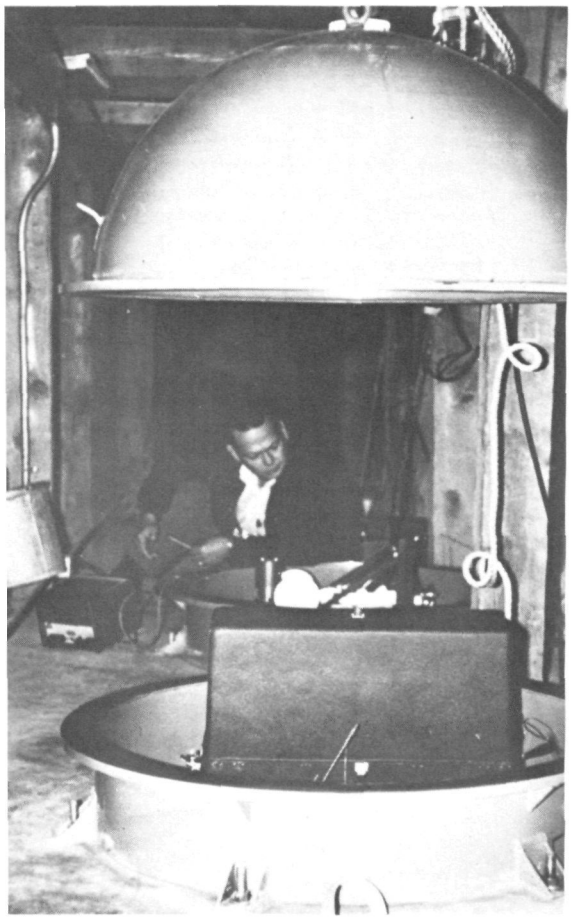
Q. Have you continued the development of new geomagnetic sensors?

A. For over 100 years observatory instruments were just magnets hanging on quartz fibers, and that is still the magnetometer used in most of our observatories. In World

continued

Aurorae are caused by interaction between solar radiation and the earth's magnetic field, which is monitored by the Earth Sciences Laboratories' network of observatories.

(Right) Banked helicorder drums at the Honolulu headquarters of the Pacific Tsunami Warning System. (Below) One of the ultra-long-period, high-gain seismographs recently installed at selected stations in the worldwide seismograph network.



War II the fluxgate magnetometer was developed but never got into the observatory business, and a few years later the proton resonance magnetometer came along, and the rubidium and cesium sensors. These have not been widely applied in any way to measuring components of the geomagnetic field because they directly measure only total field. The ASMO (Automatic Standard Magnetic Observatory) was one where you biased the field back and forth and did get component field measurements, but it has not caught on worldwide because of the expense and also because reliability has not been high enough. But, like any new development, it's got to be given a chance and be cared for and have preventive maintenance. This was never done properly, I feel, so that these have been held back. They have the advantage of being digital in nature so that you don't have to go from analog to digital, you've got digital to begin with, which is good. In the future, we plan to change our observatory instruments so they can come out with digital data, using either fluxgates or ASMO-type instruments.

Q. A few years ago there were reports of successful tests with underwater stable platforms for magnetic stations in the deep ocean. What has happened to them?

A. We aren't doing anything there now. Some years ago I did work on an underwater stable platform which proved to be very workable. But working in the sea is very expensive, and we've not had funds to pursue that. We would like to get back to it some day. In the case of magnetics, we would welcome having information from fixed stations in ocean areas, away from islands. We need this kind of data for conductivity studies under the sea, variations, the S-Q current systems, and things like that.

Q. Are you doing any work with underwater seismometers?

A. No. There are some underwater seismometers in existence. Lamont-Doherty designed them and six or seven were installed, and several of these are still working and considered useful. I suppose to get proper coverage around the world of all seismic activity we ought to have more of them; but at the present time we're pretty much stuck with land seismographs.

Q. What will addition of ultra-long-period, high-gain instruments to selected stations in the worldwide seismograph network do for your product?

A. My understanding is that this will give us much more information on distant earthquakes—on surface waves, for example, which are important in determining fault break and magnitudes—than we now have. In order to carry the new additions we're in the process of letting a contract with an outside firm to help us install and maintain these instruments in the field, along with existing network instruments. The new seismographs should let us archive a lot of additional seismic activity and since this data

Dr. Leroy R. Alldredge, Director of the Earth Sciences Laboratories of NOAA's Environmental Research Laboratories, is an internationally known authority on geomagnetism and other aspects of earth sciences.

He began his government service in the Federal Communications Commission in 1941, serving as a wartime radio monitor. In 1944, he left FCC to work for the Carnegie Institute of Washington, testing newly designed magnetic exploder devices for depth charges, torpedoes, and mines—work he continued when he joined the Naval Ordnance Laboratory in 1945. He later headed the Laboratory's Electricity and Magnetism Research Division, which conducted pioneer studies of the rapid fluctuation of the geomagnetic field, and which developed the Universal Airborne Magnetometer, since widely used by military and civil magnetic survey operations.

Dr. Alldredge joined the former Coast and Geodetic Survey as a research geophysicist in 1959, where his major accomplishment was the design and development of an automatic standard magnetic observatory. After the formation of ESSA in 1965, Dr. Alldredge became director of the former Institute for Earth Sciences, which formed the nucleus of the present Earth Sciences Laboratories.

The Mesa, Arizona, native holds B.S. and M.S. degrees in physics from the University of Arizona, a master's degree in engineering physics from Harvard University, and a Ph.D. in physics from the University of Maryland. Dr. Alldredge won the Department of Commerce's Gold Medal in 1965 and a Presidential Citation in 1964. He received the Arthur Flemming Award in 1949. He has been president, vice president, and secretary of the geomagnetism section of the American Geophysical Union. He is secretary and director of the Central Bureau of the International Association of Geomagnetism and Aeronomy (IAGA), a member of Sigma Xi, Phi Kappa Phi, and Pi Mu Epsilon, and author of numerous scientific papers.

will come back in both analog and digital form on magnetic tape it will be more readily usable by researchers. The Albuquerque Seismological Center is setting up and will monitor this contract.

Q. The exchange of seismic data between western networks seems to be gathering some momentum. How does the linking of these cooperative networks affect ESL's work?

A. Mainly it opens up a region of seismic activity that has not been readily accessible to us before. The link itself is between stations operated by our Earthquake Mechanism Laboratory and Special Projects Party, and by the University of California at Berkeley, California Institute of Technology, the California Department of Water Resources, and the Geological Survey at Menlo Park. By cooperating we link together many stations in California, Utah, and Nevada. When these signals are telemetered into one location, it will mean that we can detect activity down to magnitude 3 anywhere in the area, and down to much smaller values in many parts of the western United States. This will be a real-time exchange, by the way, as compared to the more traditional exchange of processed data long after the fact.

Q. Is your research and service program pretty much restricted to in-house projects or is it partly contracted out?

A. We are contracting out more and more. In fact, this is a growing trend in ESL and possibly in other laboratories. The increased funding we have had, and the increases we hope are ahead, don't carry much additional manpower, which, in fact, decreased about five percent this year. We have more money but fewer people to apply it, which leads us to contract out more of our work. We have quite a number of small contracts with universities for research to help solve scientific problems that we see, and with commercial concerns to provide some of our service work.

Q. With the press of administrative matters, do you still find time for research projects of your own?

A. Not very much. I wish it were a lot more. Last July 9, we increased in size by a factor of six, and we haven't increased our headquarters management staff at all, so there is even less time now.

Q. What are some of the changes you see in earth sciences now as compared to a decade or two ago?

A. For one thing, the Federal and world policy has shifted in emphasis from pure research to research aimed at solving social problems. I can see this everywhere. Many research people are changing the emphasis of their investigations to deal more with the real problems faced by society. For example, it's much easier to get money for earthquake hazard studies than for problems which are more difficult to relate to human problems. And computers have forced important changes. It used to be you couldn't solve a problem unless you could solve it analytically. Now we tend to get lazy and have the computer do it all, so the analytic phase is taking a back seat. I think this is a general change; everyone is affected by computer management of bank accounts and so on. It's part of the "future shock" story that's affecting us all.

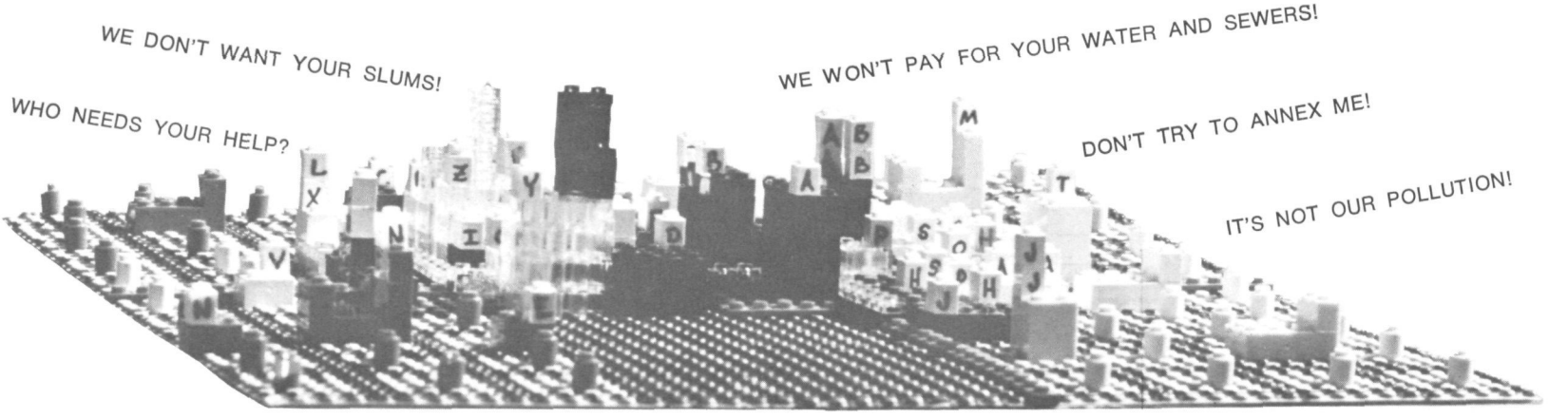
Q. Does the pace of earthquake research compare favorably with research in other areas?

A. We could always spend more because there are unemployed people in this area of investigation, but on the whole we are making reasonable progress with what we have. You are probably aware that there have been four or five Federal studies since 1964 urging the government to spend something like $12 or $15 million more per year on earthquake research. This came about because of the impetus from the Alaskan earthquake of 1964 and gained further momentum after the San Fernando earthquake of February 1971. There are now several bills pending in the Congress to provide more funds. I would conclude that the pace of earthquake research is not satisfactory compared with the social problems that can be caused by earthquakes, and when you see how incompletely we can handle them by limiting hazards, understanding prediction, and so on. There is a capability in the country to get along faster than we are, and the problems are there, many of which could be solved. □

AN ENVIRONMENTAL GAME

How the Prussian Army, the city fathers of Traverse City, Michigan, and a team of Sea Grant scientists with an unusual WALRUS are contributing to better water resource management.

BY ROLAND D. PAINE



Karl Wilhelm Ferdinand, duke of Brunswick-Wolfenbüttel and general in the Prussian army, was fleeing across the plains of Saxony with his King, Friedrich Wilhelm III. Their army had been routed by French soldiers near the village of Auerstädt.

Friedrich Wilhelm von Hohenlohe-Kirchberg, general in the Prussian army, was also fleeing across the plains of Saxony with fellow general Ernst von Rüchel. Their army had been routed by French soldiers near the town of Jena.

It was late afternoon, Oct. 14, 1806. The twin defeats of Auerstädt and Jena marked the utter destruction of a once-proud Prussian military machine and foreshadowed the surrender of the kingdom to Napoleon Bonaparte, one month later. They also foreshadowed a period of reform, emancipation of peasants, intellectual upsurge, increased freedom and thoroughgoing reshaping of government and society.

Participating in the intense period of self-analysis and reconstruction that took place throughout the Prussian kingdom was the army. And one of the intellectual techniques that was revived and sharpened for purposes of officer training was the war game. War games, in their modern form, had been originated by the Prussian army in the latter half of the eighteenth century when it was building toward its first period of influence under Frederick the Great. Earlier war games, used not for training but for sport, still exist in such games as chess.

The war game, as used for officer training, is meant to simulate real-life problems. It can be more or less complex, depending upon the kind of tactical situation to be analyzed. Sometimes designed as a model by which an actual battle is to be conducted, the major use is as a way of helping officers learn about the many factors that can affect the course of an operation. So successful was this Prussian invention that it was later adopted and expanded by the Russian, British, and American armies, among others.

An outgrowth of war games began to appear in the 1930's, when various kinds of "crisis" games were developed to permit analysis of problems in international politics. This led eventually to the development of business games, beginning in 1956 under the sponsorship of the American Management Association.

Again, as with war games, these games are used primarily for training purposes, though sometimes extended into examination of actual operational problems.

Enter the Sea Grant program, University of Michigan. Michigan Sea Grant scientists are working toward nothing less than an overall model of Great Lakes water resources, which can be used to optimize the uses of that water. "Like a game of chess," said a Michigan Sea Grant article in 1970, "the proper management of our natural resources involves understanding all the ramifications of any given move. Michigan Sea Grant studies the interactions of the uses and attributes of the Great Lakes, with an eye to providing decisionmakers with a clear understanding of the consequences of any given action. Only if the rules are clearly understood can a good 'game' be played."

The Michigan Sea Grant team is very clear about the dual nature of its objective —first, to obtain the knowledge needed for sound decisionmaking, and second, to get that knowledge into the hands of the decisionmakers in forms that they can use. Because the fresh water resources of America's "Fourth Seacoast" are deteriorating, the problems undertaken are serious and urgent. Research is geared to providing reasonable action alternatives, and NOAA is supporting the program at an annual level of about $1 million.

Public policymakers are involved in the design of some of the Michigan Sea Grant experiments, so that the scientists will better understand the kinds of information public officials need when they exercise their responsibilities to make decisions affecting water resource use. And the scientists, in turn, frequently furnish data that they know to be relevant but that the public officials were not aware of.

Dr. Allan G. Feldt of the university's Environmental Simulation Laboratory, School of Natural Resources, has worked with simulation games for several years. He and two associates have now completed the first game—called WALRUS I, for "Water and Land Resource Utilization Simulation"—for Michigan Sea Grant. "The purpose of this game," Dr. Feldt explains, "is to provide one means of communication and interaction among the Sea Grant scientists, and between the Sea Grant team and the public that they seek to serve." WALRUS I is the first of three planned gaming-simulation models of increasing complexity and sophistication. Work is currently underway on the development of a second, more sophisticated and more "true to life" model—WALRUS II.

As with all simulation games, WALRUS involves three basic elements. First, the players assume roles—roles that do not necessarily correspond to their real-life situations. Second, they have a scenario that defines a problem area. And third, there is an accounting system designed to keep track of events and their consequences during the play.

"WALRUS players assume the roles of city officials and other local groups who are faced with the problem of pollution in a nearby waterway," Dr. Feldt explains. "The various teams of players represent groups with different economic and geographical interests. In a few rounds of the game, the players are supposed to work up a solution that is acceptable both scientifically and politically. They learn, too, that no matter what decisions they make, the environment is going to reflect them—for good or for bad."

The game was tested and retested during the course of its development, first among the Sea Grant team and later by outside groups of the type that might use it for purposes of analysis, either in exercising their own decisionmaking responsibilities or for educational purposes. Numerous games have been played by city officials of Traverse City, Michigan, as well as by students and other groups in the small city at the foot of Grand Traverse Bay.

"Traverse City is particularly appropriate because WALRUS was planned as a sort of simplistic analog of the problems of Traverse City and Grand Traverse Bay," Dr. Feldt notes. Grand Traverse Bay itself bears many resemblances to Lake Michigan, in microcosm, and is the concentrated field study area of Michigan Sea Grant in developing its techniques for later extension to the problems of the Great Lakes as a whole. "So if we can develop a game that is really useful for analysis of the kinds of decisions that Traverse City has to make," Dr. Feldt says, "then we have one more tool in making Sea Grant useful to the very people it is designed to serve."

Elected officials and planning board members of Traverse City gave assistance, advice, and criticism of the game in its earlier forms, and this has helped greatly in defining the present state of the game. There is evidence too, that WALRUS is already proving useful to them, for many have expressed great interest in playing it again, saying that it has given them a new look at the total environmental system that they are dealing with. Indeed, the Chairman of the Regional Planning Commission and a long-time member of that body exclaimed, following his exposure to it: "I'm going to have to rethink my whole approach to planning because of this!"

Played by high school students, WALRUS has fascinated them and shown them how complex environmental decisions are, helping some of them begin to realize that simply "shutting down the factory" isn't an adequate solution.

Unlike most games played for fun, WALRUS does not have a single specific goal that all players strive for and that represents a "win". In chess, a Bobby Fischer attempts to defeat a Boris Spassky through checkmate. In Monopoly, each player tries to force the others out of the game by amassing property and money. But in WALRUS, as in real life, the players select their own goals. During play, they attempt to control, and possibly optimize, their own position and the status of the region with respect to any one or more of four basic elements: economic strength (measured by play money); political strength (based upon the number of residental units controlled or owned within each political jurisdiction); personal status and prestige (measured by poker chips representing "influents", which are awarded on the basis of public office and other factors); and overall environmental quality of the water (measured according to the number of units of effluents that accumulate in the bay and river system according to the land uses in existence and the type of treatment provided).

When operated on a manual basis, the game operator simply keeps a record of how many effluents are emitted from each land use and notes where it enters a river or bay. The effluents decay slightly over each round but gradually build up in the bay at a rate faster than the rate of "natural" decay. The greater the amount of development, the greater the buildup. The buildup can be decreased by providing sewer lines and treatment facilities, which must be paid for and which require political responsibility for providing for them.

The number and effectiveness of such facilities matched against their cost and associated political factors constitutes the basic attempt at control over environmental degradation that WALRUS permits. Such control requires money, understanding of the problem, and carefully developed political cooperation.

When the game is operated with computer assistance, the computer is the "environment" exercising a subtle but inescapable influence over the decisions.

The kit for the game consists of a playing board "map", and numerous pieces of different colors and sizes representing such factors as water and sewer lines, residences, agriculture uses, water plants, industries, sewage plants, and many others. Several charts are required, some to be maintained by the players and some by the game operators. They include a pollution record chart, influents and votes accounting sheet, municipal budget sheet, team property holdings, and cash flow sheet. The game ordinarily requires fifteen to twenty-five players, arranged in five teams (each at a table), and with other tables for the township boards and city council, the game operators, and the game board itself.

In short, it is a game that cannot be adequately described in words. Even in its present simple form, it is a complex undertaking whose purpose is analysis of real problems and action to recognize and solve those problems through simulation of real-life activities.

As Dr. Feldt points out: "operational games have been developed to make possible understanding of a situation in a way that is not readily transmittable through use of other media, such as the printed word. To try to convey the real meaning of a game in print is thus necessarily a contradiction in terms. The best way is to play the game."

If you would like to give it a try, you won't have to wait long. The Environmental Simulation Laboratory at the university is making arrangements to have the game produced, to make its educational and analytical benefits more widely available. □

Dr. Allan G. Feldt of the University of Michigan, one of the team that developed the game of WALRUS, initiates a group of students to its complexities.

ONE ROUND OF WALRUS

BY ALLAN G. FELDT

Part of the reason for operational games is that they convey to a player information and understanding about a situation that he cannot obtain through other media, such as the printed word. To show you how this works, here is a scene from a typical WALRUS run.

Teams of two or three people each are seated around each of five tables arranged in a semicircle around the playing board. Each team represents a particular set of businesses and geographic interests. "Red" and "Yellow" are primarily agricultural and each is in political control of a suburban township. "Ebony" is primarily involved in industrial holdings in the city, and is a major voting bloc. "Blue" is engaged primarily in recreational industry such as hotels and marinas, and is equal to 'Ebony" in political power. "White" holds most of the city's retail services and much of its political power.

The game operator is passing out to each of the tables income derived from sale of local products and services to the outside world. His assisstant is computing current pollution status, explaining his calculations to a watchful player appointed as "health officer" by the Common Council.

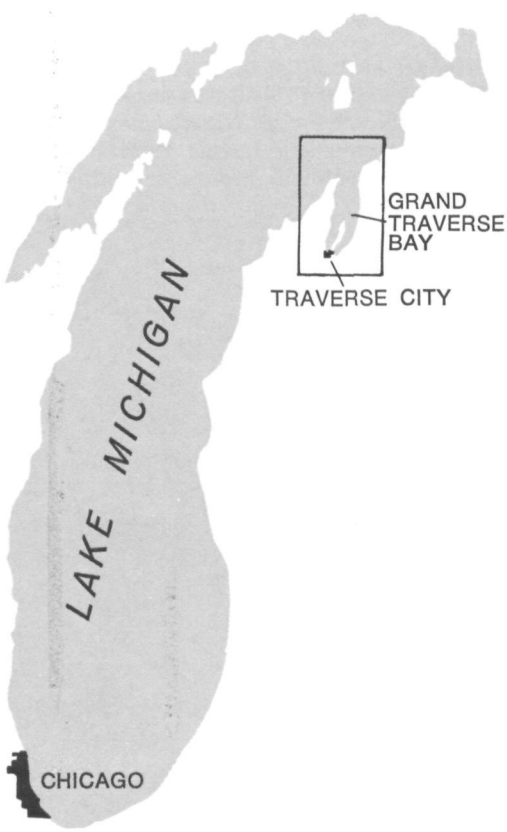
At another table in the back of the room, five people are arguing noisily about a proposal for a regional sewer and water authority; they are watched anxiously by a couple of players from one of the surrounding rural townships. The five seated players are the Common Council of the city, composed of one representative from each of the five teams. Each Council member has voting power proportional to the number of residential districts his team "controls."

Elsewhere in the room, two players are conferring about the present condition of the rural township they represent, and its plans to "go it alone" without cooperating with the proposed regional water and sewer authority. One of these players is highly animated and is dominating the conversation, while the second appears to be agreeable to the proposals but somewhat indifferent to the main thread of the discussion. The former has a majority of his property holdings in the township and has dominant voting power there as well, while the latter is from a team with only minor holdings in the township but with strong strength in the city.

In the previous round, the city strongly opposed providing water and sewer services to outlying areas unless they would agree to annexation to the city. Two developments, however, have come to light which have undermined the city's determination to follow this policy. First, the more powerful "Ebony" team has realized that the only land available for further industrial expansion is in the townships, since the city has refused to rezone available vacant land within the city for industrial uses. Industrial construction in the townships is not possible, however, without adequate water and sewer facilities which are currently available only from the city.

Secondly, the township has refused to cooperate with any attempts to annex its land to the city for fear of gradually eroding its position and power within the region. This township is under the dominant political control of the "Yellow" team, with only minor property holdings and political power within the city.

Meanwhile, the players have just discovered that the level of pollution in the bay has been rising steadily over each round and that, within the next round or two, fairly severe economic effects will be produced as a result of high pollution levels. This particularly affects the "Blue" team, which is politically strong in the city and has major land holdings in the recreation industries. Investigation of the sources of this pollution has revealed that most of the pollutants are coming from the surrounding rural townships in the form of agricultural wastes and wastes from rural residential properties with inadequate or nonexistent sewage capacity. Thus, the players have come to realize that trying to use the provision of water and sewer services as a political weapon has resulted in fairly rapid deterioration of the local environment and a deterrent to economic development—particularly the development of those teams dominant within the city governmental structure. After an intensive argument in the preceding round, three players—one each from "Ebony," "Blue," and "Red" teams—were assigned to draw up a plan for a regionwide water and sewer authority to service any and all needs of the city and the townships and to begin, as rapidly as is possible, at least sewer services to some of the major polluters in the rural townships. While one of the rural townships strongly favors this development, the other, represented by the pair of players meeting in the other corner of the back of the room, feels that it prefers to keep its township primarily agricultural. The dominant "Yellow" team is opposed to joining the region-wide authority for fear that its existence will stimulate urban development in its primarily agricultural and moderately profitable land holdings.



The other rural township team, "Red," is strongly in favor of the authority since it has come to recognize the considerable profit it can realize from sales of its agricultural land to other teams for urban development. The "Red" team has just sold part of one of its farms to the "Ebony" urban team, which is interested in industrial expansion. A very high price was obtained after considerable haggling over the relative values of land for industrial versus agricultural purposes. In effect, the agricultural land valued at the equivalent of $1000 per acre was sold for the equivalent of $10,000 per acre to the industrial developer, with a guarantee of the necessary zoning change to allow industrial development in the townships once water and sewer lines became available.

The major issue at this time is the problem of establishing the political voting strength of the regional water authority and providing it with a financial basis for paying for the services it might wish to build or purchase from the city. The question of buying or donating the city's plant and equipment to the regional authority has just come up and the players are now discussing the problem of representation in the regional authority, initial funding sources for the authority and control of the existing plant and equipment while the authority has no legal or financial existence. Furthermore, in applying for federal assistance on

Allan G. Feldt, of the Environmental Simulation Laboratory at the University of Michigan's School of Natural Resources, is the creator of WALRUS I.

any new construction, the regional authority must be able to provide 25 percent of the necessary construction costs and it has neither financial assets of its own nor taxing authority (except for user charges for services delivered).

The current discussion is seeking to resolve these ambiguities in order to make the regional authority operable as quickly as is possible. A plan for systematic extension of the water and sewer services through the entire region has been developed by the committee in its meetings, and a capital construction program for new water and sewer treatment plants at various locations within the region has been proposed. The players in the Common Council and the cooperating township have just begun to realize, however, that the administrative structure needed to fund and provide legitimate voting power for the authority has not been developed and will require additional time to complete. The alternatives before them now are to delay formation of the regional authority for yet another round while the administrative details are worked out, or to have the city begin the development of the plan on behalf of the regional authority with all of the city's obligations to be assumed later by the regional authority.

The players are faced with the conflicting demands and interests, both public and private, of loyalty to their team interests, loyalty to the city's interests, and their inherent involvement in the well-being of the region as a whole. Up to this point the region has been politically and economically undefined. But the ultimate dependence of all teams on the well-being of the regional ecosystem is rapidly becoming apparent. Players are therefore beginning to shift their attention and their loyalties to this problem.

The final decision reached is for the city to take the lead in developing the regional authority, subject to firm commitments from both townships to levy taxes on their own land holdings to provide the financial base for the regional authority to take over the obligations incurred by the city. One member of the city government has resisted this move strongly, since it effectively denies the city its major remaining incentive for annexation. He is outvoted, however.

The meeting breaks up with this agreement, and the city is obligated for the financing of a major series of developments throughout the region. During the forthcoming round, the city's commitments will be met through increased taxes and a substantial increase in indebtedness. All the players involved in the discussion will discover, however, that one of the two rural townships refuses to cooperate with the regional authority and that the support they had anticipated from this sector of the economy has disappeared. In later rounds, they will have to find ways of either overcoming the resistance of this player or of revising their plans for a regional authority, making its effectiveness independent of the noncooperating township. □

AN ENVIRONMENTAL GAME

The Place—Traverse City, Michigan on Traverse Bay
The Players—

YELLOW — Yellow and Red are both Agricultural Townships.

RED

EBONY — City Industrial

WHITE — City Retail — Ebony and White have same goals

BLUE — Recreation, Motels, Marinas, etc.

ROUND 1

Yellow and Red want to retain independence, reject offers of help for water and sewers from Ebony and White.

Ebony and White will provide water and sewers to Yellow and Red if they will agree to annexation. Ebony seeks industrial expansion.

Meanwhile, level of bay pollution has been rising and within a few rounds economic effects will be felt by all players, especially by Blue.

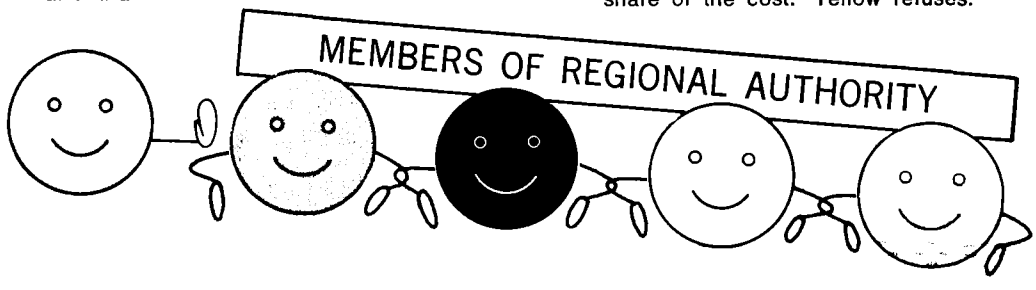
RISING LEVEL OF POLLUTION

ROUND 2

Red joins Ebony, White and Blue in setting up a regional water and sewer authority. Red sees huge profits in land sales for industrial expansion. Annexation is no longer a condition.

Yellow will not join, fears loss of agricultural character.

Ebony, White and Blue are given lead in organizing regional authority. Red agrees to raise taxes to pay for its fair share of the cost. Yellow refuses.



ROUND 3

Players are now faced with conflicting demands and interest, public and private, of loyalty to team.

Players must subordinate individual demands and loyalties for the well-being of the region as a whole, as the need for a regional ecosystem becomes more urgent.

In later rounds, players will have to find ways of overcoming Yellow's resistance, revising plans for regional authority, making its effectiveness independent of the non-cooperating township.

There's a new look in the NOAA Corps since the commissioning of the first woman officer.

Ensign Chelgren Comes Aboard

BY ANN K. COOK

Graduate engineer, sailing enthusiast, daughter of a U.S. Navy officer—Pamela Chelgren is a natural for the NOAA Commissioned Corps.

And on July 6, she became the first woman officer in the Corps' 55-year history, sworn in by Secretary of Commerce Peter G. Peterson.

As Temporary Ensign Pamela Chelgren, USNOAA, she then began the orientation course at the NOAA Officer Training Center, located at the U.S. Merchant Marine Academy in Kings Point, New York.

Smallest of the nation's seven uniformed services, the NOAA Corps has some 340 officers, all college graduates with scientific and engineering backgrounds, who serve throughout the NOAA organization. At any given time, about half of the Corps' total complement is assigned to duty aboard ship, conducting deep sea research and surveys, hydrographic and tidal current surveys, and wire drag operations. Sea duty is normally the first assignment for a newly appointed officer, and Ensign Chelgren is looking forward to it.

"I love ships, the ocean, and the outdoors," she says, pointing out that the NOAA Corps offers a unique opportunity to combine her engineering training and her life-long interest in the sea.

Having been one of 12 women engineering majors among thousands at the University of California's Berkeley campus, she is not fazed at the prospect of being the first woman in a corps of 340 men.

Nor do the numerous station changes which are the lot of Corps officers dismay her. Third of seven children of Captain John Chelgren, USN, she has moved many times since her birth on May 13, 1950, in Annapolis, Md., where her father was on the Naval Academy staff. From Annapolis, the Chelgren family transferred to the Boston area and then to Long Beach, California. It was at the next post—White Sands Missile Range, New Mexico—that Pam started school. The first school she really remembers was in Montgomery County, Md., where she attended the third, fourth, and fifth grades while her father was stationed in Washington, D.C. Later came moves to

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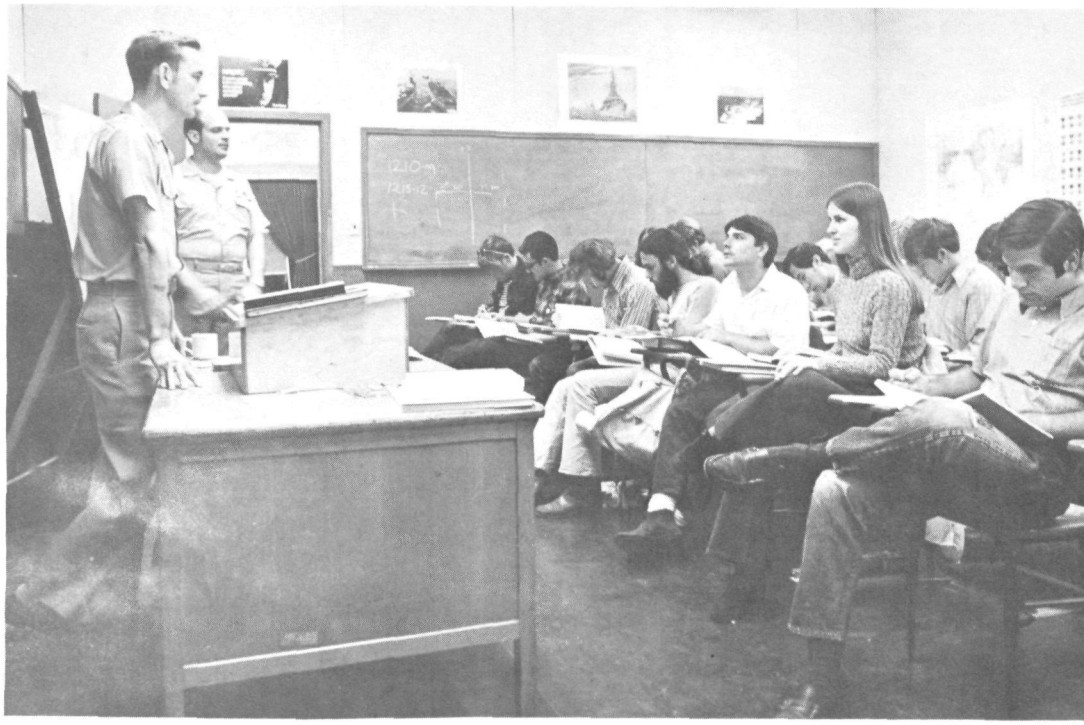
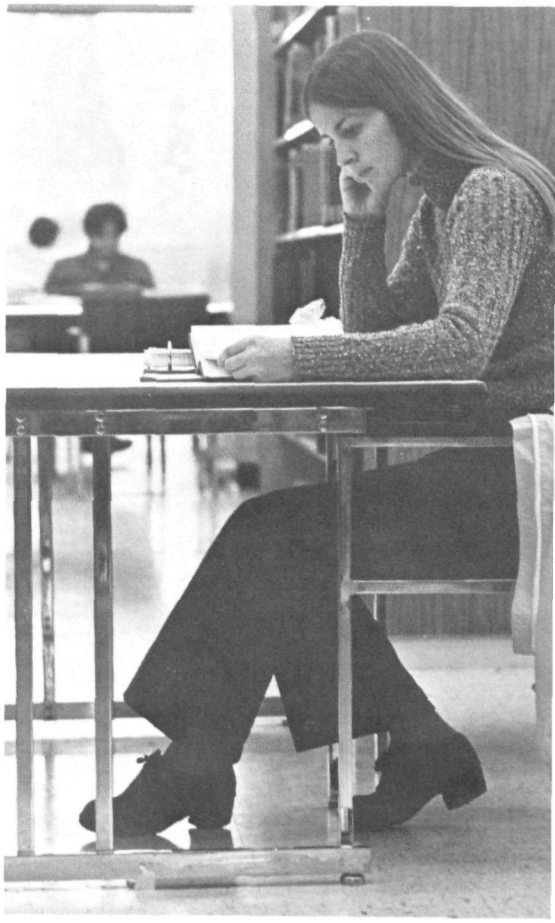
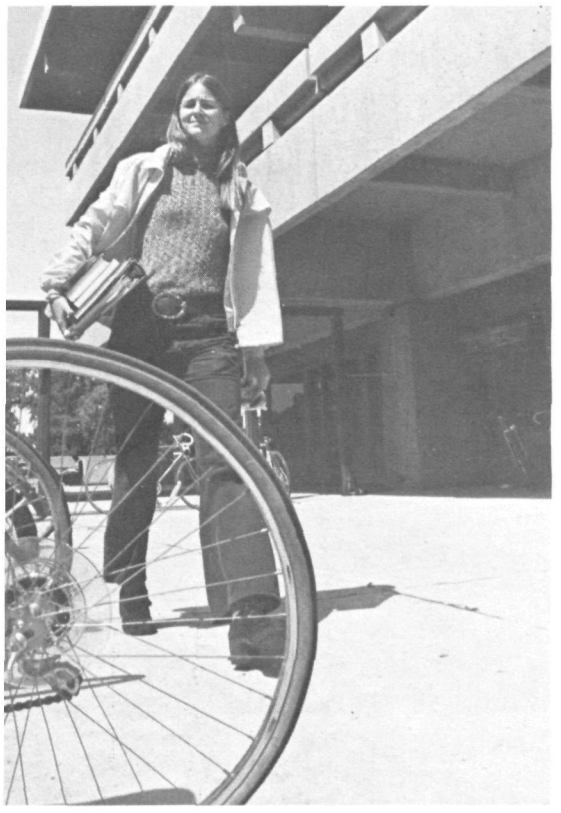
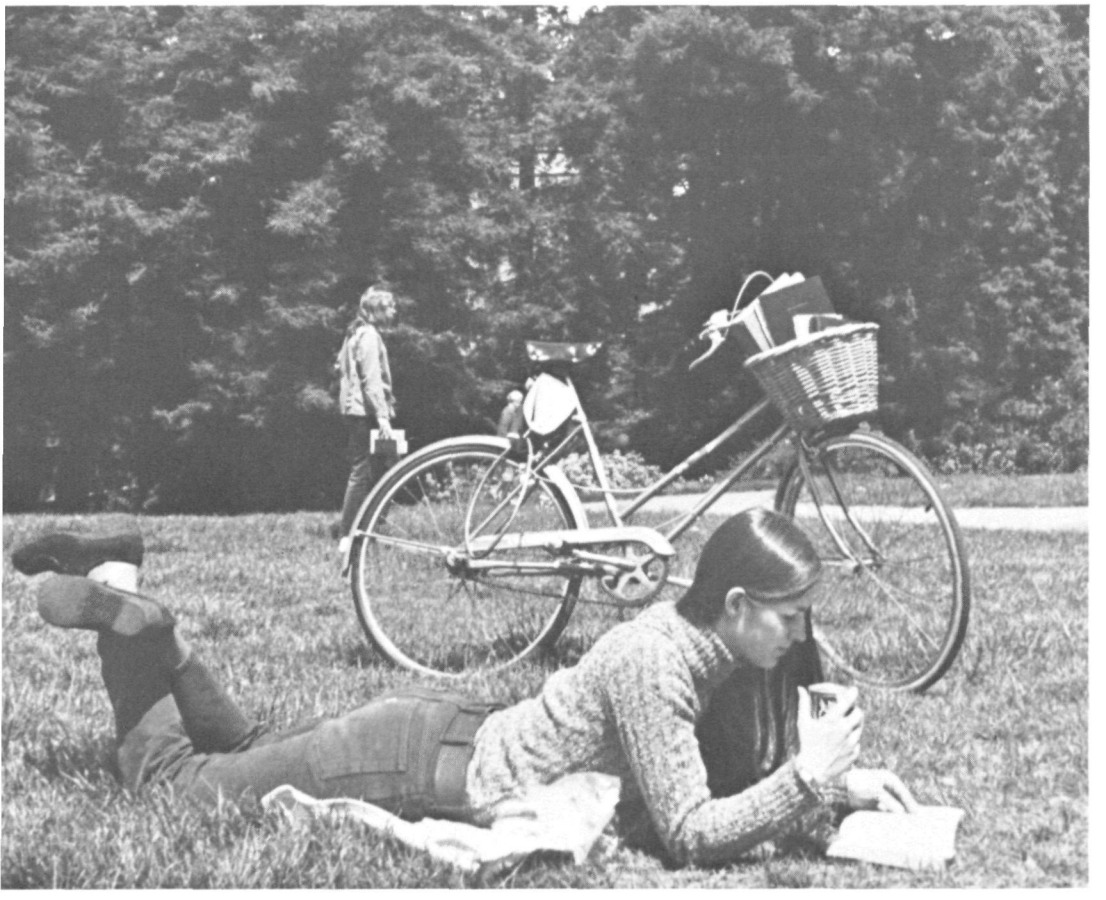


(Opposite page) The 41st NOAA Officer Training Class. (Far left) Pamela Chelgren bicycled across the campus of the University of California at Berkeley. (Above) Her interest in sailing led her to enroll in naval science courses. (Left) She worked 20 hours a week in the University's Space Sciences Laboratory, where one of her assignments was checking on the condition of data tapes from the Orbiting Geophysical Observatory-5 spacecraft. (Below) Studying in the University library.





(Above) A stop at the library between classes. (Right) A little over two years ago, Pamela Chelgren took up sailing, and it became her number one hobby. She was a member and instructor at the Cal Sailing Club, and took to the Bay waters as often as her schedule allowed. (Below) After class and before work, there was just time for a quick lunch on campus.



Santa Cruz and Oxnard, Calif., Bremerton, Washington, and Point Mugu, Calif.

"To me, moving is exciting," Ms. Chelgren says. "I get a real warm feeling looking at an empty, barren room when the furniture has been taken away. Or driving down a superhighway at night. It's the excitement of going to a new place."

Frequent changes of school gave her no problem but, of course, "you like some better than others."

She has always had a natural aptitude for mathematics and science, and while in high school at Bremerton, Wash., was chosen to attend the 1967 summer mathematics institute at West Washington State College in Bellingham, a special program for outstanding high school students.

Another memory of her years in Bremerton is playing in the school band when it welcomed Navy ships arriving in port. "Then we got to go aboard the ships—destroyers and aircraft carriers. That was fun."

Ms. Chelgren completed high school at Point Mugu, Calif., one of the top ten in the 1968 graduating class with a 3.8 grade point average. She won the Bank of America achievement award in foreign languages, the Elks' most valuable student award, and a life membership in the California Scholastic Federation—the State's honor society. She also was a State Scholar, based on her class rank and Scholastic Achievement Test scores, and received a scholarship for her first three years at the University of California, Berkeley, the only college she considered attending.

In the fall of 1968, when she was ready to enter Berkeley, the rest of the Chelgren family was moving from Point Mugu to Washington, D.C. With the family gone from the Point Mugu address, Pam's college registration forms were returned to the University. So the freshman girl's first experience at the 27,000-student school was to encounter the registration system without the proper forms. "It was terrifying," she remembers. "I was even afraid I might lose my scholarship." But she stood for hours in the long lines and finally managed to become a registered student at Berkeley.

Although mathematics was her principal interest, she felt that emphasis at Berkeley was too theoretical for her tastes, so she enrolled as an electrical engineering major. Toward the end of her sophomore year, she went to the university's vocational guidance center for testing. "The results kept showing life sciences. I was amazed," she says.

As a result she switched to bio-engineering, a field that emphasizes an engineering approach to medical research. Some aspects of bio-engineering include development of improved artificial limbs and organs, research on fluid proceses in humans and animals, and development of electronic equipment for diagnostic or remedial uses.

In her junior year, she assisted with a special research project in the University's zoology department. She is listed as a co-investigator in the report on this study of

Pamela Chelgren became the first woman officer in the NOAA Corps, when she was sworn in by Secretary of Commerce Peter G. Peterson on July 6. Her father, Navy Captain John Chelgren, held the Bible for the ceremony.

the effects of temperature and food intake variations on the Bufo boreas—or common toad.

She held summer jobs in banks in the San Francisco area, and in her senior year Ms. Chelgren worked at least 20 hours each week as a statistical clerk in the University's Space Sciences Laboratory. In an office trailer named "Saturn," she worked with data on x-rays in space gathered by OGO (Orbiting Geophysical Observatory) -5. One day, the assignment might be plotting the x-ray data; another would find her running older tapes through a computer to check on their condition—a process called "scelming."

Always interested in outdoor sports, Ms. Chelgren has skied since high school days. She also enjoys summer backpacking and camping in the Sierras. Two years ago, she decided to try sailing. "Now, it's my number one hobby," she says. She was a member and instructor at the Cal Sailing Club, and took to the Bay waters as often as her schedule allowed.

This hobby led her to enroll in two naval science courses to learn navigation. "It's very handy when that fog rolls over the Bay," she points out.

In her last quarter at Berkeley, together with such courses as fluid mechanics and naval science, her schedule included a course in music, a long-time interest of her family.

Her maternal grandmother was a concert pianist from Fargo, North Dakota, who appeared on tour in many parts of the West. Her mother studied voice and, before her marriage, planned a career in opera. All of the Chelgren children have studied piano and another instrument. In Pam's case, the second instrument was the flute, which she still plays and plans to take with her on her travels in the NOAA Corps.

Although she is not a member of any women's liberation organization, Ms. Chelgren generally agrees with their broad aims, particularly those of eliminating discriminatory legislation. "But some of the real radicals seem to hate men, and I don't go along with that."

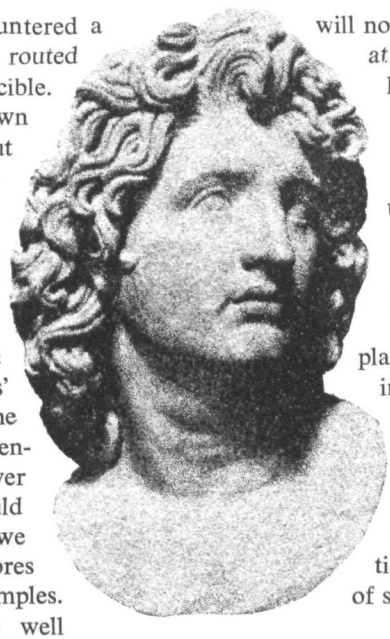
When she made an appointment with the NOAA Corps recruiters visiting the Berkeley campus, she did not know that there were, as yet, no women in the Commissioned Corps. And now, Ensign Chelgren says, "I am more interested in the challenge of the job itself, than I am in being a 'first'." □

ALEXANDER AND THE BORE

Walter B. Zerbe was a distinguished authority on tides in the Coast and Geodetic Survey, predecessor of NOAA's National Ocean Survey, for three decades. Now, 16 years after his death in 1956, an unpublished document has come to light, in which Mr. Zerbe described the near-defeat of Alexander the Great by a natural phenomenon known as the tidal bore.

Alexander the Great had never before encountered a bore. But the tidal bore on the Indus River almost routed his army which up to then had proven invincible.

The ancient Greeks knew of the tides as shown by the writings of their philosopher-scientists, but the tide in their part of the Mediterranean was so imperceptible that it played no part in their daily lives. Consequently, Alexander and his officers could hardly have known of the bore which is an awe-inspiring feature of the tidal phenomenon; and that ignorance was nearly their undoing.



Curtius, in his *History of the Life and Reign of Alexander the Great,* tells of the Macedonians' voyage down the Indus River from Pattala to the ocean, and gives a vivid description of their encounter with the bore as they approached the river mouth. But before we look at that account, it would help us to understand their predicament if we examined some background information on bores in general and glanced at some of today's examples.

Bores occur in a relatively few localities well scattered throughout the world. At its worst, it is a foaming, churning, wall of water advancing upriver from the sea. At its weakest, it has the appearance of a small wave or series of waves. The word, *bore,* comes from an old Norse word meaning *wave.* It has been called by other names, such as *eagre* in England, *mascaret* and *barre* in France, and *pororoca* in Brazil.

They occur in river mouths near the sea and there are several conditions that favor their formation. The river must empty into a bay or region in which the tides are large so that the tidal rise is rapid. The river, near its mouth, is usually wide and shallow at low tide, and its bottom has a certain slope or its sides a certain funnel-shaped convergence that help retard the advance of the tide. As the tide rises in the bay, its forward movement up the river is held back by these neutral conditions until it has risen enough to force its way upstream as a wave front or wall of water.

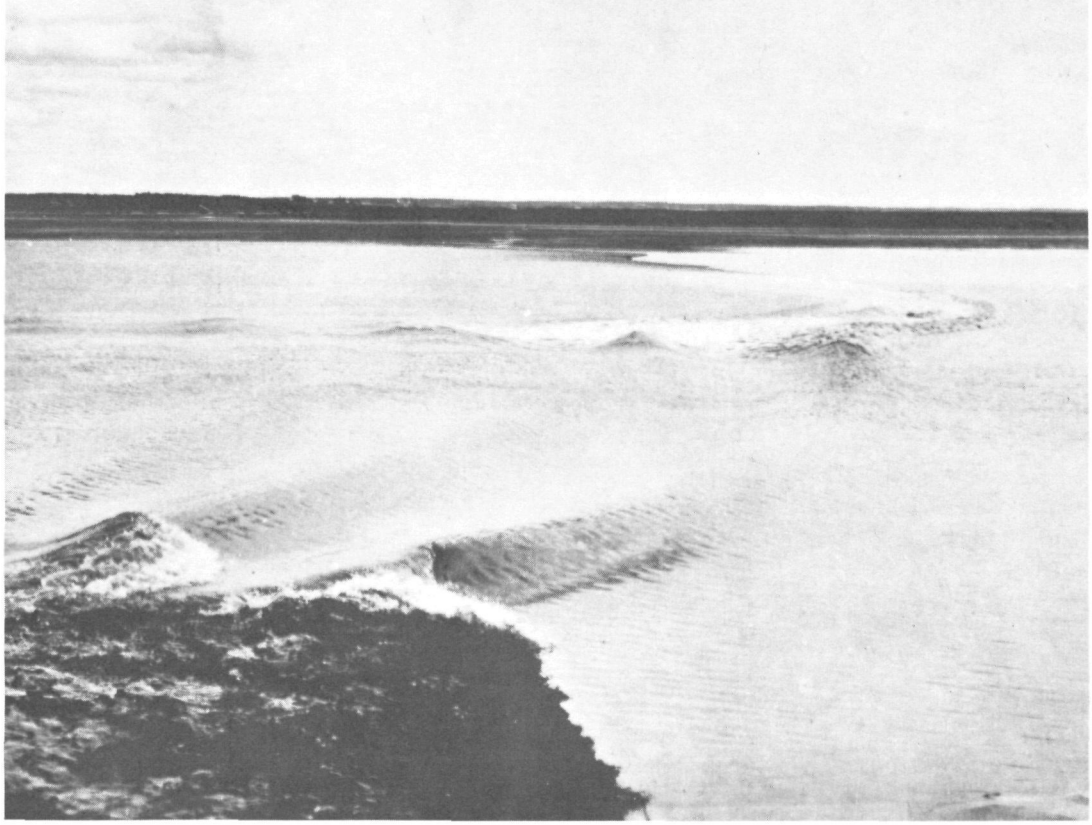
This is the bore, and as it passes an observer on shore, he will notice that the water behind it continues to rise, rapidly at first and then more slowly, until the water reaches high tide. It then falls in a more normal fashion to low tide after which the sequence is repeated.

The bore occurs twice daily soon after low tide, but where the two tides of the day are very unequal, the bore may be much more dangerous on the larger tide than on the smaller one. Like the tide, its time of occurrence can be accurately predicted.

Being a curiosity of nature, bores in some places are a considerable sightseeing attraction, such as in the Petitcodiac River at Moncton, New Brunswick, near the head of the Bay of Fundy. The range of tide varies during the month and year, but one can learn from published tide tables when the tides are largest as well as the exact time to be on hand for the bore's arrival. It is best seen at the time of month when the tide is large, for at times of small tides it is scarcely more than a large ripple.

When the tides are largest, the bore arrives at Moncton as a five-foot wall of tumbling, churning water extending a half mile from shore to shore. The first sound of its approach resembles the noise of a distant train heard across the water, and as it draws nearer the noise increases to the usual hissing, rushing sound of broken water. The bore arrives about 10 minutes after the first sound is heard. After it passes, the water continues to rise another 25 or 30 feet to high tide. In the next few hours the water falls to a low tide leaving the wharves dry and reducing the river to a stream about 500 feet wide meandering through exposed bars and mud flats. The phenomenon is then ready to be repeated.

Bores also occur in the Solway Firth and the rivers Severn and Trent in England, where they are probably somewhat less spectacular. In the Rio Araguary and some other nearby rivers of Brazil, the bore or pororoca is said to attain heights of from five to fifteen feet. There is still a bore in the mouth of the Colorado



A tidal bore passes Moncton, New Brunswick, near the head of the Bay of Fundy. When the tides are largest, the bore arrives at Moncton as a five-foot wall of tumbling, churning water.

at the head of the Gulf of California, though it is said to be much less of a spectacle than it once was, and it is in an almost inaccessible area. The bore in Turnagain Arm, near Anchorage, Alaska, reaches a height of six feet under favorable conditions. There are also quite sizable bores at a number of places in Burma, Pakistan, and India.

Probably the most spectacular and dangerous and yet the most utilized is that in the Tsientang Kiang at Haining, China. On large tides, the advancing front of churning water has a height of 10 to 11 feet (some say 15) and moves upstream at about 15 knots. River boatmen have a unique way of avoiding its dangers and yet of making use of it. On the falling tide, junks make for a stone shelf built along the river bank and remain there as the tide falls below it so that they are out of harm's way when the turbulent bore arrives. After it passes, they are soon floated by the continued rise of the water and make their way out into the stream to be caught by the aftersurge and carried at about 10 knots far upstream by this natural motive power.

This then is the type of phenomenon encountered by Alexander's army as it approached the mouth of the Indus River on its southward journey down the river toward the ocean. There is no mention of a bore in the Indus in any of today's tide tables, but natural changes in estuary by silting or scouring, as well as artificial changes, can make the difference between the existence or nonexistence of a bore. There is reported to be evidence that at one time there was no bore in the Tsientang Kiang. Before the River Seine in France was improved, beginning about 1780, it had a dangerous bore that affected the whole river to Rouen, but today it occurs in only a very short stretch on only the greatest tides.

Perhaps the bore in Alexander's time was not large. But that it was large enough to create considerable havoc and to cause amazement and consternation among the uninformed Macedonians as they sailed down the Indus toward the sea is evident from the account written about 50 A.D. by Quintus Curtius in his "History of the Life and Reign of Alexander the Great." Since any present attempt to describe the event would be a poor substitute for the picturesque language of the translation from the Latin by Pratt, published in 1809, his translation of Book IX Chapter IX is given verbatim, punctuation and all.

"As the guides had escaped from relaxed custody, Alexander was obliged to protract his stay. Parties sent to bring in other guides could not find any. His uncontrolled desire to see the ocean, and the limits of the earth, induced him to commit, without local pilots, the lives of himself and his brave men to an unknown river. The navigators were unacquainted with the channels through which they were borne, nor knew the distance of the sea, nor what tribes inhabited the shores, nor whether the estuary was free from shoal-water and calculated for long ships; in every thing dependent on blind conjecture. Their consolation for their superior's temerity, was his unvarying success.

"They had advanced four hundred stadia,* when the marine commanders reported, that a sea-breeze was perceptible, and that they did not consider the ocean to be very distant. Alexander, with joyous emotion, exhorted the crews to row diligently: 'The consummation of labour, sought by the prayers and vows of the Macedonians, was approaching. Nothing would be wanting to their glory; nothing remain for bravery to subdue; the world would be won without another combat. Ready to open on their view, were places known only to the gods.'

"Alexander, however, debarked on the coast a small detachment, instructed to make captives from the wandering savages, from whom he hoped to learn particulars approaching accurate intelligence. To the question, 'How distant is the sea?' the Barbarians replied: 'We have never heard any sea so much as named; but, in three days, you will come to bitter water, which corrupts the sweet.' It might be collected, that, ignorant of its nature, they spoke of the sea. The mariners, therefore, bend over the oars with robust alacrity; and as each day carried them nearer the object of their hopes, their ardour rose. On the third day the insinuations of the sea were perceptible in the river, blending their unequal waves by a gentle influx.

"To a second island, seated in the middle of the river, the naviagtors were then borne somewhat more slowly, because the

* *about 46 miles.*

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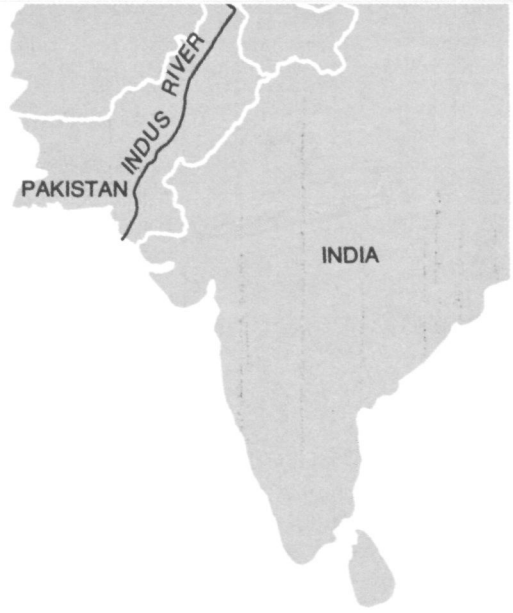


(Above) Location of the Indus River, where the tidal bore almost routed Alexander and his invincible army. (Right) Receding waters of a tidal bore at Yarmouth Sound, Nova Scotia, leaves boats high and dry on the harbor bottom. When the bore recedes, the river is narrow and shallow.

stream was counteracted by the tide. They moor their vessels, and separate in parties to forage, without a presentiment of the disaster which overtakes mariners locally uninstructed.

"About the third hour, the ocean, according to a regular alternation, began to flow in furiously, driving back the river. The river—at first, arrested; then, impressed with a new force—rushed upward with more impetuosity than torrents descend a precipitous channel. The mass on board, unacquainted with the nature of the tide, saw only prodigies and symbols of the wrath of the gods. Ever and anon, the sea swelled; and, on plains recently dry, descended a diffused flood. The vessels lifted from their stations, and the whole fleet dispersed—those who had debarked, in terror and astonishment at the calamity, ran from all quarters toward the ships. But tumultuous hurry is slow. These, with boathooks, are hauling up their gallies: these, while fixing their seats, prevent the oars from being paired: some, hastening to sail, without waiting for the complement of mariners, impel languid hulls, unmanageable, crippled in the wings of navigation; other transports could not hold those who inconsiderately pressed into them: deficient, or redundant, numbers equally obstructed the impatient. Here was clamoured, 'Wait:'—here, 'Row off.' Dissonant voices, circulating inconsistent orders, prevented the multitude from acting by their own observation, or from hearing the general command. Nor availed the pilots; whose directions were either undistinguished in the tumult, or disobeyed by terrified and promiscuous crews.

"Vessels dash together; and oars are by turns snatched away, to impel other gallies. A spectator would not imagine a fleet carrying the same army, but hostile navies commencing a battle. Prows strike against sterns: on the invading vessels, other drive aft. The fury of altercation carried the mariners to blows.

"Now the tide has inundated all the field skirting the river, only tops of knolls extant like little islands: to these, from the evacuated ships, the majority swam in consternation.

"The dispersed fleet was, partly, riding in deep water, where the land was depressed into dells; and, partly, resting on shoals, where the flood had covered elevated ground: Suddenly breaks on the Macedonians a new alarm, more vivid than the former. The sea began to ebb; the deluge, with a violent drain, to retreat into the frith, disclosing tracts just before deeply buried. Unbuoyed, the ships pitched, some upon their prows, some upon their sides. The fields were strewed with baggage, arms, loose planks, and fragments of oars. The soldiers neither daring to descend to the ground, nor reconciling themselves to stay in the transports, awaited what calamities could follow heavier than the present. They scarcely believed what they suffered and witnessed—shipwrecks on dry land, the sea in a river. Nor yet ended their unhappiness; for, ignorant that the speedy return of the tide would set their ships afloat, they predicted to themselves famine and death. Terrifying monsters, too, left by the waves, were vagrantly gliding around.

"Now night approached; and the desperate circumstances touched the king with concern; but no anxieties could overwhelm his invincible courage. All night, he superintended the watches; he sent forward horsemen to the mouth of the river, to bring intelligence when the access of the tide commenced. Meanwhile he ordered the shattered ships to be refitted, the overset to be propped up; and the mariners to be prepared, and attentive against the flux of the tide.

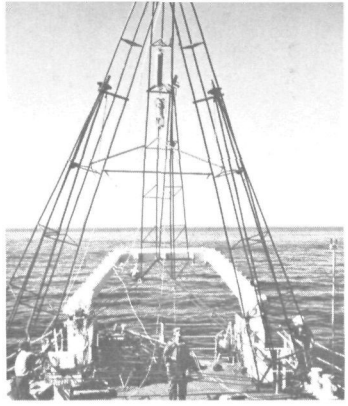
"The night consumed in vigilance and exhortations, the horsemen are descried, flying back in full career, followed by the tide. By a gradual diffusion, the inundation began to raise the ships; presently, flooding all the fields, it set the fleet in motion. Along the banks, resounded from the soldiers and mariners shouts of boundless joy, celebrating an unhoped deliverance. 'When reissued suddenly so great a sea? Whither the day before had it retreated? What were the nature of the element, elsewhere refusing, and here acknowledging, periodical laws?' with wonder they inquired.

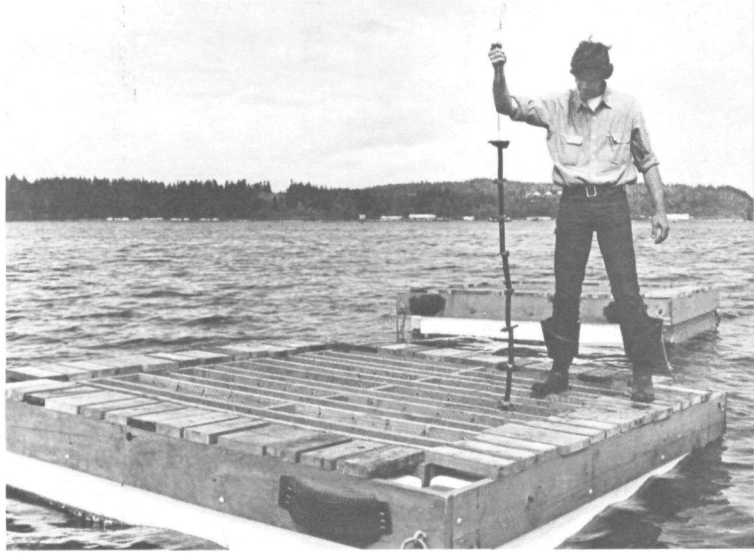
"From what had happened, the king conjectured the appointed time of the flux to be just after sunrise. To anticipate the tide, he, at midnight, descended the river with a few vessels; and, passing its mouth, advanced four hunded stadia into the sea. A favourite object accomplished, he sacrificed to Neptune and the local deities, and returned to the fleet." □

3R's for Sea Grant Students

- Realism
- Relevance
- Results

BY CAROL B. OVENS





Graduate students in the University of Washington's Sea Grant-sponsored course, "Interdisciplinary Ocean Engineering Systems Design," have used submerged towers to explore Cobb Seamount (top) and participated in aquaculture projects.

College students, not professional "think tank" experts, did the study. But bankers and businessmen, Federal and state fishery specialists, newsmen and college professors all crowded into a room in Seattle one afternoon to hear the results.

The topic: increasing Puget Sound's seafood harvest. It was a topic of vital interest to the region, where the economy has lagged and where unemployment has at times hit 13 percent. Because the students came from a Sea Grant course known for its rigorous approach to real-life problems, the audience was large, and interested.

The students described a plan to grow 70 million pounds of plate-size coho salmon each year in huge pens submerged in Puget Sound. The fish farms would also turn out 170 million assorted fingerlings, which would mature at sea and return to be caught by both commercial and sports fishermen.

How to feed the fish? Perhaps, said the students, on pellets produced from sewage sludge at $10 a ton as compared with the $200 a ton for food now used. The pens would be serviced by barges passing between them, blowing feed into the fish; at harvest time, the barges would pump the salmon out for grading and processing. Cost estimates were given, along with suggestions for financing such projects.

Ideas were also forthcoming for tripling the state's oyster population and developing new markets for clams, mussels, scallops, abalone, and seaweed. A student pointed out that warm water waste from proposed nuclear power plants in the Sound could be used to host fish demanding a warmer environment than the normal Sound water. The class even went into the possibilities of improving or weeding out inefficient boats and skippers and raising the fee for fishing licenses to reflect more accurately the true value of fishing rights.

Solutions to the social and political problems, the students foresaw, would be more elusive than would solutions to biological and technical problems.

The audience, sophisticated and skeptical, gave serious attention to the report. The questions indicated respect for the students and deep interest in their ideas. A detailed written report is being prepared to meet the numerous requests.

"Interdisciplinary Ocean Engineering Systems Design," as the course is known, is financially supported by the Washington Sea Grant program under NOAA. Its purpose is to involve graduate students in tough problems that meet today's test of relevancy, and stimulate them to propose solutions worthy of serious attention. The two previous studies undertaken in the course had also attracted widespread notice because the resulting reports demonstrated the critical professional thinking that had gone into them.

One study was devoted to the problem of oil spill in Puget Sound—important because, with the opening up of Alaskan oil resources, the Sound's deep-water facilities, refineries, and abundant electric power will likely become heavily involved. Students from business, fisheries, geography, law, and engineering participated in that study, defining the problem and making specific recommendations for prevention and control. Their 600-page report, issued by the University of Washington Press under the aegis of its Sea Grant office, is in widespread use.

The earliest study dealt with exploration and use of Cobb Seamount, a submerged mountain 270 miles off the Washington coast that rises to within 112 feet of the ocean surface. Lying on a seismic ridge, it can yield information on seafloor spreading, the geology of submarine seismic regions, and the interaction of ocean and atmosphere. The full report issued at the end of the course is in use by scientific groups undertaking research at the seamount.

The course thus encompasses several key Sea Grant objectives: bringing together people from different disciplines to make a common attack on a problem; looking for practical ways to better manage the marine environment; and making study results widely available to people who can use them. In addition, it has brought students into contact with real-life problems, giving them the opportunity to make imaginative, responsible efforts to solve those problems. □

Carol B. Ovens is an editor with the University of Washington's Sea Grant Program.

THE WEATHERMAN MAY BE A WOMAN

BY HELEN SILVER

"WEATHERMAN" or "weather observer" may once have brought to mind images of a man poring over charts, watching a radar screen, or measuring rainfall. Today, such images are out of date.

There are thousands of women working for the National Weather Service. Some fill professional positions, but far more swell the ranks of the Weather Service's network of 13,000 volunteer weather observers, many with service of 50 years or longer.

Using a standard Weather Service instrument shelter equipped with a maximum-minimum thermometer and a simple rain gage, their daily observations cover just about every kind of weather recorded in the United States. Some women observers read river gages or make other measurements on special assignment.

Most of the women who take and record daily observations of temperature, rainfall, and river levels began their work by relieving a friend on vacation, or by helping their husbands who were official observers. Others, like Miss N. Dixie Wineman, of Derry, Pa., continued a family tradition. Miss Wineman took over the duties begun by her father in 1896—continuing an unbroken span of 76 years of observations at the same location.

In the spring of this year, Miss Wineman, a retired businesswoman, said, "The maximum thermometer was stolen from the instrument shelter after having reposed in our backyard for 75 years. The Pittsburgh Weather Service Office came and installed a new one the next day. The police have not found the thief."

Like a great many of the women observers, Miss Wineman frequently provides weather records to local newspapers and radio stations. Her information is a basis for comparing extremes of temperature, rainfall, and snowfall. Occasionally a daily measurement is not taken, as in the St. Patrick's Day Flood of 1936 when five inches of rainfall in less than two hours deluged the Wineman property, washing away the rain gage.

During the record-breaking floods of this past June, Miss Wineman said that Derry was more fortunate than many other Pennsylvania communities. There was no severe flash flooding or loss of life, although she measured 10.85 inches of rainfall from Tuesday, June 20, until Sunday, June 25, breaking her records for the past 26 years. This time, she emptied the rain gage several times a day to keep it from overflowing, thereby ensuring that the precipitation measurements would be accurate.

"At 4 a.m. on June 23," Miss Wineman stated, "Derry's residents were urged by local authorities to evacuate their homes and go to schools located on high sites because they feared the reservoir would

burst. I joined the group of people in one of the local high schools. The Red Cross brought us blankets and bought out all the bread in town to make us sandwiches. The next evening, they furnished big buses to take us to a cafeteria at another school for a hot meal, and then we were allowed to return to our homes. Luckily, the reservoir held.

"This type of steady rain," Miss Wineman said, "was not as bad at Derry as at other times when five or six inches have fallen in that many hours, creating flash floods. I recall flash floods that have filled my basement with water up to my armpits."

Another woman observer also has had experiences with heavy rains. According to Mrs. Aileen Jones, the Weather Service's volunteer observer in Ketchikan, Alaska, since 1956, yearly rainfall in Ketchikan averages 152 inches. Because Ketchikan is situated on a rocky island, heavy rainfall generally runs off. On December 10, 1962, however, Mrs. Jones recalls: "The snow in the mountain started to melt and, with an extremely heavy rainfall of 7.28 inches in 24 hours, our river flooded and washed one of our local bars out into the channel. It floated out there for hours, to the amusement of everyone in town."

Referring to her detailed records, Mrs. Jones said, "This year we had snow from December 1 until after March 1—very unusual for us. Our temperature is moderate summer and winter as a general rule. It seemed like the real Alaska."

Windstorms, too, can strike unexpectedly in Alaska as on Thanksgiving Day, 1969, when 100-mile-per-hour gusts took Ketchikan's 300-foot radio tower from its moorings.

It's almost a "rule of thumb" that most of the Weather Service's cooperative observers, both men and women, are busy people, active in their jobs and community activities, and avid hobbyists. One great hobbyist and civic worker is octogenarian Ms. Ida B. Le Nord, the Weather Service's volunteer observer at Fernley, Nev., for the past 18 years.

Ms. Le Nord was born in eastern Nevada, of pioneer parents who came west in covered wagons. Through the years, she has been Fernley's town clerk and historian. She has also acquired a large collection of early-day relics, buttons, glass, bottles, and historical artifacts which she keeps on display in a small museum on her property. Tourists from many states are frequent visitors to Ms. Le Nord's museum.

Ms. Le Nord's knowledge of Nevada's history qualifies her as a consultant on the state's history, and she was a co-worker with Stanley Paher on his book, *History of Nevada*. Her climatological records on Fernley, going back to 1954, contribute to this documentary of a hardy, sometimes harsh, region of the United States.

Extreme weather is not unusual in the records of Mrs. Rollin Key, a Winner, S. Dak., housewife—another woman observer who has a service record spanning the past 33 years. Her climatological summaries of Winner's weather appear frequently in the local newspaper, providing valuable information to the area's residents.

Mrs. Mona Kurtz is one of the many observers whose stations are located on family ranches or farms. Her station is on the Kurtz ranch at the base of Irene Mountain, in an isolated valley in northeast Washington, near Wauconda. Mrs. Kurtz is the second member of the Kurtz family to be a cooperative observer. She took over the station in 1925 from her mother-in-law who had been official observer since the station was established, more than 50 years ago.

Mrs. Kurtz's excellent service of close to 50 years was acknowledged last year when she received the John Campanius Holm Award. Each year 25 volunteer weather observers are selected nationwide to receive this award in recognition of their outstanding accomplishments. Mrs. Jones, Mrs. Key, Ms. Le Nord, and Miss Wineman were the other women in the 1971 group of winners. Like most of the network's observers, all five serve without pay.

When the winners of the 1972 Weather Service awards were announced, the names of seven more women were added to the many previously honored for their day-to-day service to the Weather Service and the American public. The Thomas Jefferson Award, the Weather Service's top honor for cooperative observers, was presented to Mrs. Ethel H. Hayes of Wilmington, Ohio. John Campanius Holm Awards were given to Mrs. Ella L. Albrecht, Buxton, Ore.; Mrs. Pearlee M. Little, Enterprise, Miss.; Mrs. Pattie L. Mizelle, Greenville, N.C.; Mrs. A. H. Nelson, Bushnell, Fla.; Mrs. Hazel Pruett, Quenemo, Kans.; and Mrs. Lucille E. Weddle, Badger, Calif.

The valuable weather information gathered by these 13,000 observers—from city backyard to isolated mountain ranch—is processed and published by the Environmental Data Service, another agency of NOAA. Each fact is stored indefinitely in high-speed electronic computers and is available for use in dozens of government publications and studies. The public, too, can obtain weather facts and figures for hundreds of uses from the National Climatic Center in Asheville, N.C., where the giant computers are located.

In the Weather Service's professional ranks, two women are in charge of weather stations. Mrs. Hazel Tatro heads the Weather Service's office for the Bristol-Johnson City-Kingsport, Tenn., area at Tri-City Airport in Blountville, Tenn.

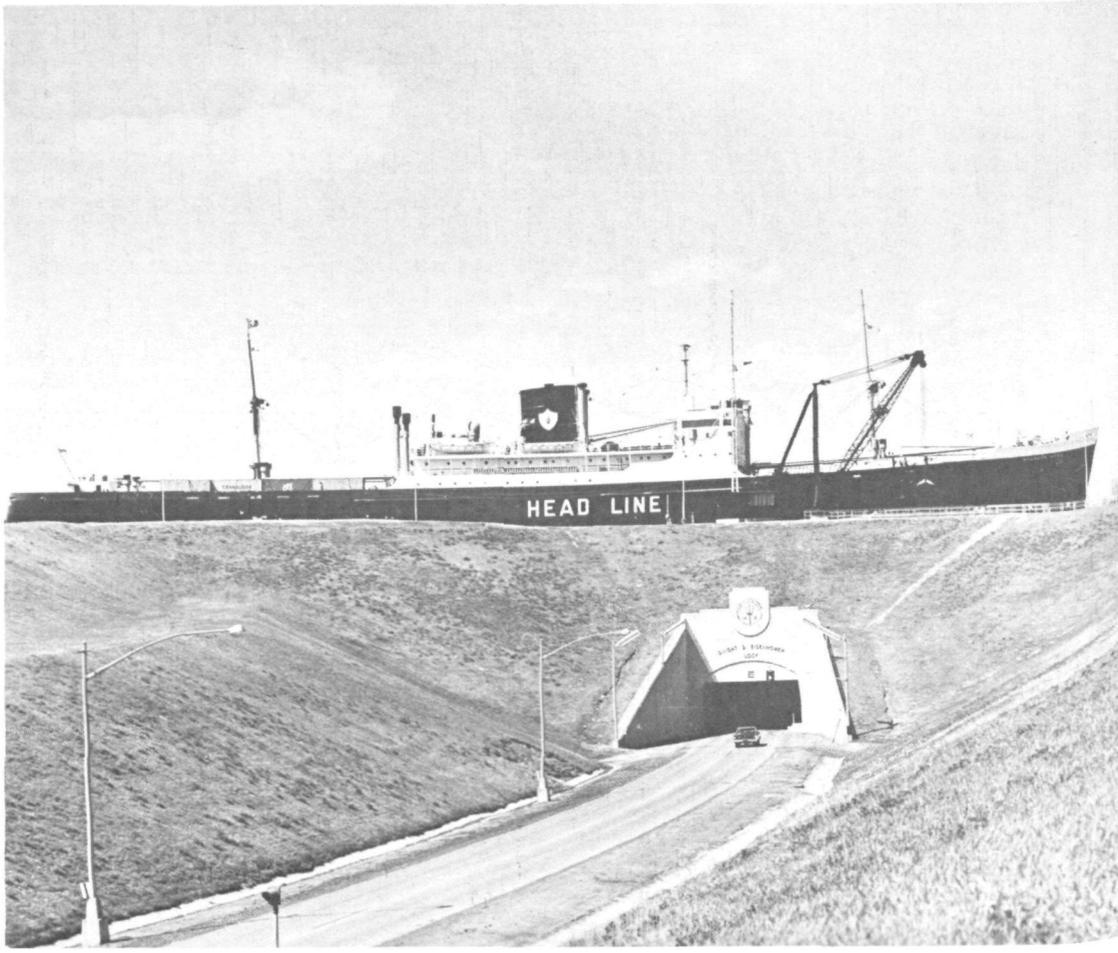
Miss Marie Fellechner has been Meteorologist in Charge of the National Weather Service's radar facility at the Naval Air Station at Patuxent River, Md., since February 1971.

Other women serve the Weather Service as observers in charge, principal assistants, and meteorologists.

Whether professionals or volunteers, these women prove that daily weather observing is a fascinating and fulfilling job or hobby for persons of any age or sex. They can take pride in contributing to the nation's storehouse of weather history. □

(Opposite page) Miss N. Dixie Wineman checks minimum-maximum thermometers in the instrument shelter at Derry, Pa., where her family has reported on the weather since 1896. (Top) Weather is just one of the many interests of Ms. Ida B. Le Nord, observer at Fernley, Nev. (Bottom) Mrs. Aileen Jones measures precipitation at Ketchikan, Alaska, where she has been a volunteer observer for 26 years.

(Below) Queen Elizabeth II and President Dwight D. Eisenhower officially opened the St. Lawrence Seaway. (Right) The Irish vessel ROONAGH HEAD enters Eisenhower lock. (St. Lawrence Seaway Development Corp. photos)



The Lake Survey Center prepared and published accurate nautical charts of the St. Lawrence Seaway before it was filled — a paradoxical project.

CHARTING A DRY SEAWAY

BY JOHN HANNA

When the first ships sailed into the St. Lawrence Seaway in 1959, they entered waters that had not been there three days before.

Yet nautical charts of the newly constructed Seaway were ready, through a cooperative effort of the Canadian Hydrographic Service and the U.S. Lake Survey—now the National Ocean Survey's Lake Survey Center.

Their experts had successfully solved the problem of charting waters that didn't exist.

Normal field activities for making charts include depth soundings and accurate positioning of landmarks. But there was no water over most of the area to be charted and the possibility that some landmarks might be under water after flooding made such conventional methods impractical.

To grasp the sheer magnitude of the St. Lawrence Seaway project, consider that between them Canada and the United States spent over a billion dollars; whole towns and villages, and even cemeteries, were moved and relocated; a brand new lake, Lake St. Lawrence, 25 miles long with a surface area of 100 square miles, was formed; an estimated 80 percent of the world's merchant fleet could now enter the Great Lakes through an area formerly limited to 14-foot-draft navigation; and many miles of new highways and railroads were built. The Seaway cut 20 hours off the transit time from Montreal to Lake Ontario, and shipping costs were reduced by $22.50 per ton.

Work on the U.S. side was authorized on May 6, 1954, by Public Law 358 (Wiley-Dondero Act), 83rd Congress, 2nd Session. President Eisenhower signed the bill one week later and construction began in September of that year. The Buffalo District of the Corps of Engineers was responsible for design and construction of U.S. navigation works. The power project was constructed jointly by the Power Authority, State of New York and the Hydro-Electric Power Commission of Ontario. The St. Lawrence Seaway Development Corporation was appointed to operate and manage the U.S. part of the Seaway.

From tidewater in the Gulf of St. Lawrence to Lake Ontario, this mighty river is nearly 550 miles long and rises some 245 feet. Its average flow is 240,000 cubic feet per second, or 108 million gallons of fresh water per minute.

Most of the work was performed in the area from the head of the river at Lake Ontario downstream to Montreal, a distance of about 200 miles. The river below Montreal is generally deep and wide, and required little or no improvement. The work area was divided into five sections; from west to east they are: (1) Thousand Islands Section, 68 miles long; (2) International Rapids Section, 44 miles long; (3) Lake St. Francis Section, 30 miles long; (4) Soulanges Section, 16 miles long; and (5) Lachine Section, 31 miles long. The International Boundary extends generally down the middle of the river in the first two sections, which are shared by the two countries. The other three are in Canada.

The greatest effort was probably expended in the International

Rapids Section. There the United States built a 10-mile-long ship channel, two deep-draft locks, a 3,000-foot-long, 114-foot-high control dam and the U.S. half of the 16-turbine, 3,200-foot-long power dam. Canada built a control dam and lock and part of the power project. In addition, Canada built four other locks, accomplished extensive channel dredging, through solid rock in some sections, and deepened the Welland Canal connecting Lakes Erie and Ontario to 27 feet. Two of the new Canadian locks bypassed the Beauharnois power dam in the Soulanges Section, which had been built previously to Seaway specifications.

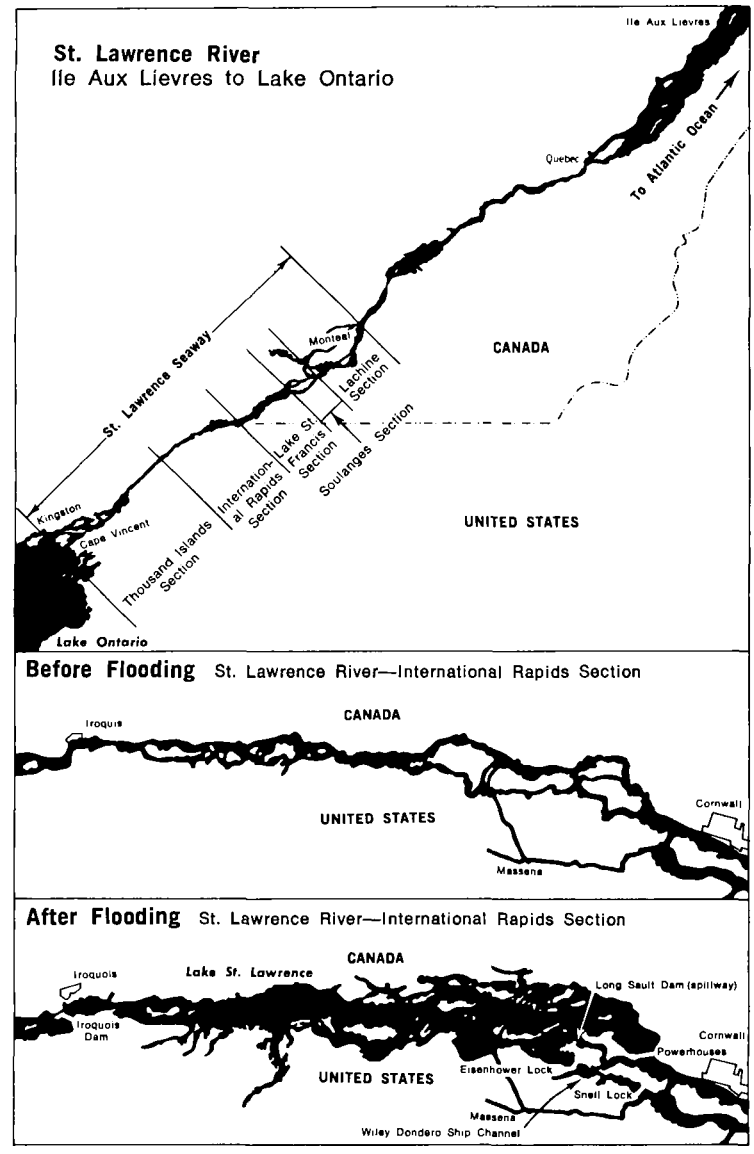
One of the requirements during construction of the Seaway was that 14-foot-draft navigation could not be interrupted. Therefore, normal flows in the river were maintained even though the two locks, control dam, and power dam at the downstream end of the International Rapids Section were built in the "dry." For example, the control dam was constructed in two sections; the river flowed through half the channel while the first part was constructed, then the river flowed through that part while the second section was being built. Cofferdams were erected to retain, control, or direct normal flows. When the power dam was completed, a cofferdam was blown up and the backed-up water poured through the breach. In the first hour water reached the dam, in eight hours it was 50 feet deep, and in three days the 25-mile-long Lake St. Lawrence had been formed with 90-foot depths in some places.

It was also the International Rapids Section that presented U.S. and Canadian chartmakers with one of their strangest jobs. There were physical changes elsewhere, but none so drastic as the change of the International Rapids Section from a narrow, winding river with many islands and rapids to a 100-square-mile lake.

A meeting was held in the fall of 1956 between charting experts from the Canadian Hydrographic Service and the U.S. Lake Survey, Army Engineers to determine a plan of action for charting the Seaway. Commercial shipping, a good percentage of it oceangoing and entering the Great Lakes for the first time, would have to have charts. So the decision was reached that provisional charts would be made and, as soon as possible after flooding, hydrographic surveys would be conducted and new charts issued.

But the problem of showing water depths where there was no water still existed. First, all available data on the topography of the area and hydrography of the river was collected and traded between the two chartmaking agencies. All pertinent preliminary and final construction drawings were obtained from the Corps of Engineers, Power Authority, State of New York, Hydro-Electric Power Commission of Ontario, St. Lawrence Seaway Authority of Canada, St. Lawrence Seaway Development Corporation of the U.S., and others involved in letting contracts for various phases of the work. One of the most valuable tools came from aerial photographs taken before any construction began. From them, topographic contour maps were made which were invaluable in plotting the limits of the area to be covered by water. Construction drawings also contributed significantly. Even though all buildings, telephone poles, trees, and bridges which would be submerged were removed, certain other changes in land features were inevitable. Some land cuts were made, and some areas filled in. The cuts were primarily for navigation and involved lopping off points of land and partial or complete removal of islands. All vertical control and a good percentage of the horizontal control were furnished by Lake Survey.

The crucial question, of course, was how to determine depths in the yet-to-be-formed manmade lake. They were computed mathematically. The chartmakers knew the depths in the original river bed, knew the elevations of the surrounding land area, and knew what the eventual pool level would be—from then on it was a matter of adding water depths to the pool elevation, subtracting land elevations from the pool elevation, and doing it for thousands



The change of the International Rapids section from a narrow, winding river to a large lake posed the greatest problem for the chartmakers.

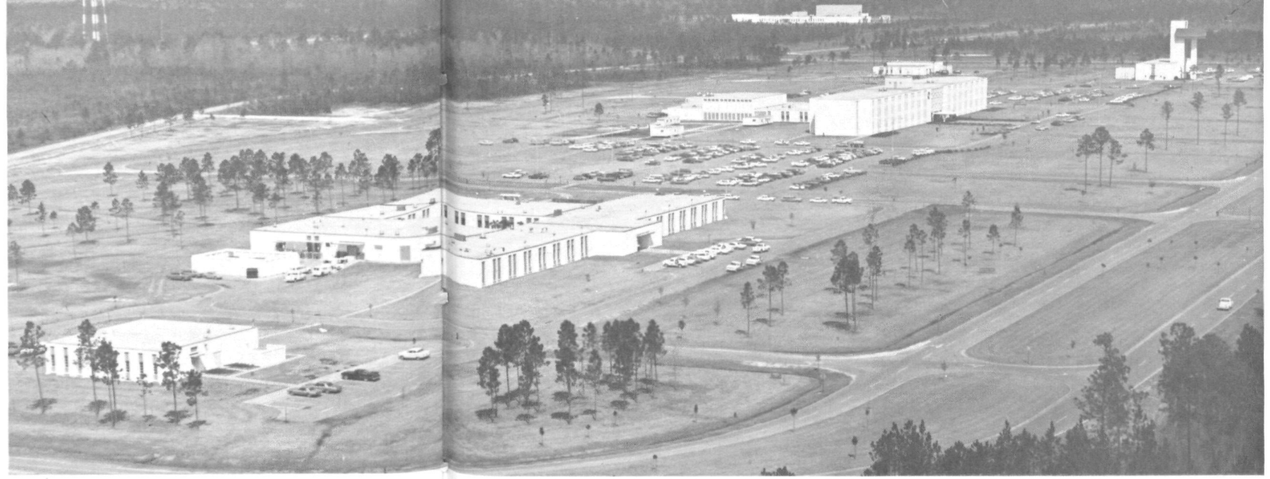
and thousands of points. To speed up the process, Lake Survey's chart compilation department went to a production-line setup. The overall chartmaking project was under the direction of Gilbert E. Ropes, then Chief of Lake Survey's Planning and Reports Branch and since retired. He and his chartmakers, including platemakers and press operators, received well-deserved praise when the completed charts were delivered three weeks before Lake St. Lawrence existed!

But how accurate were these charts? Survey crews could hardly wait to get out and field check these rather uniquely prepared charts. Ropes said later, "This field inspection showed that the provisional charts were remarkably accurate."

Except in one isolated instance. Lake Survey's survey vessel OGEMAW, a 40-footer, was conducting routine sounding work in a shoal water area when there was a tremendous "thump." After finally getting the boat stopped, the crew looked around and realized that they were in somebody's basement. A contractor had neglected to remove the foundation of a house that had been moved, and they were inside it. After marking the hazard on a field drawing, they escaped their predicament with no further damage by correctly timing and riding the bow wave of a passing freighter. □

science center on the gulf

Federal, state, and university research programs are thriving, where outlaws once buried gold, and NASA tested moon rockets.



BY RAYMOND WILCOVE

Gold, pirate loot, and Napoleon's ransom!

There's perhaps only one place in the United States where NOAA personnel can spend their time off looking for treasures of a bygone era. It's at NASA's Mississippi Test Facility (MTF) where the rockets to the moon were tested.

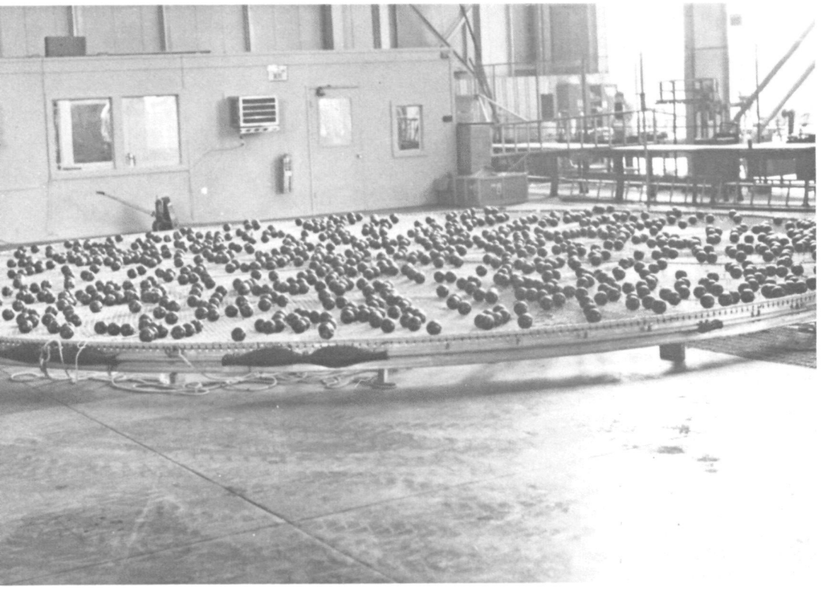
Here at a 142,000-acre site adjacent to the Mississippi gulf coast, the ghosts of the past vie with the 20th-century activities of four NOAA facilities—the National Data Buoy Center and the National Oceanographic Instrumentation Center's Gulf Coast Regional Center, both part of the National Ocean Survey (NOS); the Fisheries Engineering Laboratory of the National Marine Fisheries Service (NMFS); the Range Support Branch of the National Weather Service (NWS) and, nearby, at Slidell, La., its Lower Mississippi River Forecast Center and its Weather Service Meteorological Observatory.

No one knows whether any of the treasure reportedly buried at MTF has ever been found—if it has, no one is telling—but local inhabitants say it's still there. Somewhere on this expanse of 200 square miles —located on the banks of the Pearl River near Bay St. Louis and acquired by NASA in 1962—there are said to be vast amounts of gold and other loot buried by one of Mississippi's most notorious outlaws, James Copeland, who was hanged in 1857.

And under an oak tree Jerome Bonaparte, brother of Napoleon Bonaparte, buried $80,000 in gold he had collected to ransom his brother from captivity. When the movement to free Napoleon failed, Jerome was never able to return from Europe to dig up the ransom. Or so the story goes.

In the lobby of what was once NASA's "Central Control," the towering figure of an astronaut overlooks relics of Logtown, one of the old towns which have vanished from the area. Included among the Logtown relics is a September 7, 1901, edition of the New Orleans Times-Democrat, found in the old Logtown Post Office, which proclaimed across its front page: MR. M'KINLEY IS SHOT BY AN ANARCHIST, and beneath the headline the sad news that THE PRESIDENT, WHILE HOLDING A RECEPTION AT THE PAN-AMERICAN EXPOSITION IN BUFFALO IS TWICE WOUNDED BY AN ASSASSIN.

In the Fisheries Experiment Laboratory, four-inch plastic balls simulate the acoustic characteristics of fish.



Attached to a net, the plastic balls are placed in a large tank, where they become targets for sonar signals. The experiments are testing hydroacoustic techniques for fish assessment.

It is in this atmosphere of old and new that NOAA has established some of its most forward-looking projects. Here sophisticated equipment and facilities no longer needed by NASA are being used in support of programs being conducted by NOAA, the Interior Department, the Environmental Protection Agency, the states of Mississippi, Arkansas, and Louisiana, and a number of universities.

Some of the programs may seem way out, but they all have their practical aspects. Thus, for example, NMFS' Fisheries Engineering Laboratory is carrying out experiments in a four-story fish tank where fish are simulated by plastic balls in conducting hydroacoustic tests. (The fish will come later).

And in another building are 13 baths, but none for bathing. They are being used by NOIC's Gulf Coast Regional Center to check oceanographic and meteorological equipment.

And a short distance away is the Natioanl Data Buoy Center where engineers and scientists work on what may one day be a worldwide buoy system which will automatically report ocean data of immeasurable value to mankind.

Close by is NWS' Range Support Branch, the oldest NOAA facility at MTF, where the effect of space vehicle noise on the surrounding area was determined.

And at the NASA Slidell Computer Complex, about 20 miles from MTF, are banks and banks of computers which are utilized by the National Weather Service's river forecast center for a watershed area of some 200,000 square miles in Louisiana, Mississippi, Tennessee, Arkansas, and Missouri.

These are a few of the highlights in the multifaceted operations of NOAA. Here at MTF are to be found not only sophisticated facilities and equipment, but also skilled and knowledgeable scientists, engineers, and technical experts of numerous federal and state agencies, and private industry too, for private industry is playing a big role in NOAA operations as it did previously in those of NASA.

The largest NOAA operation at MTF is that of the National Data Buoy Center (NDBC), headed by James W. Winchester, which is within the Office of Marine Technology at NOAA headquarters in Rockville, Md. NDBC is developing a family of buoys to collect data from the marine environment for an entire spectrum of users ranging from university scientists to the National Weather Service. The information from the buoys, reported automatically to shore stations, is designed to fill an environmental data gap in maritime areas of the globe. Eventually, the establishment of a network of automatic buoys throughout the oceans, coastal waters, bays, estuaries, and large lakes will provide data required for predicting weather, sea conditions, fish migration, and other conditions with an impact on man and his endeavors.

The buoy program provides a good example of the close cooperation that exists at MTF between the government and private industry. The instrumented platforms which are being stationed this year in the Gulf of Mexico and the Gulf of Alaska for testing were designed by General Dynamics, San Diego, Calif.; fabricated by Daco Industries, Biloxi, Miss.; and prepared for testing at MTF. The meteorological and oceanographic sensors for the buoys are being furnished by Westinghouse Electric Corporation, Annapolis, Md., and EG & G Environmental Equipment Division, Waltham, Mass. Evaluation of the experimental buoys, both the large 100-ton platforms designed by General Dynamics and smaller but less expensive buoys with more limited capabilities designed by General Electric Company, Magnavox Company, and Lockheed Missile and Space Company, is being conducted also by NDBC at MTF.

National Data Buoy Center's nerve center is located in what was formerly NASA's Vertical Checkout Building (known in the MTF vernacular as the VCB Building). Within this complex one becomes intensely aware of the close cooperation that exists between government agencies as well as private industry. Here is to be found a highly sophisticated electronics laboratory which supervises the installation and checkout of the complicated electronic equipment which goes into the deep sea buoys.

continued

The visitors reception center at the Mississippi Test Facility reflects the site's diverse history.

The laboratory also contains a shore radio station, which communicates with the buoys. The station is used during the check-out phase of the operation. It is similar to the Coast Guard's Miami, Fla., radio shore station which receives and relays the environmental data received from the buoys every three hours, or on demand, to NOAA's National Meteorological Center in Suitland, Md. Engineering data is transmitted to NDBC at MTF to help it evaluate the buoys' performance while on station in the ocean.

The Coast Guard is working in close cooperation with NOAA on the buoy program. It transports the buoys to their operating sites and provides the necessary servicing and maintenance support for the buoys at sea and communications services in Miami and San Francisco. In addition, the Coast Guard, which handled the buoy program before it was transferred to NOAA in October 1970 by the President, is also supplying some of the buoy program's key personnel.

The huge Vertical Checkout Building also houses a facility of the National Marine Fisheries Services' Fisheries Engineering Laboratory. In the center area of the building, a fish tank has been constructed which is 37 feet tall, has a diameter of 33 feet, and contains 235,000 gallons of water. The weight of the tank and its liquid contents is 2¼ million pounds.

This is the site of the Hydroacoustic Test which is being conducted by Curtis Campbell, a General Electric engineer, and four aides. Purpose of the text is to collect engineering data to assist NMFS in establishing an acoustic method for detecting fish in the ocean, including estimates of their type, number, and the depths at which they operate.

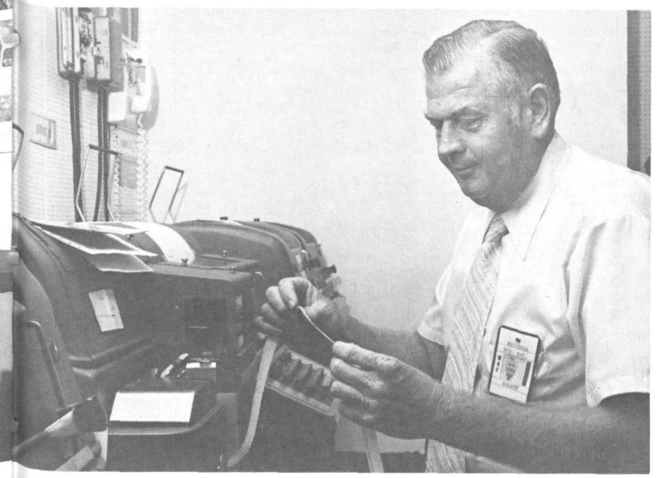
"The Massachusetts Institute of Technology, under contract to NMFS, has developed a computer simulation of an acoustics fisheries assessment system and we're collecting engineering data to test the simulation accuracy," explained Campbell. "We are collecting data to see how well it works. We're trying to determine what part of the job it will do and what it will take to do the rest of the job."

The first phase of the experiment involves working with four-inch plastic balls which are used to approximate the acoustic characteristics of fish. The buoyant balls are moored to a net which can be raised or lowered to various depths by divers.

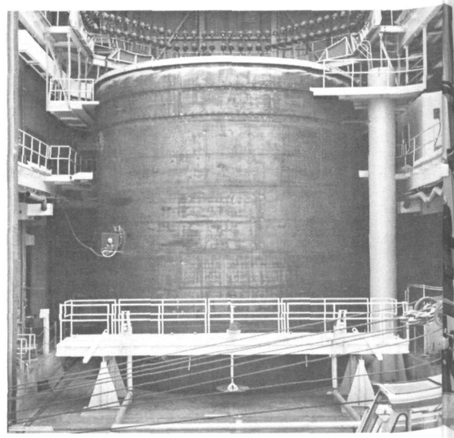
Sonar signals three-tenths of a millisecond in duration are bounced off the plastic balls. The purpose is to determine the number of targets and their depth in the tank. During the experiment, the targets are raised and their number is decreased from 1000 to 50.

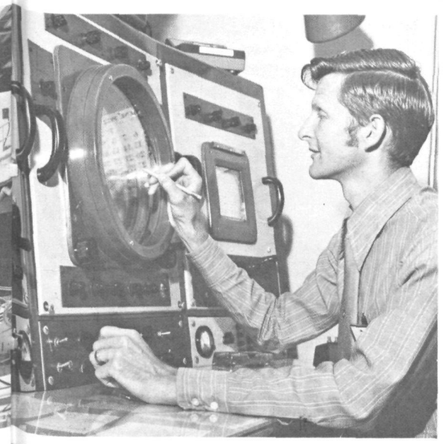
"Can we determine how many targets there are and their depth? That is the crucial question," said Campbell, who added that an 80 percent detection rate would be considered successful.

Bright lights are focused on the bank from above, and four cameras and a full

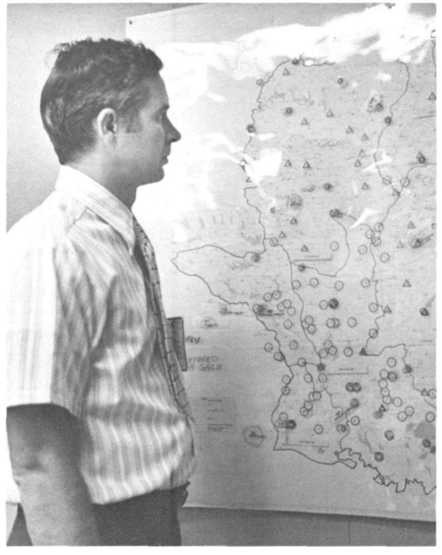


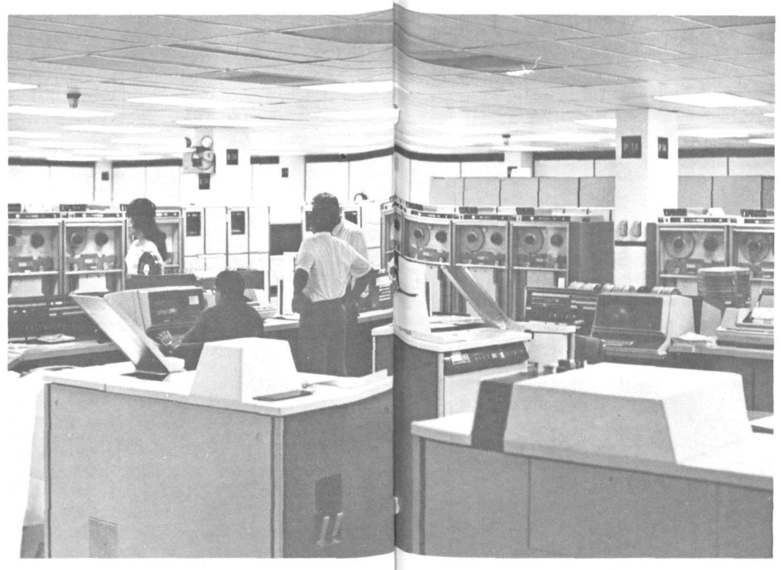
(Above) Divers enter the Fisheries Engineering Laboratory's giant tank in the former Saturn V/Apollo vertical checkout building, to raise or lower the screen which holds the acoustical targets. (Right) The tank provides a controlled environment with biologically stable conditions for use in evaluating the performance of systems for remote sensing of biological and physical ocean phenomena. (Below) Charles E. Schauss, principal assistant at the National Weather Service River Forecast Center, studies a map of river basins from which water flows into the Mississippi. (Below, center) NASA's Slidell Computer Complex processes precipitation and drainage basin data for the Lower Mississippi River Forecast Center.





(Above) Clarence E. Vicroy, hydrologist in charge of the Lower Mississippi River Forecast Center, reads teleprinter data inside the center's communications room. (Left) At the Weather Service Meteorological Observatory, radar specialist Charles Harper notes heavy cloud concentration detected by the WSR-57 weather radar. The radar was moved to Slidell from New Orleans, La., where the increasing number of high-rise buildings was interfering with its coverage. (Below) Wind recorders display data gathered by instruments at 25, 50, and 75-foot levels on a mast outside the observatory. Official in charge John Rhyne is at left, and electronic technician Harry Ulmer at left.





closed-circuit TV system are used to monitor the experiment. The data will be submitted to MIT, which in turn will report to the Fisheries Engineering Laboratory, headed by William H. Stevenson. A decision will then be reached whether computer simulation can be used to establish criteria for an acoustic system. Current plans are to conduct additional tests with actual fish, which are now in a small outdoor pond not far from the tank awaiting their turn. The actual experiment with the fish would take 30 to 45 days. Campbell said the tank will also be used for tests of other remote-sensing systems.

Stevenson said the hydroacoustic test is only one of a number of interesting fisheries studies underway at MTF. Stevenson, who has been with the National Marine Fisheries Service and its predecessor Bureau of Commercial Fisheries for a decade, established the Fisheries Engineering Laboratory in October 1970.

Stevenson stressed that the laboratory is unique in the NMFS. Its task? To improve man's capability to acquire information on oceanic marine life and to develop the tools for locating and identifying them and determining their number.

The NMFS official said his organization is "basically an engineering management group which conducts technological engineering evaluations and test and development required by the National Marine Fisheries Service to improve its capabilities and fulfill its mission."

Some of the work being engaged in by the Fisheries Engineering Laboratory has fascinating possibilities. One is the development of a program which will enable aircraft to track, count, and evaluate fish life in the ocean through remote sensing. Another is the application to fisheries of oceanographic information acquired by satellites.

Still a third is the engineering design and testing of biological sampling equipment, such as sampling nets, and the development of automated techniques for analyzing biological samples, such as automatic plankton-sorting systems and automatic fish-scale analyzers for determining the age of fish.

Stevenson emphasized that the Mississippi Test Facility offered an unparalleled opportunity to utilize the skills of other federal agencies and private industry in solving problems that face the National Marine Fisheries Services.

"We work on the concept that there is a large body of technology which is applicable to resolving some of the instrumentation and equipment problems which exist in fisheries. This capability can be found in the Atomic Energy Commission, NASA, the Department of Defense, and other federal organizations which have extensive technological capabilities," explained Stevenson. "Many of the systems and equipment developed for other purposes can be used for fishery activities. Our method of operation is to identify a problem, determine whether existing technology may be applicable to the problem, and then work with people

continued

who have the necessary technological capability to modify, develop, and test the system for its application to the National Marine Fisheries Service."

As one example of "our pragmatic approach," Stevenson said his laboratory is working closely with the Geological Survey, which also has a facility at MTF. "They have remote-sensing expertise and we have fisheries expertise. We pool and share our resources. This would be very difficult if we weren't located at the same facility."

One of the most interesting NOAA operations at MTF is the completely computerized facility operated by the National Oceanographic Instrumentation Center to test, evaluate, and calibrate oceanographic and meteorological sensors. The facility is under the direction of NOIC's Gulf Coast Regional Center headed by Otis A. Cason.

Dewey Little, a NASA engineer who assisted in establishing the facility, said the multi-million dollar operation is "the only one of its kind in the United States and probably in the world." He said it is capable of testing, evaluating, calibrating, modifying, and repairing "just about any type of oceanographic and meteorological instrument in the world."

A primary mission of the facility is the support of the National Data Buoy Program by calibration of oceanographic and meteorological instruments for the buoys. To this end, the laboratory is organized into an oceanographic area, where conductivity (and/or salinity), temperature and pressure conditions may be controlled to a high degree of accuracy, and a meteorological area where the parameters of air temperature, humidity, barometric pressure, solar radiation, and air velocity may be accurately simulated. In addition, through a cooperative approach, NOIC will have access to a U.S. Geological Survey facility, also located at MTF, to measure instrument response to water current velocity.

The equipment comprising the facility represents a particularly sophisticated approach to the establishment of controlled conditions and computer-controlled data handling and acquisition. In the oceanographic calibration area for example, five test "baths," for calibration of the "wet" sensors and seven adjustment "baths," for performing necessary adjustments on the instruments, may be filled with synthetic sea water from one (or more) of five 2000-gallon tanks—or from a 10,000-gallon natural sea water tank—should the particular application require sea water. The filling, establishment of the solution, and control of the temperature is accomplished from a Master Facility Console, supported by individual bath controls. Data accumulated during tests or calibration will be acquired automatically from the testing station by a computer which will handle the data, perform necessary processing, and both display the data in useable form and store it for later use. No clipboards or handwritten data sheets here.

Of particular note is the Solar Radiation Calibration Chamber supported by a standards calibration and testing station on the roof of the building. When completed, this facility will rank as one of the best in the country in the field of solar radiation measurement and instrument calibration.

Little stressed the importance of calibrating instruments so that the data they provide are accurate. "It takes 30 to 60 days now to calibrate oceanographic and meteorological sensing equipment," he said. "At this facility, we can calibrate five sensors at once in about 10 days." The 13 baths (or water pools) are used to test the sensors as to salinity, pressure, and temperature.

The calibration facility is available on a reimbursable basis to all government agencies and to private and educational organizations and institutions wishing to avail themselves of its capabilities.

The oldest NOAA facility at MTF is located in the Meteorology Building. A unit of the National Weather Service, it provides weather support for the data buoy program and weather information for the NASA earth resources mission.

John Rhyne, in charge of the facility, and Harry Ulmer, his electronics assistant, were among the first employees to arrive at MTF. This fall they completed 10 years of service at the small but important facility. At one time, when NASA was busy testing the moon rockets, the facility had as many as 10 people furnishing forecasts and observations on conditions in the atmosphere. Now with the winding down of the moon program, a blanket of relative quiet has settled over the small building which houses Rhyne and Ulmer.

Major weather service facilities are now located about 15 miles down the road from MTF at the NASA Slidell Computer Complex, which was established about the same time as MTF. Part of its computer facilities are now utilized by the NWS Lower Mississippi River Forecast Center (RFC), headed by C. E. Vicroy, which was dedicated January 11, 1972.

Banks on banks of sophisticated computers are available at this NASA facility to make the extensive mathematical calculations required by the forecast center every 24 hours or less to cover a five-state drainage area. Prior to the availability of the NASA computer complex, the inability to compute the river and rainfall data fast enough prevented the application of the new National Weather Service digital simulation forecast model, which is now in use at RFC.

The Lower Mississippi River Forecast Center predicts flood waters (and low waters also, an important factor in the fight against pollution) throughout a 200,000-square-mile area extending from Cairo, Ill., to the Gulf of Mexico. To this vast area, the RFC now transmits daily river stage and emergency flood forecasts, bringing a new degree of security to millions of residents in the five-state area.

Charles E. Schauss, principal assistant at the RFC, said approximately 510 rainfall observers report their findings daily to five river district offices (RDO) at Memphis, Tenn., Little Rock, Ark., Jackson, Miss., and New Orleans, Lake Charles and Shreveport, La. The RDOs transmit the data to the Forecast Center, which uses the computers to prepare the river forecasts. The forecasts are then transmitted to the RDOs, which disseminate them to the public.

Seven hydrologists are now employed at the River Forecast Center. One of their intriguing tasks, said Schauss, is to work up a mathematical conceptual hydrologic model which seeks to simulate nature.

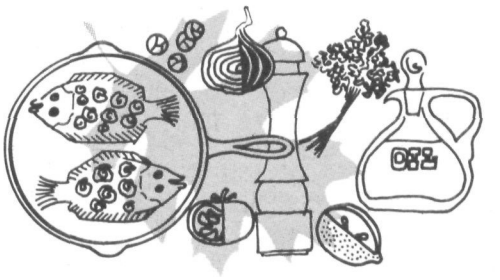
"By doing this, we try to forecast what the water will do," explained Schauss. "How high will the water rise? How fast? How long?" Indicative of the task facing the center's hydrologists, Schauss noted that the drainage area over which the center exercises responsibility includes at least a dozen rivers and their tributaries, including the Mississippi, Pascagoula, Pearl, Yazoo, Ouachita, Red, White, Atchafalaya, St. Francis, Lower Arkansas, and Tennessee rivers.

"That's a lot of water," commented Schauss.

Operating closely with the River Forecast Center is the Weather Service Meteorological Observatory, a branch of the New Orleans Weather Service Forecast Office. Harold J. Monroe, Jr. is the Official in Charge. Operational since last May 1, this facility employs a WSR-57 weather radar with a range of 250 nautical miles. It is the responsibility of this section to observe the development, progress, and movement of severe local storms and maintain continuous surveillance over the coastal waters for detection of tropical storms and hurricanes. All radar information is transmitted to the public hourly via the NOAA Weather Wire teletypewriter circuit. In addition to OIC Monroe, four Weather Radar Specialists and two Electronics Technicians are now located at the radar site.

To coordinate the activities of the various NOAA agencies, a council has been established at MTF headed by James W. Winchester, director of the National Data Buoy Center. All NOAA facilities at MTF are represented on the council.

The NASA facilities and equipment at MTF and Slidell now used by NOAA and other agencies and groups make it possible to unite the services of men and women skilled in space and environmental research. Much of the credit for the success of this new venture must go to Jackson M. Balch, MTF's director, whose foresight and energy largely made it possible. It was Balch who was at the helm at the end of one era, when the last moon rocket was tested November 30, 1970, and the beginning of a new era in which the nation's 350-million-dollar investment will continue to be used to solve mankind's pressing environmental problems. □



ENTERTAINING NOTIONS

The leaves are turning red and gold, the air is invigorating, and the crisp feel of fall is in the air. It's time for festivals, football games, and fun—time for entertaining.

The National Marketing Services Office of the National Marine Fisheries Service suggests some seafood dishes that will fill the bill for groups from six to a hundred. For the most part, their ingredients are plentiful and economical—a bonus for the entertainment budget.

Finding an interesting, but practical entree for breakfast or brunch is often difficult. The duo of King Crab Newburg and Tuna Scramble, in quantities for 25, 50, or 100 people, provides an elegant and satisfying "brunch for a bunch."

ALOHA SEAFOOD PLATTER

1 7½ ounce can salmon
1 7½ ounce can tuna
1 small pineapple or a No. 2 or 2½ size can of pineapple
1 avocado
Juice of 1 lemon
1 papaya
2 small cans mandarin oranges
1 cup commercial sour cream
Grated peel and juice of 1 lime
¼ cup finely chopped chutney
1 cup macadamia nuts (chopped)

Drain salmon and tuna. Break into large chunks and arrange in center of a large platter, about 12 by 18 inches. Peel pineapple, remove eyes, and slice into rounds, halve the slices removing the core, or substitute well-drained canned pineapple. Arrange a row of pineapple on one side of platter. Halve, peel, and slice the avocado, dip each slice in lemon juice. Peel, halve, remove seeds, and slice papaya. Drain mandarin oranges. Arrange papaya in a row beside the pineapple. On the opposite side of platter arrange slices of avocado and the mandarin oranges. Garnish with marachino cherries and lime slices, if desired. Cover the platter with plastic film and chill. Mix the sour cream with the grated peel and juice of the lime, add chopped chutney. Chill. Serve dressing and nuts in separate small bowls at serving time. Makes 6 servings.

Note: All salmon or all tuna may be used or a combination with shrimp or crabmeat.

SEAFOOD SWIRLS WITH FRUITY SAUCE

2 pounds pan-dressed sole, flounder, or other thin fillets (6 to 8 fillets), fresh or frozen
1¼ teaspoons salt
1 cup coarsely shredded carrot
¼ cup finely chopped onion
¼ cup melted margarine or cooking oil
1 can (13¼ ounces) crushed pineapple
2 tablespoons vinegar
1 tablespoon brown sugar
1 tablespoon cornstarch
1 teaspoon soy sauce
½ medium-sized green pepper, cut into short strips

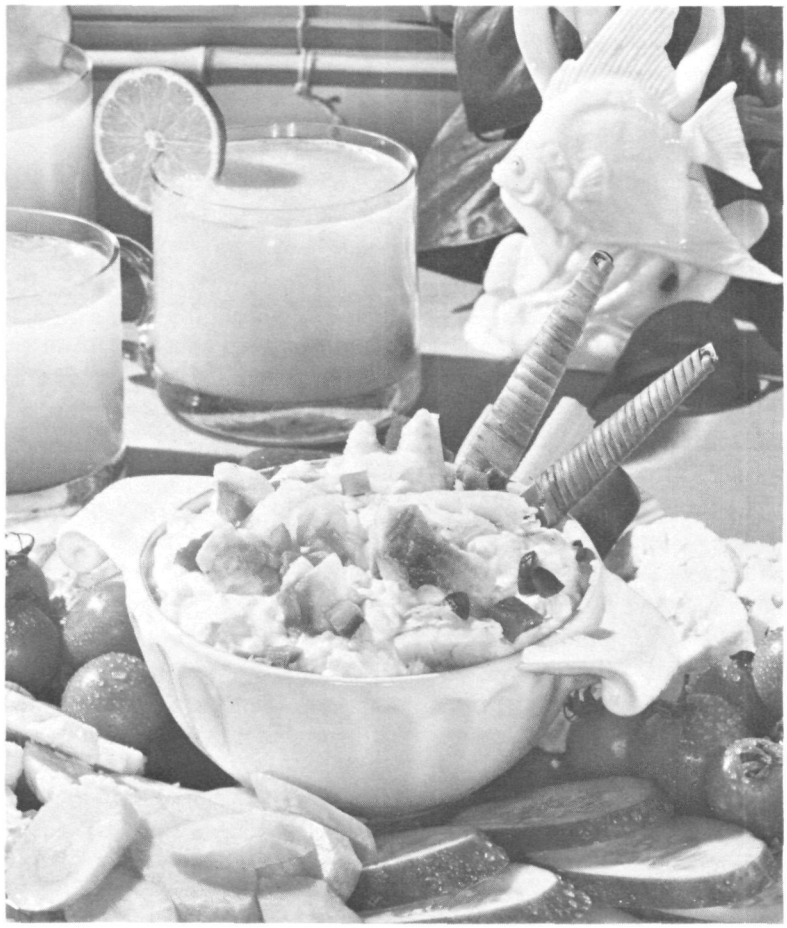
Thaw frozen fish. Sprinkle fillets with 1 teaspoon salt. Cook carrot and onion in 2 tablespoons margarine or cooking oil until onion is tender, but not brown. Drain crushed pineapple; save syrup. Add 2/3 cup drained crushed pineapple and remaining ¼ teaspoon salt to carrot mixture. Spread an equal amount of carrot-pineapple mixture over each fillet. Roll fillets and place in a shallow 1½ quart casserole with open end down. Drizzle remaining 2 tablespoons melted margarine or cooking oil over fish. Bake in moderate oven, 350° F., about 30 minutes or until fish flakes easily when tested with a fork. Baste with pan juices several times during cooking. Add water as needed to pineapple syrup to make 1 cup of liquid. Combine liquid, vinegar, brown sugar, cornstarch, and soy sauce; mix well. Cook, stirring constantly, until clear and thickened. Stir in remaining crushed pineapple and green pepper; heat. To serve spoon sauce over fish rolls. Makes 6 to 8 servings.

continued

SEAFOOD RAGOUT

1 pound cod fillets or other fish fillets, fresh or frozen
1 pound scallops, fresh or frozen
1 package (6 ounces) frozen king crabmeat
1 cup chopped celery
1 cup chopped onion
¼ cup butter or margarine
1 can (28 ounces) tomatoes
2½ cups boiling water
1 can (8 ounces) tomato sauce
1½ teaspoons salt
½ teaspoon chopped garlic
½ teaspoon sugar
2 bay leaves
¼ teaspoon basil
¼ teaspoon pepper
Hard rolls

Thaw frozen fillets. Cut fillets into 2-inch pieces. Thaw frozen scallops. Rinse scallops with cold water to remove any shell particles. Cut large scallops in half. Thaw crabmeat and remove any cartilage. Cut crabmeat into bite-size pieces. Cook celery and onion in butter until tender in a 4-quart saucepan. Add remaining ingredients except fish, shellfish, and hard rolls. Boil 10 minutes, stirring occasionally. Add fish and scallops. Simmer for 5 to 10 minutes longer or until fish flake easily when tested with a fork. Add crabmeat and heat. Remove bay leaves. Serve with hard rolls. Makes 6 servings.



CREAMY PERCH DIP

1 pound ocean perch fillets, fresh or frozen
2 cups boiling water
1¼ teaspoons salt
½ pint (1 cup) small curd cottage cheese
½ pint (1 cup) dairy sour cream
½ cup shredded raw carrot
¼ cup well-drained chopped sweet pickle
2 tablespoons chopped pimiento
1 teaspoon horseradish
Chopped parsley
Assorted crisp vegetables or favorite crackers or chips

Thaw frozen fillets. Place fish in boiling water with 1 teaspoon salt. Cover; simmer 7 to 10 minutes or until fish flakes easily when tested with a fork. Drain; cool slightly. Remove skin and bones, if any. Chill and flake. Combine cottage cheese, sour cream, carrot, pickle, pimiento, horesradish, and remaining ¼ teaspoon salt; mix well. Stir in flaked cooked fish. Chill several hours before serving. Sprinkle with parsley. Serve with assorted crisp raw vegetables (carrot, cauliflower, or cucumber slices, celery chunks, cherry tomato halves, etc.) or crackers or chips as desired. Makes about 3 cups dip.

Note: Yogurt may be substituted for sour cream, if desired.

KING CRAB NEWBURG

Ingredients	25 portions	50 portions	100 portions
King crab meat (fresh or frozen)	3 lb. 12 oz.	7 lb. 8 oz.	15 lb.
Butter or margarine	9 oz. (1⅛ cups)	1 lb. 2 oz. (2¼ cups)	2 lb. 4 oz. (1 qt. ½ cup)
All-purpose flour	4½ oz. (1⅛ cups)	9 oz. (2¼ cups)	1 lb. 2 oz. (1 qt. ½ cup)
Paprika	1 Tbsp.	½ oz. (2 Tbsp.)	1 oz. (¼ cup)
Salt	1½ tsp.	½ oz. (1 Tbsp.)	1 oz. (2 Tbsp.)
Cayenne pepper	¼ tsp.	½ tsp.	1 tsp.
Hot milk	1½ qt.	3 qt.	1½ gal.
Sherry	½ cup	1 cup	2 cups
Toast points			

Thaw frozen crab meat. Drain crab meat. Remove any remaining shell or cartilage from crab meat and cut into 1-inch pieces. Place crab meat in double boiler and heat. Melt butter; blend in flour and seasonings. Stir into milk. Cook and stir constantly until thickened. Add crab meat and sherry. Serve on toast points, using a ½ cup ladle.

BAYOU JAMBALAYA

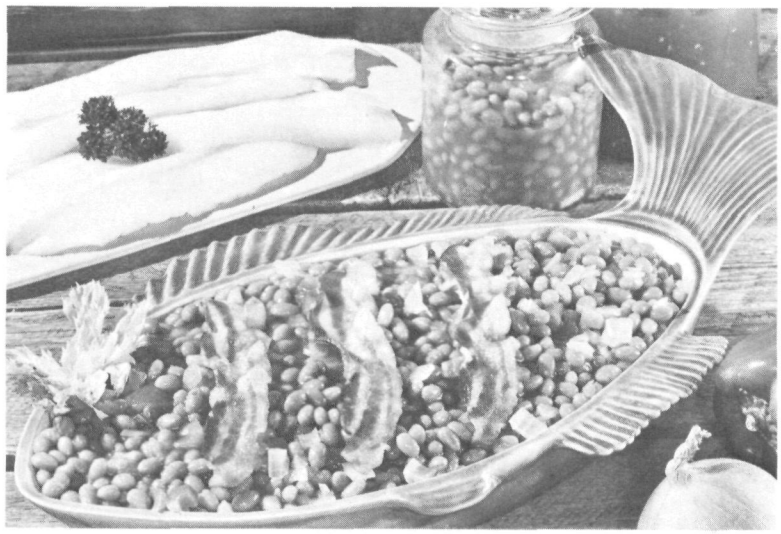
2 cans (4½ to 5 ounces each) shrimp
or
½ pound cooked, peeled, and cleaned shrimp, fresh or frozen
1 can (10 ounces) fresh or frozen oysters, undrained
6 slices bacon, cut crosswise into ¾ inch pieces
1 cup sliced onion
¾ cup sliced celery
½ cup coarsely chopped green pepper
1 clove garlic, finely chopped
1 can (1 pound) tomatoes
1½ cups water
1 cup uncooked rice
2 teaspoons salt
½ teaspoon leaf thyme
⅛ teaspoon paprika
1 small bay leaf
2 to 3 dashes liquid hot pepper sauce

Thaw frozen shrimp or drain canned shrimp. Thaw frozen oysters. Fry bacon until crisp in Dutch oven. Remove bacon bits from pan; drain on paper toweling. Add onion, celery, green pepper, and garlic to bacon drippings; cook slowly until vegetables are almost tender, not brown. Add tomatoes, water, rice, and seasonings; mix. Cover and simmer gently 20 minutes. Add oysters (undrained) and bacon bits. Cover; cook 15 to 20 minutes longer or until rice is desired tenderness, stirring occasionally. Mix in shrimp; heat. Makes 6 servings.

TUNA SCRAMBLE

Ingredients	25 portions	50 portions	100 portions
Canned tuna (6½ or 7 oz. cans)	2	4	8
Eggs	4 lb. (36 large)	8 lb. (72 large)	16 lb. (144 large)
Salt	½ oz. (1 Tbsp.)	1 oz. (2 Tbsp.)	2 oz. (¼ cup)
White pepper	½ tsp.	1 tsp.	2 tsp.
Hot milk	1 qt.	2 qt.	1 gal.
Butter or margarine (melted)	4 oz. (½ cup)	8 oz. (1 cup)	1 lb. (2 cups)
Toast points			
Parsley, chopped	½ oz. (½ cup)	1 oz. (1 cup)	2 oz. (2 cups)

Drain tuna. Break into large pieces. Beat eggs slightly. Add salt, pepper, and milk; mix. Pour butter into 4 baking pans (about 12 x 20 x 2 inches), about 4 oz. or ½ cup per pan. Place about 12 oz. or 2 cups tuna in each pan. Cover with about 6 lb. or 3 qt. of egg mixture per pan. Bake at 350° F. (moderate oven) 25 to 35 minutes or until eggs are firm, stirring once after 10 minutes baking. Serve on toast points, using a No. 8 scoop (½ cup) to measure portions. Garnish with parsley.



FLOUNDER SURPRISE BEAN BAKE

2 pounds flounder or sole fillets, fresh or frozen
4 slices bacon
1 small onion, minced
2 tablespoons chopped green pepper
1 can (1 pound) baked beans
1 can (10 ounces) tomatoes, drained
½ teaspoon dry mustard
½ teaspoon curry powder
2 tablespoons molasses
2 teaspoons salt

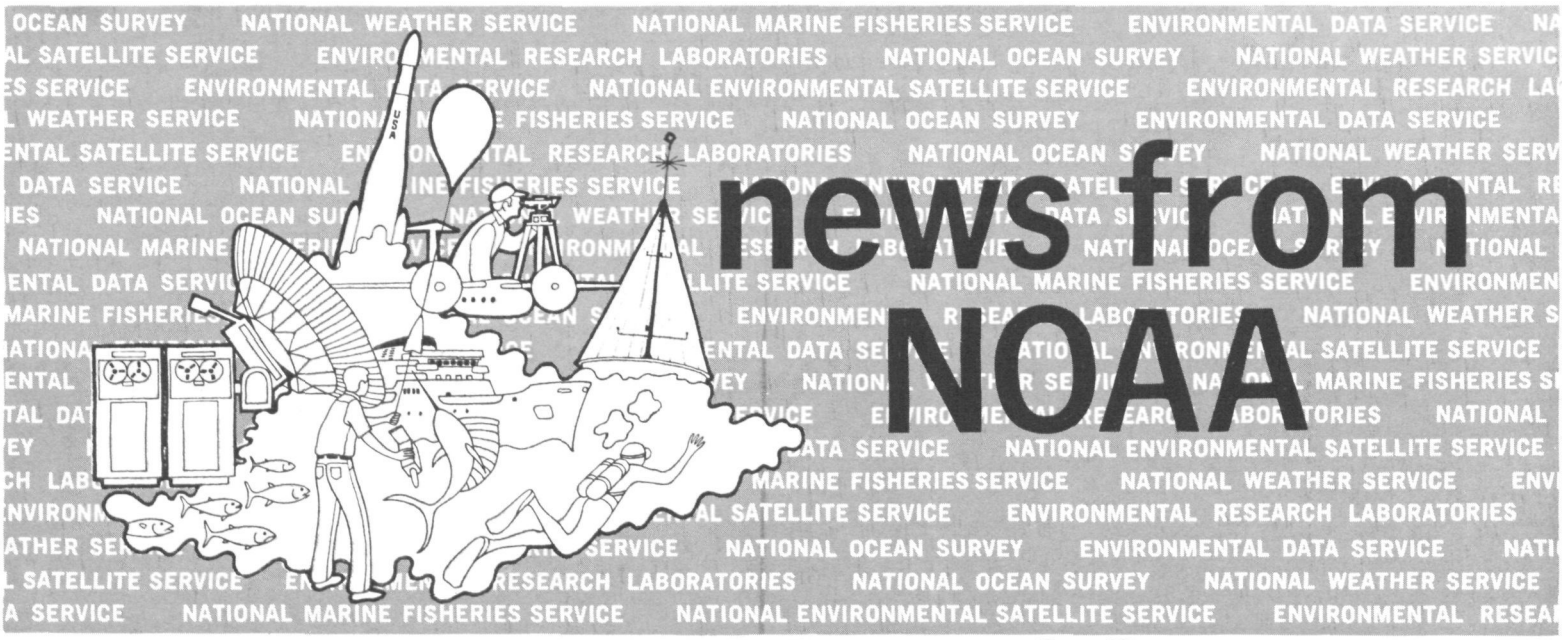
Thaw frozen flounder fillets. Divide into serving size portions and place in a well-greased baking dish. Sprinkle with salt. Dice one slice of bacon and saute until all fat is removed. Add onion and green pepper and saute until vegetables are tender. Add baked beans, tomatoes, mustard, molasses, and curry powder to sauteed vegetables. Pour bean mixture over fish fillets. Top with 3 slices of bacon. Bake in a 350° F., oven until flounder flakes easily when tested with a fork, approximately 20 to 25 minutes. Makes 6 servings.

TWICE-AS-GOOD CASSEROLE

2 pounds flounder fillets, fresh or frozen
2 teaspoons salt
1 quart water
1 can (1 pound) salmon
1 quart shredded day-old white bread
2 cups sliced celery
1 cup chopped onion
¼ cup chopped parsley
2 tablespoons drained capers
1 egg, beaten
1 cup mayonnaise or salad dressing
2 tablespoons lemon juice
1 tablespoon Worcestershire sauce
2 teaspoons dry mustard
½ teaspoon curry powder
Lemon slices and parsley

Thaw frozen flounder. Place fish in a well-greased steamer insert pan. Sprinkle fish with salt. Cover and cook over boiling water for 5 minutes or until fish flake easily when cool. Remove skin and flake. Drain salmon, reserving liquid. Flake salmon. Combine fish, bread, celery, onion, parsley, and capers. Combine egg, mayonnaise, salmon liquid, lemon juice, and seasonings. Fold mayonnaise mixture into fish mixture. Place in a well-greased 3-quart casserole. Bake in a moderate oven, 350° F., for 45 to 60 minutes. Garnish with lemon slices and parsley. Makes 12 servings.

Note: This casserole may be prepared a day ahead and refrigerated. Allow about 30 minutes' additional baking time.



Pribilof Island Fur Seal Research Reserve Proposed by Secretary of Commerce Peterson

The United States will press vigorously for an experimental ban of all fur seal harvesting on St. George, one of the two main Pribilof Islands, Secretary of Commerce Peter G. Peterson has announced.

Secretary Peterson stated that such a ban would be a key element of a major research effort by NOAA to identify the principal factors governing the seal population level. During the research period, fur seal harvesting would continue from the rookeries of St. Paul, the other main Pribilof Island.

Comparisons of changes in the seal population of the harvested and unharvested rookeries should give a much better picture of the extent to which various factors—harvesting, the Bering Sea ecosystem, commercial fishing, and possible marine contaminants—affect the seal population. The experiment should also afford data as to whether seal harvesting has any important impact on the level of fish stocks available for commercial fishing.

"The Pribilof fur seal operation has been widely recognized by governmental and conservation organizations as a conservation success story," the Secretary said. "Prior to the treaty in 1911, international hunting for fur seals in the open ocean substantially contributed to the decimation of the herds. Under Federal management, the population level has been raised well over fivefold—from a dangerously low 200,000 around the turn of the century to well over a million animals today.

"Nevertheless, we believe it is vital to obtain more information on what effect the cessation of harvesting will have, not only on the fur seal population, but also on the total ecosystem. We believe such knowledge is basic to achievement of the best possible conservation program, and we do not wish to settle for less.

"There will, of course, be some economic effects and, in particular, some employment effects on St. George Island. To keep any such effects to a minimum, I have instructed NOAA to take immediate and comprehensive steps to find other employment for any St. George residents affected by the decision.

"The details of the proposed NOAA research program will be given to the International North Pacific Fur Seal Commission this year. This is ample time for complete discussions and action at its next scheduled meeting in March 1973. Indeed, the Commission may wish to call a special meeting earlier to consider the proposal," the Secretary said. Agreement in the Commission is required for action in reducing the harvest and in establishing the research control area.

Up through the ice in the Bering Sea comes the Perry PC-8 submersible on a mission involving the study of walrus habits. The study, conducted by a team of biologists and oceanographers led by Dr. G. Carleton Ray of Johns Hopkins University, was sponsored by NOAA's Manned Undersea Science and Technology office, the National Science Foundation, and the Office of Naval Research.

Causes of Coastal Upwelling Explained by Investigation

An investigation of coastal upwelling off of Oregon was conducted this summer by the NOAA Ship OCEANOGRAPHER, Oregon State University's research vessels CAYUSE and YAQUINA, and one research aircraft from the National Center for Atmospheric Research.

Dr. David Halpern, a physical oceanographer with NOAA's Pacific Oceanographic Laboratory in Seattle, was chief scientist for the studies conducted from the OCEANOGRAPHER. The scientific party included scientists from the Pacific Oceanographic Laboratory, Florida State University, New York University, and the National Science Foundation.

When the winds blow from the North, the surface layer of the ocean flows away from the coast, with the result that cold subsurface water rises to the surface near the coastline. This water, which is rich in nutrients, reacts rapidly with sunlight to produce large amounts of microscopic plants that become the primary food source for fish.

The research vessels measured the density of the water and its variations, and deployed and recovered special-purpose buoys instrumented to measure temperature, currents, winds, pressure, and other sea elements.

Five Receive $1000 NOAA Awards; Fifteen Units Cited for Excellence

Five NOAA Awards and fifteen Unit Citations for Special Achievements were presented at the NOAA Awards Night Dinner Dance in Silver Spring, Md., on September 23.

The winners of the 1972 NOAA Awards were Leonard T. Olson, Dr. Theodore R. Rice, A. Glenn Jean, Lt. Lowell R. Goodman, and Arthur Gustafson. For special contributions to NOAA programs, each received one thousand dollars and a plaque.

The Award for Public Service, recognizing unusually significant contributions to the quality and effectiveness of NOAA's public service programs, was given to Leonard T. Olson, Aviation Services Quality Control Officer at the National Weather Service Forecast Office in New York City.

The two winners of the Engineering and Applications Development Award, given for unusually significant contributions to the operating or research programs of NOAA through achievements in engineering, applied technology, or systems and equipment development, were A. Glenn Jean, Deputy Director of the Space Environment Laboratory in NOAA's Environmental Research Laboratories, Boulder, Colo., and Lieutenant Lowell R. Goodman of the NOAA Commissioned Corps, assigned to the National Ocean Survey's GEOS-C Project at Wallops Island, Va.

Dr. Theodore R. Rice, Director of the National Marine Fisheries Service's Atlantic Estuarine Fisheries Center at Beaufort, N.C., received the 1972 NOAA Award for Scientific Research and Achievement, recognizing unusually significant contributions to scientific research and development and outstanding contributions to scientific literature.

Arthur Gustafson, Meteorologist in Charge of the Weather Service Forecast Office at San Francisco, Calif., was the winner of the Program Administration and Management Award, recognizing unusually significant contributions to the efficiency and quality of NOAA's management and administrative activities.

Unit Citations, recognizing groups of employees who have made substantive contributions to NOAA programs and objectives, were awarded to the following:

In the National Weather Service—Aviation Forecast Staff, NSSFC, Kansas City; Aviation Forecast Staff, WSFO, Chicago; WSFO, Phoenix; WSFO, Birmingham, Ala.; WSO, Kahului, Hawaii; WSO, Sault St. Marie, Mich.; WSFO, Denver; Meteorological Office, San Diego; WSO, Long Beach, Calif.

In the National Ocean Survey—Officers and crews of the NOAA Ships PATHFINDER and DAVIDSON; Methodology and Instrument Support Section, National Geodetic Survey.

In the Environmental Data Service—Marine Section of the Information Group, EDS headquarters; Environmental Guides Development Group, National Climatic Center, Asheville, N.C.; Printing Plant, NCC, Asheville.

Solar-Terrestrial Data Activities Merged in Center

Data activities in the fields of seismology, geomagnetism, marine geology and geophysics, solar activity, interplanetary phenomena, the ionosphere, cosmic rays, aurorae, and airglow have been consolidated in a single facility—the National Geophysical and Solar-Terrestrial Data Center operated by the Environmental Data Service.

The Boulder-based data center contains what amounts to be an observational history of the planet's earthquake activity, fluctuations in the geomagnetic field, and the myriad interactions between radiation from the sun and the earth's outer atmosphere. Its holdings also include a wide range of gravity and geomagnetic data taken by NOAA and other ships at sea, ocean floor sediment samples, and acoustic profiles that show cross-sectional views of the ocean floor beneath its sediment mantle.

The National Geophysical and Solar-Terrestrial Data Center also operates the corresponding world data centers for these disciplines under the auspices of the National Academy of Sciences.

The center provides on request, at nominal cost, primary data from national and worldwide sources and issues a variety of regular and special data publications. It also produces geomagnetic activity indices, United States and world charts of geomagnetic field components, compendia of United States earthquakes, and interdisciplinary summaries of solar-terrestrial phenomena.

A. H. Shapley, Associate Director of the Environmental Data Service, heads the National Geophysical and Solar-Terrestrial Data Center. Ms. J. Virginia Lincoln leads the solar-terrestrial data services, and K. L. Svendsen the solid earth data services. A data studies division, under T. N. Gautier, develops new data applications and research on the earth's environment.

Meteorite Magnetism Offers Insights Into Formation of Solar System

Meteorite-borne messages from a vanished world are being decoded by NOAA and university scientists, in an effort to describe forces which helped form our solar system some four billion years ago.

The messages are written in remanent magnetism—the magnetism remaining in a magnetized body after the body is removed from the influence of a magnetic field—in the nickel-iron particles of certain meteorites. If these clues are being read correctly, they indicate the existence of at least a 0.02-gauss magnetic field at the time the primordial solar nebula began condensing into planets. (The earth's magnetic field today is about 0.5 gauss.)

This information should help scientists explain whether magnetism played an important, cooperative part with gravitational forces in distributing planetary materials to their present orbital distances from the sun, and in the accretion of the planets themselves.

The investigators are D. E. Watson of NOAA's Earth Sciences Laboratories, Dr. E. E. Larson of the University of Colorado, and Dr. M. W. Rowe and J. M. Herndon of Texas A&M University.

As reconstructed by the investigators, nickel-iron particles condensed from an ionized gaseous state much above 800 degrees Celsius and were magnetized during cooling in the primordial magnetic field; then, these particles were joined together under the influence of at least a 0.02-gauss field. At some later undetermined point in their long flight through space, they were again heated, this time to about 500 degrees Celsius, and were partially remagnetized by a 0.10-gauss field existing at that time and place. Possibly the meteorite passed close to or was part of a planetary body possessing a magnetic field, or the sun; or the solar magnetic field was much larger than it is today.

Although much remains to be done before solid conclusions can be drawn, the implications of this continuing investigation could be profound. "If we can show there was a significant magnetic field during the coalescence of the solar nebula," Mr. Watson says, "We may be able to explain some previously unexplained properties of the solar system."

Three Universities Awarded Sea Grants

Among major Sea Grants awarded recently were $1,793,700 to Oregon State University, $1,190,000 to the University of Rhode Island, and $1,500,000 to Texas A&M University.

Half-Millionth Radiosonde Repaired by NWS

The half-millionth reconditioned radiosonde emerged from the assembly line at the National Weather Service's Reconditioning Center in Joliet, Ill., on August 22—ready to be used again.

Each reconditioned radiosonde may become one of the 300 such instruments launched daily from the National Weather Service's network of stations to obtain valuable information on conditions in the upper air.

Hydrogen- or helium-filled balloons lift the small boxes of specially designed instruments as high as 18 miles above the earth. After the ballons burst at about 90,000 feet the radiosondes float back to earth on miniature parachutes. Approximately 25 percent of the radiosondes fall in populated areas where they are easily found and subsequently returned to Joliet in the postage-paid, preaddressed mailing sacks provided inside each instrument box.

Some radiosondes make as many as seven flights, multiplying the saving many times over.

Earth Resources Satellite Data Available From NOAA Facility

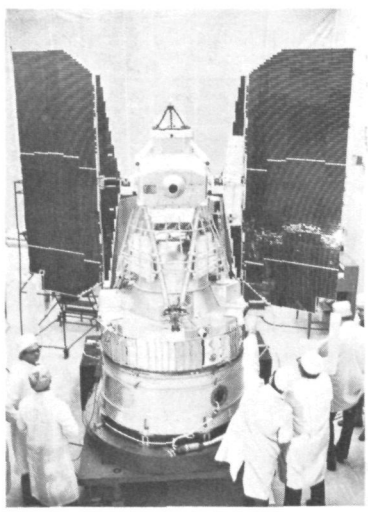
NOAA is operating a major center for disseminating data from the National Aeronautics and Space Administration's Earth Resources Technology Satellite (ERTS-1).

Launched July 23 into a 570-mile-high, near-polar orbit, the spacecraft circles the earth 14 times each day, crossing the Equator at 9:42 a.m. local time, and completing global coverage every 18 days. Its return beam vidicon cameras photograph the earth in the green, red, and near-infrared portions of the spectrum, while its multispectral scanner subsystem returns images in the green, red, and two near-infrared bands. Both systems view areas 115 statute miles on a side, or 13,225 square miles of the earth's surface in each image.

ERTS-1 is an experimental spacecraft, intended to demonstrate the usefulness of repeated global sensing of conditions on the earth's surface. More than 300 investigators—including scientists from the Departments of Agriculture, Commerce, Interior, the Environmental Protection Agency, and the U.S. Army Corps of Engineers—are evaluating the ERTS data for applications in agriculture, cartography, forestry, geology, geography, hydrology, oceanography, and meteorology.

During the satellite's projected one-year lifetime NOAA investigators will be using ERTS-1 data in studies of sea ice distribution, snow runoff potential, circulation and surface characteristics of oceans, lakes, and bays, air and water pollutants fishery resources, severe storm detail, and aeronautical chart improvements.

NOAA's Earth Resources Data Center at Suitland, Maryland, will furnish data gathered by the new spacecraft to users in the oceanographic, hydrologic, and atmospheric sciences and to the general public. Other data centers are operated by the Departments of Interior and Agriculture. To aid in selecting the data desired, NOAA has established public browse files at 22 locations around the nation, where ERTS data in 16-mm. form is available for review. Once a user has made a selection from the browse file material, he may order copies in a variety of formats: system-corrected images, scene-corrected images, or digital data. Orders specifying the photographic frames and data format required should be mailed to the National Climatic Center, NOAA-Environmental Data Service, Federal Building, Asheville, N.C. 28801. Costs vary with the type of format and the number of copies requested.



Project Stormfury on Alert

The 1972 Project Stormfury alert, which began in July, will continue through October 31, as the program's scientists await the opportunity to seed hurricanes.

Project Stormfury is a joint Department of Commerce/Department of Defense program of scientific experiments to explore the nature of tropical storms and hurricanes, and to investigate the possibility of modifying them. Dr. Robert M. White, Administrator of the Commerce Department's National Oceanic and Atmospheric Administration, and Rear Admiral William J. Kotsch, U.S. Navy, Deputy Director for Operations (Environmental Services) of the Joint Chiefs of Staff, Department of Defense, have overall responsibility for the direction of the Project.

The project's major goal for 1972 is to confirm the promising results of the experiments conducted in 1969. On each of two days—August 18 and 20, 1969—Hurricane Debbie was seeded five times during an eight-hour period. After seeding on August 18, the hurricane's maximum winds at 12,000 feet decreased 31 percent, dropping from 98 knots (113 miles per hour) before the experiment to 68 knots (78 miles per hour) after seeding. Seeding on August 20 was followed by a decrease of 15 percent, from 99 knots (114 m.p.h. to 84 knots (97 m.p.h.).

Other experiments planned for 1972 include seeding of hurricane rainsectors and rainbands, and continuation of experiments on lines of tropical cumulus clouds not associated with hurricanes.

Dr. R. Cecil Gentry, Director of NOAA's National Hurricane Research Laboratory, Miami, Fla., is Director of Project Stormfury. Captain L. J. Underwood, U.S. Navy, Commanding Officer of the Fleet Weather Central at Norfolk, Va., is Assistant Director of the Project and Project Coordinator for the Department of Defense.

Aircraft and flight crews for the 1972 experiments are being provided by the NOAA Research Flight Facility, Miami, Fla.; Navy Hurricane Hunter Squadron VW-4, Naval Air Station, Jacksonville, Fla.; U.S. Marine Aircraft Group 14, Cherry Point, N.C.; three Weather Reconnaissance Squadrons of the U.S. Air Force Air Weather Service—the 53rd WRS, Ramey Air Force Base, Puerto Rico; the 58th WRS, Kirtland Air Force Base, N.Mex.; and the 55th WRS, McClellan Air Force Base, Calif.

NMFS Laboratory Opens in Florida

The National Marine Fisheries Service's new Panama City, Fla. laboratory, a unit of the Gulf Coastal Fisheries Center, was dedicated September 23.

Built to accommodate a 50-member professional and support staff, the laboratory is headed by biologist Eugene L. Nakamura. Studies focus on the biology and ecology of coastal marine fishes—with emphasis on sport species—and the ecology of estuaries.

The laboratory building covers 13,400 square feet and is situated on 12 acres of land donated by the Committee of 100, Panama City Chamber of Commerce. The laboratory operates the 43-foot research cruiser RACHEL CARSON.

Biological research at the new facility centers on identifying resident fish species, their abundance and distribution, habitat factors, and possible constraints on quantities and dispersal of fish. Ecological studies are devoted to collecting salient data on estuaries to permit evaluations of modification or change, and to determining the significance of estuaries to marine fishery resources.

EUGENE L. NAKAMURA

Thirty Volunteer Weather Observers Honored by NWS

Thirty volunteer weather observers have been selected to receive the 1972 Thomas Jefferson and John Campanius Holm Awards given by the National Weather Service.

Six observers were given the Thomas Jefferson Award for unusual accomplishments in meteorological observations. This award, the highest made, is named for Jefferson because the statesman-scientist made an almost unbroken series of weather observations from 1776 to 1816. Four of the 1972 award recipients have over 30 years of service, and two have over forty years' service as volunteer weather observers.

The volunteer weather observers honored with Thomas Jefferson Awards for 1972 are: Floyd C. Butel, Overbrook, Kans.; Jim Curry, Wolf Canyon, N.Mex.; Mrs. Ethel H. Hayes, Wilmington, Ohio; Perry C. Quattlebaum, Conway, S.C.; Max H. Sherrod, Palmer, Alaska; and Frank T. Street, Henderson, Ky.

The John Campanius Holm Awards, presented for continued excellence as volunteer weather observers, are named in honor of the first person known to have recorded the weather systematically in the American colonies. The Reverend Holm made records of the climate, without the use of instruments, near the present site of Wilmington, Del., in 1644 and 1645.

Volunteer weather observers who received the John Campanius Holm Awards for 1972 are: Mrs. Ella L. Albrecht, Buxton, Oreg.; H. Douglas Baker, Scott City, Kans.; Fred S. Brown, Woodstock, N.H.; Donald B. Crisler and family, Port Gibson, Miss.; William H. Cumming, Houlton, Me.; John H. Daybell, Porterville, Calif.; Ellis H. Forby, Onaka, S.Dak.; Harold L. Good, Cloverdale, Oreg.; Richard J. Hoge, Watertown, Wisc.; Stanley E. Kasparek, Fairbury, Nebr.; Martin G. Kizer, Apache, Okla.; Philip J. Kress, Richardton, N.Dak.; Mrs. Pearllee M. Little, Enterprise, Miss.; John A. McCormick, Fallon, Nev.; Mrs. Pattie L. Mizelle, Greenville, N.C.; Mrs. A. H. Nelson, Bushnell, Fla.; John N. Payne, Jr., Evansville, Ind.; Lyle B. Prince, New Harmony, Utah; Thomas J. Proffitt, Columbia, Va., Mrs. Hazel Pruett, Quenemo, Kans.; James B. Robertson, St. Thomas, V.I.; Earl F. Smith, Haverhill, Mass.; Arthur E. Suess, Menno, S. Dak.; and Mrs. Lucille E. Weddle, Badger, Calif.

Instrument Array Records Motion In Earthquakes

An array of instruments designed to provide uniquely useful data on earthquakes and their effects has been completed in the San Francisco Bay Area.

Developed by geophysicists in the Seismological Field Survey of NOAA's Earth Sciences Laboratories, the new array is among the most comprehensive strong-motion recording systems now in use.

The APEEL—from Andreas-Peninsula Earthquake Engineering Laboratory—array is positioned along a 20-mile line running roughly northeastward some 20 miles south of San Francisco. The array crosses the San Andreas Fault, San Francisco Bay, and the Hayward Fault. Strong-motion accelerographs are installed at 15 locations along the line, interspersed with other seismic instruments—seismographs and seismoscopes—to record data from any future damaging earthquakes in the area.

The instruments are mounted on bedrock and Bay mud, on level ground and hillsides, and on different sides of two of the area's major faults. Besides surface installations, selected stations are being equipped with instruments installed in "downholes" drilled through the layers of Bay muds to the Franciscan bedrock foundation. Accordingly, the data should tell scientists much about the relative motion experienced by structures on bedrock, alluvium, bay mud, and hillside building sites, attenuation of motion near the faults, and variations of motion on opposite sides of the faults.

Completion of the APEEL array is the culmination of six years of cooperative effort between NOAA and interested organizations in the San Francisco Bay area. This array supplements an initial eight-instrument spread installed in cooperation with the U.S. Geological Survey.

Shellfish Film Produced by NMFS

A new 28-minute documentary motion picture, "Take Two From The Sea," has been produced by the National Marine Fisheries Service for the Shellfish Institute of North America. Elliot A. Macklow, Chief of NOAA's Motion Picture Service, served as executive producer and designed the film primarily for young audinces. A ten-minute theatrical, short subject version will be released this fall by Universal Pictures for showing in theaters nationwide.

Baker, Munson, and MacDonald Appointed to Ocean Survey Posts

Three members of the NOAA Commissioned Corps have been appointed recently to major posts in the National Ocean Survey. They are Captain Leonard S. Baker, Director of the National Geodetic Survey; Captain Robert C. Munson, Associate Director of NOS for Marine Surveys and Maps; and Captain Kenneth A. MacDonald, Director of the Lake Survey Center.

CAPTAIN LEONARD S. BAKER

CAPTAIN ROBERT C. MUNSON

CAPTAIN KENNETH A. MACDONALD

Capt. Baker was formerly Chief of the Geodesy Division and Deputy Director of the National Geodetic Survey. He joined the NOAA Commissioned Corps in 1947, and subsequently served in various capacities aboard eight of the agency's ships and as chief of photogrammetric, geomagnetic, and geodetic field parties.

Captain Munson joined the Commissioned Corps in 1951, and has served aboard seven survey vessels, commanding three. He headed the Survey's field office and International Tsunami Warning Center in Honolulu from 1968 to 1970, and then became commanding officer of the NOAA Ship DISCOVERER.

Captain MacDonald's most recent post was as U.S. Field Director for the International Field Year for the Great Lakes. A commissioned officer since 1952, Captain MacDonald has worked with various field parties throughout the United States; in Ethiopia on a survey of the Blue Nile drainage basin; aboard seven survey vessels, commanding four of them; as chief of the Operations Division of the Mid-Continent Field Office; and as Chief of the Marine Science Services Division at NOAA headquarters.

Geysers Affected by Earth Tides

One component of earth tides—the 18.6-year tidal component—appears to exercise significant influence on the behavior of geysers in Yellowstone National Park, Wyo. Dr. John S. Rinehart of the Environmental Research Laboratories reported recently in *Science*.

"Th variations in geyser activity," Dr. Rinehart wrote, "are attributed to mechanical straining by the tidal forces of the geothermal area in which the geyser is located. Such strains could be expected to influence the rate of heat flow to the geyser. Further examination of the Yellowstone records shows that at least two geysers, Grand and Steamboat, respond dramatically to the 18.6-year component."

Rinehart's analysis of records kept from 1927 through 1969 for Grand Geyser showed "strong correlations between frequency of eruption and variation in earth tidal force." In periods of high tidal force—1930, 1955, and 1970—Grand Geyser erupted several times daily, but became almost dormant in 1943 and 1960, when tidal force was least.

Steamboat Geyser, for which only six years' (1963-1969) records are available, showed an opposite reaction, becoming most active during periods of low tidal force.

Tidal forces are produced by gravitational combinations between the earth, moon, and sun, causing the familiar phenomenon of ocean tides and the less familiar one of earth tides—a deformation of the solid portions of the planet that varies with changes in tidal forces and is of the order of one part in 10 million, or about an inch in 160 miles. These changes are generally periodic, having semidiurnal, diurnal, fortnightly, semiannual, 8.8-year, 18.6-year, and 20,900-year frequency components.

The 18.6-year component arises from the five-degree inclination of the orbital planes of the earth and sun and causes about a 10 percent change in the average tidal force over an 18.6-year period. Apparently, the geyser connection is the first observed correlation between this tidal component and a geophysical process.

CORRECTION

Inaccurate statements appeared in the story which accompanied the article, "A City With Sea Legs," in July's NOAA Magazine.

The story stated that the idea for FLIP (Floating Laboratory Instrument Platform) originated at the Woods Hole Oceanographic Institution. Actually FLIP, as such, grew from the work of Dr. Frederick N. Spiess, Fred Fisher, and Phil Rudnick at the Marine Physical Laboratory of the Scripps Institution of Oceanography. The Marine Physical Laboratory has operated FLIP for the ten years since that time, supported by the Navy through ONR.

The statement about FLIP's stability (three-inch movement in 30 foot waves) was an exaggeration. A better figure is a heave response of 1/10 to 1/20 of the wave height, although the actual number depends on the shape of the ocean wave spectrum.

Finally, concept and design studies on the stable platform with pivoting legs, at present supported by the Advance Research Projects Agency through ONR, are being carried out in Scripps' Advanced Ocean Engineering Laboratory under the direction of Dr. Spiess. That program is still concerned with development and design; no firm commitment for construction exists.

U.S.-to-Africa Survey Completed

Marine scientists from five nations have completed a ten-week exploration of the Mid-Atlantic Ridge and the continental margin of northwest Africa.

Working aboard the NOAA Ship DISCOVERER from July to September were marine scientists from NOAA, together with scientists from England, Portugal, Spain, and Mauritania, including oceanographic personnel from the University of Miami, University of Wisconsin, Texas A&M University, University of Connecticut, and Imperial College, London. The R/V ISELIN of the University of Miami also participated in the investigation.

At the Mid-Atlantic Ridge, where molten rock is believed to be continuously welling up from the earth's interior, the scientists lowered instruments to collect rock samples from depths ranging from hundreds to thousands of feet.

The second objective of the expedition, to determine the original edge of the northwest African continental margin, was carried out jointly by the DISCOVERER and the ISELIN. The two ships used the technique of seismic refraction, which employs sound waves, to probe the ocean bottom. Scientists hope that the information obtained on the position and shape of the edge of northwest Africa will enable them to reconstruct exactly how Africa and North America fitted together before they drifted apart.

all in the family

PERSONNEL NOTES

Lieutenant Commander Fidel T. Smith has been named to fill the Operations Officer position vacated by Cdr. Sundean.

Sanford R. Miller, formerly Supervising Aviation Forecaster at the National Severe Storms Forecast Center in Kansas City, Mo., is now Meteorologist in Charge of the new Weather Service Forecast Office in Sioux Falls, S. Dak.

John T. Moseley, who has been Meteorologist in Charge at the Alexandria, La., Weather Service Office for the past three years, has been named MIC at the Montgomery, Ala., Weather Service Office.

Commander Donald R. Tibbit has been advanced to Deputy Associate Director for Marine Surveys and Maps in the National Ocean Survey. He was formerly Chief of the Requirements Branch in the Marine Chart Division.

Edward R. Schiffmacher, of the Environmental Research Laboratories' Space Environment Laboratory, has been selected to head the Environmental Data Service's new Data Operations Group at Boulder, Colo.

Commander Richard E. Alderman has been assigned full-time to the Department of State's Office of International Organizations.

Mark T. Takata is the new Official in Charge of the Weather Service Office, Lihue, Kauai. He is the first American of Japanese ancestry to head a weather office in Hawaii.

Commander James G. Grunwell is now Chief of Ship Facilities in the National Ocean Survey's Office of Fleet Operations. He was formerly Executive Officer of the RESEARCHER.

Steven N. Anastasion heads the Office of Marine Coordinator which has been activated in the Office of the Associate Administrator for Marine Resources, to provide direct support to the NOAA Administrator in his role as Chairman of Interagency Committee on Marine Science and Engineering (ICMSE), including the provision of the ICMSE Executive Secretary.

Commander Kelly E. Taggart, former Executive Officer of the NOAA Ship OCEANOGRAPHER, has assumed the post of Chief of Mapping, Charting and Geodesy in NOAA's Office of Marine Resources.

Claire D. Jensen, who has been Supervising Aviation Forecaster at the San Francisco Weather Service Forecast Office since 1969, has been named Meteorologist in Charge of the Weather Service Office in San Diego, Calif.

Marvin E. Miller, who has been Meteorologist in Charge at the Columbus, Ohio, Weather Service Office the past year, is now Meteorologist in Charge at the Wilmington, N.C., Weather Service Office.

Commander Wayne L. Mobley has been named Chief of Operations at the National Ocean Survey's Atlantic Marine Center in Norfolk, Va., where he previously served as Chief of the Processing Division.

Harold E. Mackel, Alonzo Smith, Jr., Merritt N. Techter, David G. Fordham and **William E. Eggert** were among ten Commerce Department employees honored for their outstanding work in continuing the development of equal employment opportunities for minorities and women in the Department.

Robert H. Reece, Chief of the Executive Affairs Staff at the National Weather Service Headquarters in Silver Spring Md., since 1970, has been appointed Principal Assistant at the San Francisco (Calif.) Weather Service Forecast Office.

Susan S. Kumer, a Cartographic Aid in the Coastal Compilation Section of the Photogrammetric Division at the National Ocean Survey's Atlantic Marine Center in Norfolk, Va., recently became the first woman assigned by AMC to a field party when she was detailed for two weeks to Photo Party 61.

John R. Burke has been selected to be the Meteorologist in Charge of the newly established Weather Service Forecast Office at Louisville, Ky. He has been MIC of the Weather Service Office in Louisville since 1969.

Blaine W. Amann, Weather Service Specialist at the National Weather Service Office in Rochester, Minn., has been selected to be Official in Charge of the office.

Dr. Brian J. Rothschild, former Deputy Director of the National Marine Fisheries Service Northwest Fisheries Center, is now Director of the NMFS Southwest Fisheries Center, in La Jolla, Calif.

Dr. Harry R. Glahn has been named Deputy Director of the Techniques Development Laboratory of the National Weather Service's Systems Development Office. He will continue to serve as Chief of TDL's Objective Forecast Branch.

James W. Zoller, Principal Assistant at the Weather Service Forecast Office in Detroit, Mich., since 1968, has been selected Meteorologist in Charge at the Weather Service Forecast Office in Omaha, Nebr.

John W. Fassler has been named the State Climatologist for Montana, with headquarters in Helena.

Lieutenant Melvyn C. Grunthal has been assigned to the National Ocean Survey's Coastal Mapping Division and will begin flight training this fall to become a pilot for air photo missions.

James R. Spillers, a Weather Service Specialist at Toledo, Ohio, since 1965, is now Official in Charge at the Greenville-Spartanburg, S. C., Weather Service Office.

Raymond R. Waldman, who has served in forecasting assignments at Cleveland, Ohio, since 1953, has been named Meteorologist in Charge of the Weather Service Office in Milwaukee, Wisc.

Dr. Daniel A. Panshin is the Office of Sea Grant's new Program Director for Advisory Services. He was formerly extension oceanographer with the Oregon State University Sea Grant Marine Advisory Program.

Commander Freddie L. Jeffries is the new Executive Officer of the NOAA Ship McARTHUR. One of four Black officers in the NOAA commissioned corps, he is the first to be named Executive Officer of a NOAA ship.

Glenn H. Trapp, former Meteorologist in Charge of the Rochester, Minn., Weather Service Office, has been selected Meteorologist in Charge of the Corpus Christi (Tex.) Weather Service Office.

James K. Tyrrell, Leading Fire-Weather Forecaster at Medford, Oreg., for the past ten years, is the new Meteorologist in Charge at Salem, Oreg.

Harold M. Gibson, who has been Meteorologist in Charge at Des Moines, Iowa, since 1970, has become MIC at the Weather Service Forecast Office in New York, N.Y.

Charles Cochrane, General Weather Forecaster at the Los Angeles Weather Service Forecast Office, has been named Meteorologist in Charge of the Weather Service Office in Walla Walla, Wash.

James F. O'Neil has been appointed Deputy Director of the National Ocean Survey's Executive and Technical Services Staff, and will serve also as Acting Chief of the Staff's Plans and Programs Division.

Robert S. Tibbetts is the new Chief of Photo Party 62, operating out of NOAA's Atlantic Marine Center, Norfolk, Va.

Robert E. Fennell, formerly meteorologist in Charge at the Weather Service Office in Tulsa, Okla. recently entered on duty as MIC at the WSO in Huron, S. Dak.

Richard A. Foster, who has been Official in Charge of the Weather Service Office at Greenville, S.C., for the past four years, has been named OIC at the Youngstown, Ohio, WSO.

Commander Lavon L. Posey, who has been Chief of the NOAA Corps' Commissioned Personnel Division for the past four years, is the new Executive Officer of the NOAA Ship RESEARCHER.

Clifford E. Goodall, who has been Meteorologist in Charge of the Weather Service Meteorological Observatory at Pittsburgh, Pa., since 1968, is now Meteorologist in Charge at the Harrisburg, Pa., Weather Service Office.

Lieutenant Commander Christian Andreasen is now Chief of the NOAA Corps' Commissioned Personnel Division.

William P. Hayes, who has been Meteorologist in Charge at the Weather Service Forecast Office in Albany, N.Y., since 1969, has assumed his new duties at the Rochester, N. Y., Weather Service Office.

Commander Wesley V. Hull is the new Chief of the Coastal Mapping Division of the National Ocean Survey's Office of Marine Surveys and Maps. He was formerly the liaison officer with the Army at Fort Sill, Okla.

Clifton J. Champion, Jr., former Weather Service Specialist in the Weather Service Office at Santa Maria, Calif., is the new Official in Charge at the Greensboro, N.C., Weather Service Office.

Grayson V. Cordell, State Climatologist for Montana since 1968, is now Meteorologist in Charge of the Helena, Mont., Weather Service Office.

Urgent Need for Lobster Management Recognized

Fisheries Directors of 11 Atlantic coast states from Maine to North Carolina, meeting with Federal fisheries officials in Baltimore during August, agreed unanimously on the urgent need for a comprehensive management plan to avoid depletion of the American lobster resource.

The meeting followed an announcement by Commerce Secretary Peter G. Peterson that the need for such a program is pressing in order to protect the American lobster, which constitutes the single most important Atlantic coast fishery.

The State and Federal officials agreed to seek uniform laws or regulations including an increase in the minimum size of legally taken lobsters. The delegates also discussed, among other topics, legislative and regulatory changes necessary to implement such an agreement as well as how best to avoid over-exploitation.

Dr. Robert M. White, NOAA Administrator, reiterated an earlier statement by Secretary Peterson that while additional research is essential for the full development of a resource-wide management plan, the urgency of the situation overshadows the need to await additional basic research.

Dr. White added that the management plan will be a cooperative effort between NOAA's National Marine Fisheries Service and the states, and that what the Federal government can do depends to a large extent on how effectively the states can develop and implement a cooperative, comprehensive management plan.

Technical and policy committees were formed with State and Federal representatives to develop further the plans discussed at the Baltimore meeting and discussions with the lobster industry are planned for the near future.

States represented at the planning meeting were Maine, New Hampshire, Rhode Island, Massachusetts, Connecticut, New York, New Jersey, Delaware, Maryland, Virginia, and North Carolina.

NACOA Reviewing Warnings of Agnes

The National Advisory Committee on Oceans and Atmosphere (NACOA) is conducting a review and evaluation of the Nation's flood forecasting and warning program and its performance during the east coast floods of June 1972.

Because of the extent and severity of the disaster, Dr. Robert M. White, NOAA Administrator, asked Dr. William A. Nierenberg, Chairman of NACOA, to undertake the review. A dying tropical storm, Agnes, dumped record-breaking torrential rains all along the eastern seaboard after landing near Panama City, Florida, on June 19. Most river basins north of the Carolinas and east of the Appalachians as far north as New York State experienced flooding in the week that followed.

TEST BUOY ANCHORED OFF ALASKA

A 100-ton experimental ocean buoy was anchored last month in the Gulf of Alaska for testing in sub-Arctic waters.

Meteorological information transmitted by the buoy, which will remain on station throughout the winter, is expected to aid weather forecasting for Alaska and the entire west coast of North America.

The buoy is one of a series being stationed in the ocean to explore the feasibility of a national system of buoys that will furnish vital oceanographic and meteorological information.

While on station, the buoy (designated EB-03) will report environmental data from the Gulf of Alaska every three hours, or as needed, to shore receiving stations in San Francisco, Calif., and Miami, Fla., for relay to NOAA's National Meteorological Center in Suitland, Md. Communication services are being provided by the Coast Guard, which is also furnishing necessary servicing and maintenance support for the buoy at sea. Once the winter sets in, the buoy will be on its own. It is designed to withstand 150-knot hurricane winds, 60-foot waves, 10-knot currents, and two years on station without servicing.

The buoy program is being conducted under the direction of NOAA's National Ocean Survey at its National Data Buoy Center at NASA's Mississippi Test Facility in Bay St. Louis.

EB-03 was pushed by a tugboat, as it began its long journey from the Data Buoy Center in Mississippi to the Gulf of Alaska.

Weather Modification Activities Reported to NOAA Under New Law

Proposed regulations for reporting weather modification activities to the Commerce Department were published June 10, 1972, in the *Federal Register.*

When they become effective, the regulations will implement Public Law 92-205 of December 18, 1971, requiring all non-Federal weather modification activities in the United States and its territories to be reported to the Secretary of Commerce. Federal agencies are expected to be included in the requirement by Executive Order. NOAA is in the reporting program on behalf of the Secretary.

During the 90 days after publication in the *Federal Register,* interested persons were invited to submit written comments to the NOAA Administrator. These comments will be considered for incorporation in the regulations. The final regulations are expected to take effect late in 1972.

The reporting program will be administered by the Office of Environmental Modification, headed by Donald F. Moore, NOAA Assistant Administrator. The records of weather modification activities will be made publicly available to the fullest extent practicable. The Public Law requires publication of summaries of these records from time to time, and NOAA intends to publish an annual summary.

Forecasts for 88 U.S. Cities Issued To Aid Travelers

The National Weather Service inaugurated a new service for travelers on September 20, when it began issuing on its teletypewriter circuits twice-daily lists of abbreviated forecasts for 88 U.S. cities.

By consulting these lists in their newspapers, or hearing them read over the air, travelers can obtain destination forecasts quickly and efficiently. For each city listed, there is a brief description of recent weather, plus forecasts for two 24-hour periods to follow.

In announcing the new forecasts for travelers, Dr. George P. Cressman, Director of the National Weather Service, said: "There is no question that weather forecasts for distant cities are a major unfilled need. Our offices are continually bombarded with requests for predictions at destinations hundreds of miles away. This information is in our system, but the problem has been how to get it to the person who needs it. Individual responses are out of the question for any city large enough to have a weather office. The demand is too great. Busy telephones and frustration are the result. Mass dissemination is the only answer. We believe these abbreviated forecasts—if passed along by the media—will do the job quickly and effectively, and fill a large gap in the public-service spectrum."

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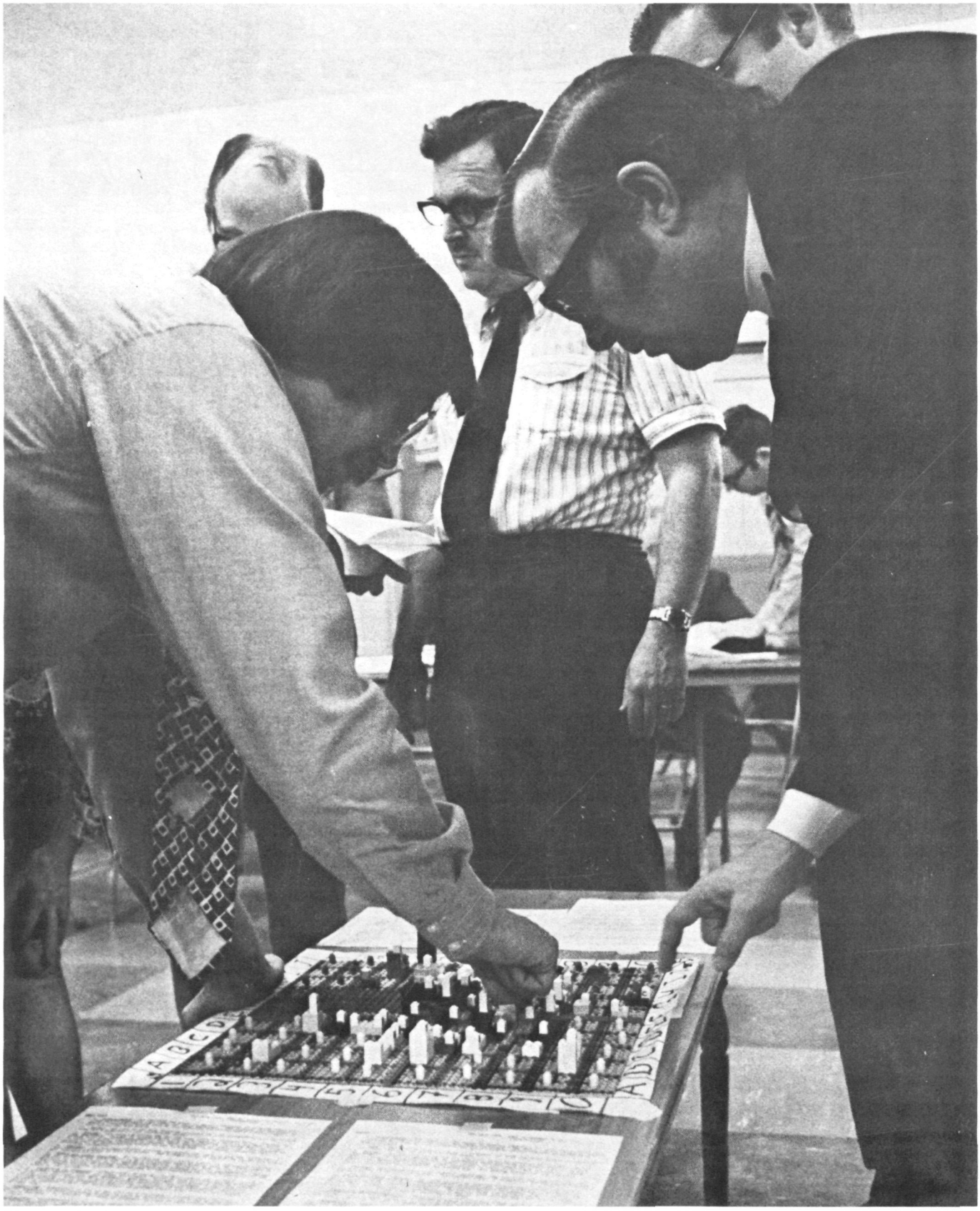

Players locked in struggle in a new environmental game (See Page 22).