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VOLUME 5 NUMBER 4 OCTOBER 1975

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On the occasion of America's 200th anniversary, NOAA celebrates its own fifth anniversary with a bicentennial red-white-and-blue salute.

3 A Message From the Administrator—*by Robert M. White*

4 NOAA: A Five-Year Look—*by Ann K. Cook*

12 The Last of the Apollos—*by L. Erick Kanter*

18 The Salt Menace—*by Brian Gorman*

21 The Second Biggest Oilspill—*by Louise A. Purrett*

25 Maps for Victory—*by Grace Wegner*

28 New Concepts for Ocean Transport—*by Kurt R. Stehling*

33 Weather Tech, U.S.A.—*by Edwin P. Weigel*

38 Reflections of a Novice Aquanaut—*by Howard W. Pollock*

44 From Processes to People—*by Milton Sloane*

50 A Woman Tackles the Weather—*by Valerie Anderson*

52 Elusive Ingredients in the Stratospheric Storehouse—*by Joan Vandiver Frisch*

55 Numbers, Numbers Everywhere—*by Gerald D. Hill, Jr.*

61 The Survey's Seagoing Troubleshooters—*by Raymond Wilcove*

64 Sea Fare: An American Tradition

68 NOAA/update

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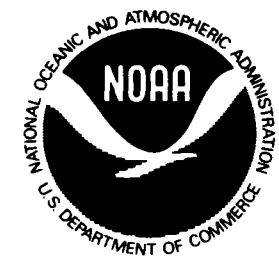


A Message From the Administrator

This month NOAA observes its fifth birthday and, at the same time, takes the opportunity to honor our Nation's bicentennial.

As we have done for several years, we shall mark the NOAA anniversary by welcoming the public to many of our facilities across the Nation, and on several of our ships, during October. Washington's Open House will be held on the NOAA Ship Researcher and in the new World Weather Building. We shall also have the pleasure of honoring several members of the NOAA family at the annual Awards Luncheon, for outstanding service to the agency and the Nation.

While we look back with immense satisfaction and pride upon the history of our country and upon our first five years, we shall not belabor them. We have chosen to document our efforts in a single article in this magazine; the rest of the material between these festive covers deals with the present.

We have made a beginning—a good one. We can best honor our past by rising to the requirements of a future which is sure to demand the most and the best we can bring to it.

Happy birthday, NOAA, and now for tomorrow.

Robert M White

NOAA: a five-year

BY ANN K. COOK

Most of the 13,000 men and women who came to work as NOAA employees on Monday, October 5, 1970, the agency's first official day of operation, were engaged in providing environmental services and products or in conducting research and development to improve those services. "Monitor and predict;" "explore, map, and chart;" "improve man's understanding of the physical environment" . . . those were the phrases most often used to describe the new agency's mission.

To a great extent, the phrases still apply. But, in its first five years of life, NOAA's role has been transformed in fundamental ways.

"The most significant," according to the agency's Administrator, Dr. Robert M. White, "is the general establishment of NOAA as an important environmental management agency, as well as an agency concerned with environmental science and service. The Coastal Zone Management Act, the Marine Mammal Protection Act, the Marine Protection, Research, and Sanctuaries Act—all passed in 1972—and the Endangered Species Act of 1973, enormously broadened NOAA responsibilities in environmental management and commercial fisheries. "These," Dr. White points out, "have changed NOAA from a strictly scientific and technical agency into one that now must deal with many of the social, political, and economic problems that interface with the scientific problems of the environment which we have dealt with so extensively."

The second change is NOAA's emergence as a source of objective information on the environmental effects of various proposed actions.

"People who have to make decisions, which are essentially political decisions by elected officials, must weigh economic development against preservation of environmental quality," Dr. White explains. "My feeling is that it's not good for the country to err on either side of this problem. There are too many emotions involved, and not enough data. To err on the side of favoring economic development as against environmental quality, or to err in the other direction, is dangerous. Somebody has to put all the factors together, so that the decision-makers have all the needed information.

"We are trying to position NOAA in such a way that our investigations of the environment, our studies of the impact of man's activities on the environment, are based so solidly on data, proper analyses, and good scientific assessment that we become looked to as an obviously impartial and reasonably objective source of information on what environmental impacts are. Our job is to get balanced information to decision-makers, and achieving this balance is a major responsibility and obligation of NOAA."

The years 1972 and 1973 were banner ones for the new organization. In rapid succession several new laws—the Coastal Zone Management Act, Marine Mammal Protection Act, Marine Protection, Research, and Sanctuaries Act, Endangered Species Act, Offshore Shrimp Fisheries Act, and Weather Modification Reporting Act—gave NOAA a variety of new responsibilities.

Referring to the new laws, Dr. White said later: "The wisdom of assembling responsibility for multifaceted aspects of the nation's ocean interests in one organization has been borne out. This has enabled the management of interlocking programs in a way that makes each function an element of a larger national drive. The Sea Grant College Program, the Coastal Zone Manageagement Program, and our various fisheries efforts are so intertwined that to deal with them separately, as would have been required prior to the formation of NOAA, would make administration difficult and consistent policy direction impossible . . .

"NOAA has given the nation a mechanism to assist in addressing in an integrated way the urgent problems of ocean food supply management, environmental degradation, environmental aspects of the development of ocean energy resources, and the ever-present challenge of protecting our people and their property from ocean-related natural hazards.

"The emergency of a central Federal agency to deal with the wide range of ocean efforts has given other government entities a place to go for assistance and a focal point for the Congress as it establishes new ocean policies and laws."

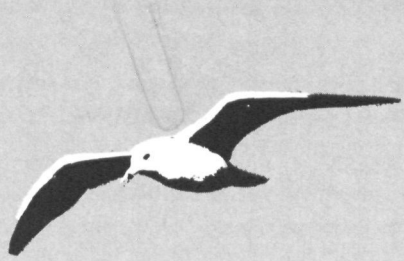
Designed to foster management of the finite and increasingly valuable shore regions in the public interest, the Coastal Zone Management Act calls for States to prepare comprehensive plans for balanced use of their coastal zones, maintaining environmental quality while providing for economic development. Under the law, NOAA gives matching fund grants, both for planning and carrying out approved State coastal zone management programs, and for establishment of estuarine sanctuaries. Grant funds became available about the beginning of 1974, and within 12 months, 29 of the 34 eligible States and territories had applied for and received program development grants. By the end of June 1975, all other eligibles except American Samoa had joined the program, and two estuarine sanctuaries —one in Coos Bay, Oregon, and another on Sapelo Island, Georgia—had been established.

"The Coastal Zone Management Act," Dr. White says, "recognizes the need for a balanced approach to environmental management problems. NOAA does not tell the States what to do. Our job is to make sure that the plans they develop conform with the balanced policies set down by the Congress. The Act provides a focus for resolving environmental issues of use and preservation of coastal areas. This resolution calls for information, lots of information, not only about our shorelands and offshore waters, but about projected industrial, population, and economic growth. Part of NOAA's task is to help the States acquire the necessary understanding with regard to the physical, biological, and chemical processes of the coastal zone. Before the Coastal Zone Management Act was passed, some 95 percent of the Sea Grant effort for five years had been devoted to the study of problems of the coastal zone, laying the base for coastal zone management programs in many states. Furthermore, the Fisheries Service, EDS, and NOS are contributing their special expertise to the success of this program. Thus, NOAA's large pool of essential talent and knowledge is being drawn upon in implementing the act."

The sanctuaries provisions of the Marine Protection, Research, and Sanctuaries Act, intended to preserve or restore marine areas for their conservation, recreational, ecological, or aesthetic value, also were assigned to the Office of Coastal Zone Management. The first marine sanctuary—site of the wreckage of the U.S.S. Monitor—was designated in January 1975.

Assignment to NOAA of responsibilities under the Marine Mammal Protection Act,

look



Dr. White believes, "came about because NOAA was increasingly regarded as an agency that could deal with the enormously difficult problems in a considered way. The existence of the National Marine Fisheries Service, looking at both commercial and recreational populations, made it possible for NOAA to undertake this task.

"This Act, as well as the Endangered Species Act of 1973, gave NOAA responsibility for protecting many marine mammals and endangered species. Both call for extensive research on marine ecosystems. Problems of management of seal populations on the Pribilof Islands, of the porpoises accidentally caught in the process of fishing for yellowfin tuna, and protection of the world's whale stock are difficult and costly to resolve."

After the passage of the Marine Mammal Protection Act, the NOAA Administrator was appointed United States Commissioner to the International Whaling Commission, which has since instituted conservation measures to preserve many whale species. We have made great strides, but "the fight is neither won, nor over," Dr. White asserts.

To examine the reasons for fluctuation of the Alaska fur seal population, NOAA in 1973 set aside one of the Pribilof Islands as an unharvested control area. The harvested populations on St. Paul Island are being compared with the control group on unharvested St. George Island, in order to identify the factors affecting survival and abundance. With this information, the herd can be managed effectively at optimum levels in the future.

The ocean dumping provisions of the Marine Protection Research, and Sanctuaries Act led to the establishment of NOAA's Marine Ecosystems Analysis (MESA) program, now managed by the Environmental Research Laboratories. Its first project, planned for seven years, is being carried out in the New York Bight—the ocean area east of New York, New Jersey, and Delaware, where the wastes of millions of people are dumped—dredge spoils, industrial wastes, sewage sludge, and toxic acids. Through studies of the physical, chemical, and biological characteristics of the Bight, MESA is determining the effects of this waste dumping on the area's fisheries and beaches. The program now is beginning a similar study of Puget Sound, and in addition is examining the environmental consequences of mining manganese-rich nodules from the ocean floor.

MESA offers a prime example of integrated use of the cross-section of talents made possible by the creation of NOAA. It draws on the scientific capabilities and facilities of all six major NOAA components and of institutions supported by the Sea Grant program.

"The information gained," Dr. White notes, "will help solve a whole range of national problems which come into sharp focus along our coasts—the building of offshore facilities, development of energy resources, ocean transportation and deepwater ports, and offshore nuclear power plants."

An example of how NOAA know-how pays off for Federal agencies directly engaged in this energy search and in need of unbiased environmental information is the major research effort currently being carried out for the Interior Department's Bureau of Land Management (BLM). Under a contract with the BLM, NOAA has mobilized personnel and equipment from several of its components to conduct environmental impact studies this year in potentially oil-rich Alaskan waters. The BLM, which has jurisdiction over continental shelf oil leases, is making practical use of NOAA's capabilities to carry out in-depth studies of the impact of the exploration and development of oil and gas resources in the Gulf of Alaska and the Bering and Beaufort Seas.

In addition, the National Ocean Survey is producing a series of bathymetric maps to assist the BLM's oil leasing programs in areas off the Atlantic coast, in the Gulf of Mexico, and off the channel islands of southern California which geologists consider prime targets for oil exploration. These maps will provide precise and up-to-date measurements of the sea bottom and facilitate the preparation of environmental impact statements on the possible effects of ocean oil exploration in the new areas.

NOAA contributes in many other ways to the nation's search for new energy sources and for solutions to the related problems of deepwater ports and transportation of fuels. Nearly all of NOAA's major components, as well as the Sea Grant program, have taken part in the Council on Environmental Quality's studies on energy development. Some are participating in studies of offshore floating nuclear power plants and of outer continental oil and gas development. In cooperation with the Maritime Administration, baseline levels of petroleum hydrocarbons across the Pacific Ocean are being determined. Minute quantities of hydrocarbons in the tissues of marine organisms in Prince William Sound, Alaska, are being measured before completion of the Trans-Alaskan Pipeline. Such baseline studies will make it possible to determine, in future, whether levels of manmade contaminants are rising—providing an early warning system of possible environmental damage.

In a program of near-shore water circulation studies started soon after NOAA was formed, the National Ocean Survey has assessed water motion in sounds, inlets, and bays, including Cook Inlet, Alaska, and now is starting a five-year study of circulation in Puget Sound. Such surveys are vital to marine transportation, especially oil shipment, to pollution control, and to management of the coastal zone. Since 1972, NOS also has been making special hydrographic surveys of shipping channels in developing areas such as Alaska, where petroleum shipping operations and other activities are burgeoning rapidly.

A Deepwater Ports Project Office was established this year within the Environmental Data Service to meet NOAA responsibilities under the 1974 Deepwater Port Act, which calls for the agency to review, evaluate, to prepare recommendations on deepwater port license applications and related environmental impact statements.

One of the most difficult tasks of environmental management in which NOAA is involved is that of managing fisheries resources. "During the past five years," Dr. White points out, "we have taken steps to push for much-strengthened international fisheries management regimes, working through international organizations. Even though we remain unsatisfied, I think it's fair to say that we have achieved much stricter and broader conservation measures on the part of other nations to protect our fisheries.

"But, as the present Law of the Sea deliberations unfold, and as Congress decides upon its course of action, it is clear that in the near future our nation will be responsible for an expanded economic jurisdiction

over oceanic resources. We will need new arrangements for managing our fisheries that provide for their conservation as well as their development. The Fisheries Service has been active in devising management schemes for a future 200-mile economic jurisdiction, and also has developed a comprehensive national fisheries plan which I think will set the pattern for the development of U.S. fisheries in the years ahead. NOAA, working with the states and the affected industries, hopes to conserve these valuable and renewable resources, while at the same time establishing meaningful management systems which can enable our fishing industry to thrive."

To bring users of the sea information on marine resources, products, and services available from NOAA and other Federal and state agencies, the agency in late 1972 created an integrated NOAA Marine Advisory Service within the Office of Sea Grant. The NOAA Marine Advisory Service, Dr. White notes, is an excellent example of the benefits realized by unifying ocean programs. "Before NOAA, there was no uniform marine advisory service dealing with all aspects of marine affairs; now there is."

Also he views the designations, beginning in 1971, of eight universities as Sea Grant Colleges, as among key achievements in NOAA's five-year history, "a landmark event that, 100 years from now, will be looked back upon much as the establishment of Land Grant Colleges a century ago is now."

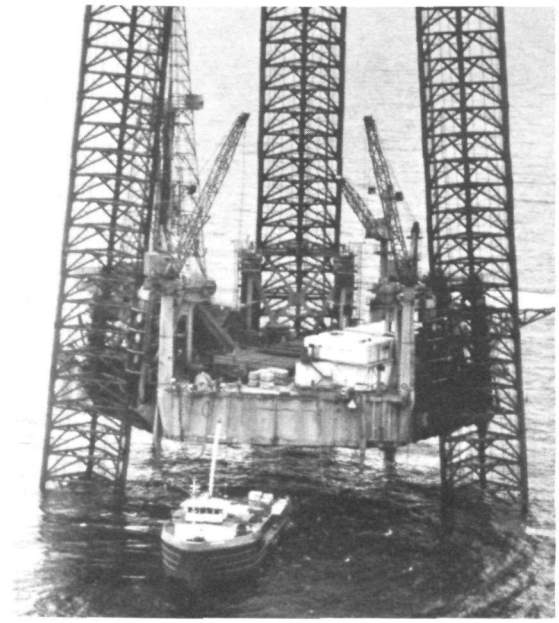
To a great extent, NOAA's ability to respond to the myriad new needs for environmental information stems from its ability to develop observing platforms and systems for multiple environmental uses based on the capabilities and interests of the organizations from which NOAA was formed.

Since 1966, the Environmental Science Services Administration, NOAA's predecessor, had operated a satellite system primarily designed to observe the earth's weather system and provide information for weather forecasts and warnings.

"If it were not for NOAA," Dr. White believes, "the satellite system might have remained essentially meteorological, rather than evolving as it has into a system that monitors solar activity and provides vital data on the oceans. NOAA satellites have become key elements of an ocean monitoring assessment system."

Two months after the new agency came into being, its first satellite—NOAA-1—was placed in polar orbit, providing unprecedented nighttime, as well as daytime, coverage of the world's weather. Operational uses of satellite data again were expanded with the October 1972 launch of NOAA-2, which added the capabilities of sounding the atmosphere over vast ocean and polar areas and providing global data on sea surface temperature and ice conditions.

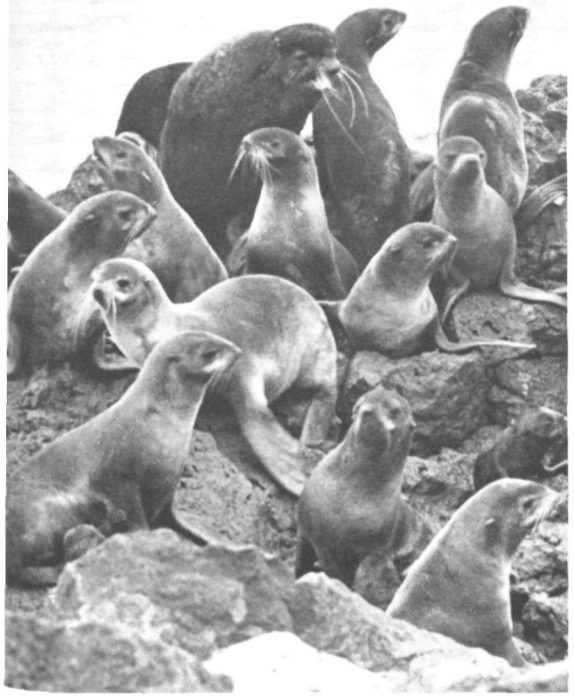
The most significant advance in satellite coverage of weather and oceans came with the orbiting of two operational earth-synchronous environmental satellites, one in May 1974 and the second in February 1975. Launched by NASA and operated by NOAA, these spacecraft—prototypes for NOAA's future GOES (Geostationary Operational Environmental Satellite) system—constitute, according to Dr. White, "the most significant step forward in weather and ocean monitoring systems since the first polar-orbiting satellite. They have clearly brought about dramatic improvements in our ability to track severe storms." Continuously viewing nearly hemispheric areas of the globe, earth-synchronous satellites make it possible for the first time to determine winds over large ocean areas.

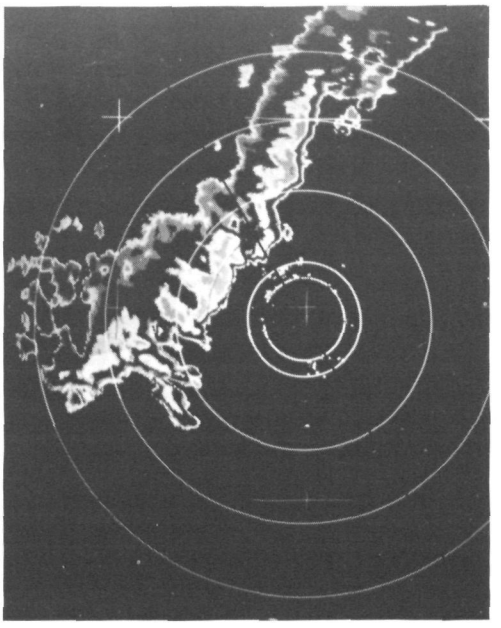


Another important attribute of these spacecraft is their ability to collect environmental data from instruments on remote platforms at sea and ashore. Among these will be the buoys developed by the National Data Buoy Office, essential platforms for marine environmental monitoring in conjunction with ships, aircraft, and satellites. In 1972, the buoy project began to deploy test networks in the Gulf of Mexico. Large moored data buoys since have been placed in the Gulf of Alaska, in the storm-ridden western Atlantic, and off the Pacific coast. During the test and evaluation phase, the buoys' instruments have provided important operational data for weather and ocean forecasting. By 1980, NOAA plans to have 32 buoys deployed along the data-sparse coastal areas of the United States: 16 in the Pacific Ocean; nine in the Atlantic; four in the Gulf of Mexico; and three in the Great Lakes.

The NOAA fleet—brought together from the National Ocean Survey, the National Marine Fisheries Service, and the Lake Survey Center—provides another major data collection and research capability, and its use has been broadened and improved. "Operation of the fleet has been consolidated," Dr. White points out, "and the fleet has been upgraded. Some of our ships are used for a variety of purposes, and the NOAA Corps officers who operate them now are being trained to deal with fishery and other ocean observations, in addition to their traditional charting and surveying activities."

Preparation of charts from data gathered by the fleet's survey ships has been speeded by means of automated data acquisition and processing techniques. Today, a large portion of the fleet is collecting environmental





baseline data that will serve as the basis for decisions on oil and gas development.

Beneath the surface of the sea, submersibles and habitats have been used by NOAA's Manned Undersea Science and Technology program to explore and study the waters, undersea features, and marine life in areas from the Bahama Banks to the Bering Sea.

Joining ocean and atmospheric activities in one agency, Dr. White says, has brought about broader use of environmental observing systems. "The Environmental Research Laboratories now are using remote-sensing techniques, originally developed for the atmosphere, for probing the oceans." One, now under development, is an over-the-horizon radar capable of sensing sea state or roughness. Other remote-sensing techniques that five years ago existed largely on paper have been developed by ERL into experimental systems: Doppler radars that measure wind velocities in thunderstorms and other weather systems and thus help to improve understanding of severe storms and tornadoes; lasers and lidar that detect and measure winds, chemical constitutents, water content, and other atmospheric characteristics; and acoustic sounders capable of detecting such phenomena as the formation and dissipation of urban inversion layers and wind shear over airports.

"NOAA," as Dr. White notes, "is the Nation's principal disaster warning agency. We are attempting to understand the phenomena which cause destruction, develop techniques for their prediction, and the technology for tracking and predicting them. NOAA operates the largest environmental observing network of any agency in its attempt to monitor and predict such natural environmental events as hurricanes, tornadoes, tsunamis, and floods. To do this, we deploy a remarkable array of observing devices and communications systems. The observing devices range from earth-orbiting satellites to networks of radars which allows us to pinpoint severe weather. Communications systems of many kinds, including facsimile, teletype, and radio broadcasts, all help us to meet the needs of the public by disseminating warnings of rapidly changing environmental conditions."

In June 1972, tropical storm Agnes cut a swath from south to north through the eastern states, creating record floods that killed 118 people and caused $3.5 billion damages, making the storm the worst natural disaster in U.S. history as far as property damage is concerned. Asked by the NOAA Adminstrator to evaluate the performance of the National Weather Service's storm warning system, a panel of the National Advisory Committee on Oceans and Atmosphere rated the performance as good, and in some cases outstanding, although the warning system had been strained to the limits of its capacity. Among the system's principal deficiencies, the panel reported, were delivery of warnings to the public, public response to warnings, rainfall forecasts and observations, and adequate flash-flood warning systems.

By the following year, NOAA—in cooperation with other Federal agencies involved—had developed a detailed plan for improving warnings and preparedness for all kinds of natural disasters—hurricanes and storm surges, tornadoes and severe local storms, fire weather, severe winter weather, river and flash floods, tsunamis, droughts, frosts, and freezes. The plan was designed to reduce the disaster toll by significantly improving the accuracy and timeliness of warnings, by developing the capability of warning all people in threatened areas, and by making assistance in disaster planning available to all U.S. communities.

Specific improvements planned included the two-satellite geostationary system; expanded networks of long- and short-range radars and additional remote radar displays; extension of river and flood forecast and warning—as well as flash-flood warning—services throughout the United States; improvement of airborne automated data systems; implementation of the Automation of Field Operations and Services system at Weather Service Forecast Offices, to eliminate manual handling of data; and the assignment of community preparedness specialists at key weather service offices to aid in developing community weather disaster preparedness plans and to educate the public in protecting life and property during weather emergencies.

Less than a year later, when the planned improvements in the warning system had just begun, the system's effectiveness underwent another severe test. On two days—April 3 and 4, 1974—148 tornadoes struck 13 states, killing some 300 persons and injuring 6142 others. The most devastating outbreak of tornadoes ever recorded anywhere in the world, its toll of lives was high, but timely Weather Service warnings were credited with keeping fatalities in the hundreds rather than the thousands. However, the disaster gave renewed emphasis to the need for completing the planned warning and preparedness system as swiftly as possible.

"The past five years have seen dramatic improvements in the disaster warning system," Dr. White says. "We're now introducing a whole new system of modern radars. We have started to introduce new weather and other natural disaster communications systems, as for example, our VHF-FM continuous weather broadcast facilities. We will

have completed, in this five years, the NOAA Weather Wire—extending teletype communications systems to mass news media to all of the lower 48 states. In addition to that, we have received approval to move ahead with the automation of our field weather operations through the AFOS system." AFOS—Automation of Field Operations and Services—is a system of highly computerized meteorological offices planned for installation in some 275 locations by 1980.

As to some other recommendations of the natural disaster warning and preparedness plan: the two geosynchronous satellites are now operating; improvement of data systems in research and reconnaissance aircraft is underway; the radar network has been extended so that only a few gaps remain to be filled, and a community preparedness program has been established in the Weather Service.

Since the formation of NOAA, the Weather Service has extended its activities farther from land, and added new kinds of marine warnings. A new Office of Oceanography was created in the Weather Service, charged with increasing real-time ocean observations and predictions. Now, Marine Forecast Units have been established at National Weather Service Forecast Offices in Anchorage, Washington, D.C., San Francisco, Honolulu, and Miami. In 1973, the National Meteorological Center began issuing computerized wind wave and swell predictions to guide the Marine Forecast Units in preparing forecasts and warnings for ocean areas. The following year, the Center began using satellite data to prepare sea-surface temperature analyses for both the Atlantic and Pacific Oceans.

Because many environmental monitoring and prediction problems are global in nature, NOAA has cooperated actively with international organizations in developing the World Weather Watch, the Integrated Global Ocean Stations System, the Global Atmospheric Research Program, and the Earthwatch concept of the United Nations Environmental Program (UNEP).

Earthwatch and UNEP evolved from the history-making June 1972 Conference on Environment and Man, convened in Stockholm to consider how the earth's environment could be protected by international action. Earthwatch is to be a comprehensive assessment, that includes monitoring, research, and information exchange, to evaluate critical global problems such as climate change, marine pollution, land use practices, and natural disasters. GEMS—the Global Environmental Monitoring System—is part of Earthwatch, building on existing national and international programs and facilities. One such international program already in operation is the World Weather Watch, an effort initiated in the early 1960's.

The combination of ocean and atmospheric programs in a single agency has facilitated participation in several major international experiments.

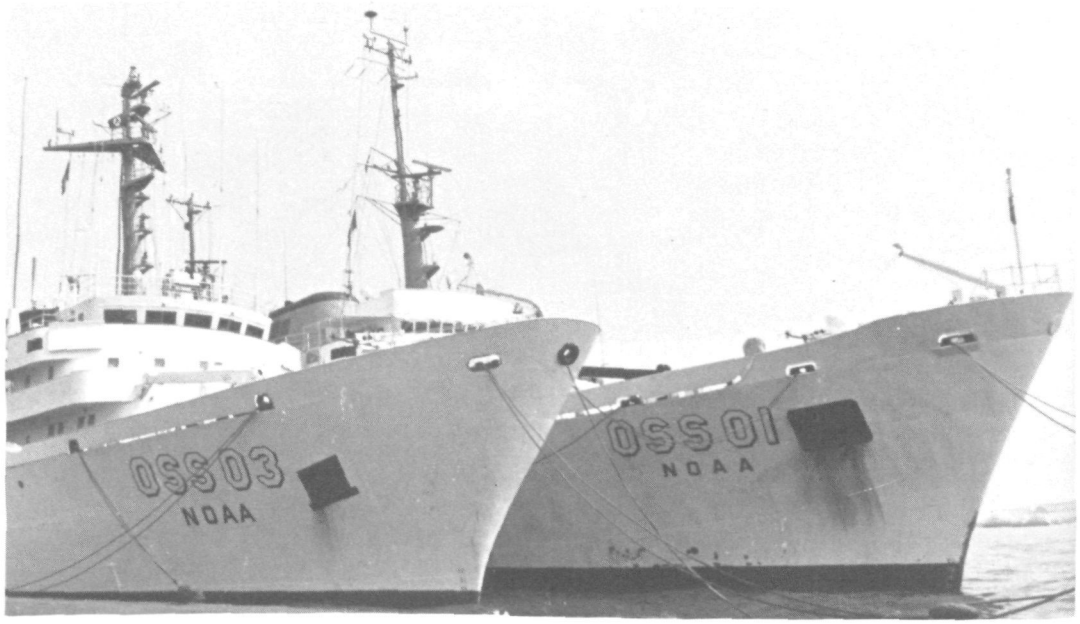
First, there was IFYGL—the U.S.-Canadian International Field Year for the Great Lakes. During its field phase in 1972-1973, more than 100 million observations were gathered in Lake Ontario by ships, buoys, aircraft, and shore installations, to provide a scientific basis for improved management of water quality and quantity in the Great Lakes. Early results of IFYGL data analyses indicate that the atmosphere plays a major role in determining the development of circulation and thermal patterns in the Lake.

From June through September 1974, ships, aircraft, and buoys from many nations were deployed across the Equatorial Atlantic to study the relationships between tropical ocean and weather conditions and large-scale atmospheric circulation. Called GATE—Global Atmospheric Research Program-Atlantic Tropical Experiment—the project was the greatest international cooperative undertaking in the history of the atmospheric sciences.

Oceans have served as the avenue for other international projects in which NOAA has taken part or coordinated all U.S. participation. NOAA leads the U.S. effort in the Cooperative Investigation of the Caribbean and Adjacent Regions, sponsored by the Intergovernmental Oceanographic Commission; it is the U.S. Executive Agent for the U.S.-U.S.S.R. agreement on Cooperation in Studies of the World Ocean; and it serves as the national focus for the United States' bilateral undertakings in marine affairs with France and Japan.

With other U.S. agencies, NOAA joined in the 1974 French-American Mid-Ocean Undersea Study, in which scientists from the two nations descended 12,000 feet beneath the sea surface in submersibles, for man's first look at the Mid-Atlantic Ridge.

An emerging problem that critically affects the lives of all men on earth is climate change, both natural and man-induced. For several decades, NOAA has operated a climate monitoring station at Mauna Loa, Hawaii, amassing the world's only long-term records of carbon dioxide and other constituents in the atmosphere. Now, NOAA has established three additional stations to monitor the factors involved in long-term changes in climate: one in the Antarctic, one in the Arctic, and a third in American Samoa. As contributions to the World Weather Watch and Earthwatch, nine other

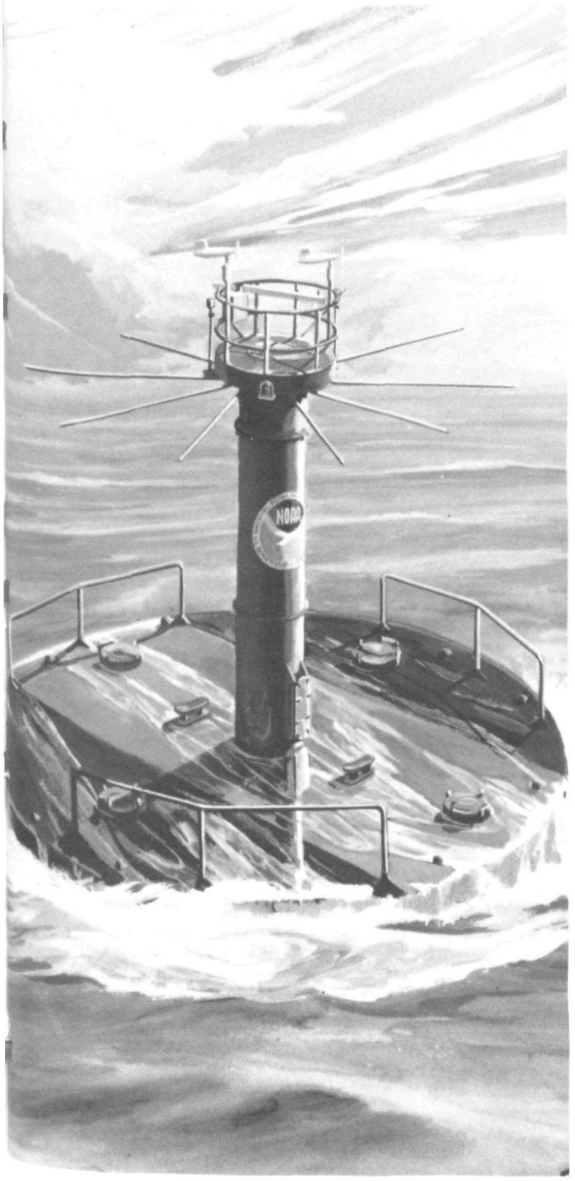


nations intend to establish 18 more baseline stations, creating an international network that will provide effective global coverage of long-term climatic changes.

Within NOAA, growing awareness of the dependence of man's social and economic wellbeing on climate and climate change has led to the recent establishment in the Environmental Data Service of a Center for Climatic and Environmental Analysis, and the beginning of a cooperative EDS-NASA-Department of Agriculture Large Area Crop Inventory Experiment which will determine whether satellite data can make crop assessment more timely and accurate.

At ERL's Geophysical Fluid Dynamics Laboratory, scientists continue the development of increasingly accurate mathematical models of the atmopshere and the ocean-atmosphere system. Using these computer models, the Laboratory is gaining new insights into the long-term climatic consequences of changing the composition of the atmosphere.

Recently, the specter of partial destruction of the stratosphere's ozone layer, by supersonic transport exhausts or by freon from spray cans and other uses, has been raised. Because the ozone layer shields all living things from the sun's ultraviolet rays, any decrease in it increases the probability of human skin cancer and of adverse effects on agriculture. Three of NOAA's Environmental Research Laboratories—Air Resources, Aeronomy, and Atmospheric Physics and Chemistry—have been examining various aspects of the upper atmosphere, including the ozone layer. Their studies—and those of the National Academy of Sciences—indicate that the danger to the protective layer is very real, although much more research is needed before the full implications are understood completely.



Paralleling NOAA's assessment of natural and inadvertent climate changes is the search for methods of modifying the atmosphere for the benefit of man. When NOAA was formed, its major ongoing weather modification program was Project Stormfury, an exploration of the feasibility of diminishing the force of hurricanes. In 1969, the joint ESSA-Department of Defense effort had repeatedly seeded Hurricane Debbie and, after the seedings, the storm's maximum winds at higher levels had decreased substantially. Since then, nature has not cooperated with the project and no storms appropriate for the experiment have occurred in Stormfury's operating area of the Atlantic, Caribbean, and Gulf of Mexico. Now, NOAA is planning to move the project to the western Pacific—where records show three times more seedable storms occur than in the Atlantic—and resume Stormfury operations from a base in Guam in 1977.

In the meantime, the Environmental Research Laboratories have conducted cumulus cloud seeding experiments in Florida each summer, examined the possibility of altering the patterns of snowfall from winter storms in the Great Lakes Region, and tested methods of reducing lightning and hail. This research was turned to timely use in cooperation with NASA for its Apollo-Soyuz flight.

The air fleet operated by the Research Facilities Center (formerly the Research Flight Facility) for weather modification and other research projects has been modernized with the retirement of two older planes, acquisition of a WC-130 and two new WP-3D aircraft, and installation of improved data-collection systems.

Under the Weather Modification Reporting Act of 1972, weather modification activities in the United States and its territories now are reported to NOAA, which issues periodic summaries of these reported activities.

Information gathered by the varied and farflung operational and research programs of NOAA and other private, national, and international organizations, is archived and disseminated through the Environmental Data Service's national centers of climatic, oceanographic, and geophysical and solar-terrestrial data centers. "Without NOAA," Dr. White says, "such an Environmental Data Service could not exist. Its rapid development of improved automated data systems has made EDS the most comprehensive environmental data service in the Nation."

Of the agency's many accomplishments during the past five years, Dr. White believes, "almost all would have been more difficult to achieve if NOAA had not been established. Our ocean and atmospheric programs have been able to interact in a way that has made all of them more effective."

And what does the future hold for NOAA?

"The biggest job we're going to have in marine resources," Dr. White predicts, "is managing fisheries resources in an economic zone of 200 miles. We will be involved with the states, the industry, and other groups interested in fisheries—setting up a management system, implementing it, conducting surveillance, and enforcing its provisions. This is going to be a very large, important program.

"In coastal zone management," he continues, "the real problems, and real opportunities, lie ahead. Coastal zone management will grow and expand into a major activity, affecting every citizen of this country. It is going to be an enormously complex and difficult task.

"Definitely, there will be deep ocean mining," the Administrator says, "and here NOAA will play an increasingly central role, not only in its environmental aspects but also in its management aspects.

"In environmental monitoring and prediction, our major task now is to complete the natural disaster warning system. We will see that to completion, certainly by 1980, with new generations of polar-orbiting satellites and the AFOS automated systems bringing a complete transformation in the field operations of the Weather Service.

"The first GARP Global Experiment will be carried out, to collect a complete set of data for studying large-scale global motions of the atmosphere.

"Investigations of climatic problems, and the long-range consequences of man's activities on the whole environment, will be a major effort," Dr. White adds. "In connection with this, ocean conditions will be more intensively monitored. Successful development of ocean-sensing techniques from satellites may finally make its possible to achieve a simultaneous view, not only of ocean temperatures, but of other ocean parameters as well. Such ocean monitoring systems will become increasingly important both for protecting life and property and for providing the sampling and monitoring that is essential to preservation of a quality environment.

"In geodesy," he notes, "we will carry out the releveling of the vertical network, as well as the readjustment of the North American horizontal datum, begun last year to provide a geodetic reference system with an overall accuracy of one part in a hundred thousand.

"I hope that we will be able to expand our marine boundary survey program, so that the coasts of the United States will be properly surveyed. And, in connection

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In the mid-60's, first the National Academy of Sciences and then the President's Science Advisory Committee examined the national needs for ocean programs and recommended expanded efforts in marine sciences. The consensus among these groups and other leading members of the scientific community, as well as within the Congress, was that ocean programs were too widely dispersed, in too many government organizations, and that a more coherent effort was required. Within the Congress, initiatives for increased development of oceanic resources led to the passage of the National Sea Grant Act and the Marine Resources and Engineering Development Act in 1966. A key feature of the latter Act established a Commission on Marine Sciences, Engineering, and Resources. Purpose of the Commission was to study all aspects of marine science and recommend a comprehensive plan for a national oceanographic program that would meet present and future needs.

The Stratton Commission—as it came to be known for its chairman, Dr. Julius A. Stratton—was appointed in January 1967, and published its report, "Our Nation and the Sea," in January 1970. Its recommendations were founded on the premise that the misuse of ocean resources and of the total physical environment are inseparable. Therefore, the Commission urged that all of the oceans, the atmosphere, and certain aspects of the solid earth be considered together in forming an organization to conduct the Nation's ocean program. The many existing ocean activities within the Federal Government, the Commission recommended, should be brought together with atmospheric programs to form a civil center of strength with the scientific and technical capabilities, facilities, and resources to carry out a concerted, unified national oceanic and atmospheric program.

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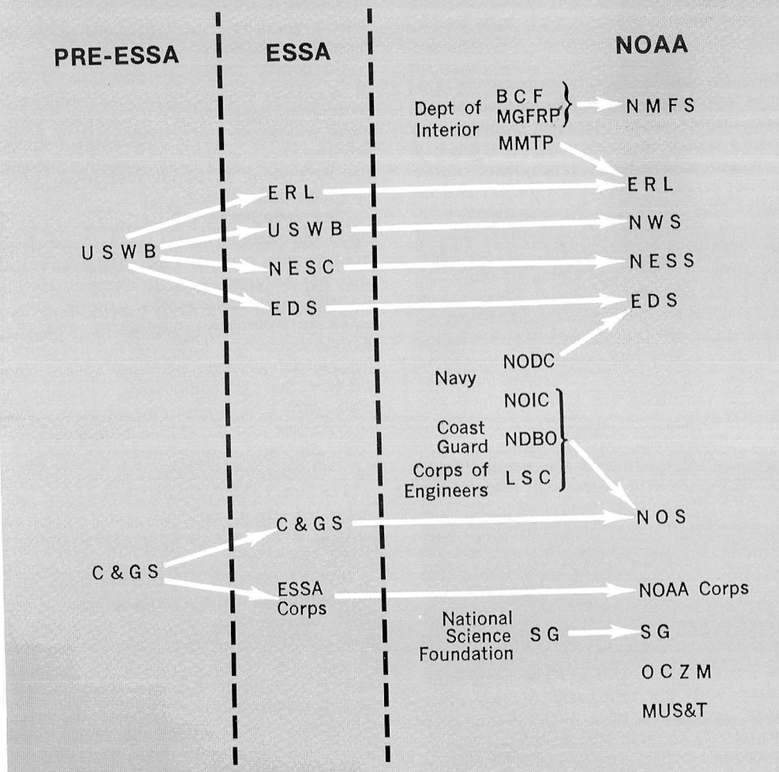

with our mapping and charting programs, we will have to begin considering fleet replacement.

"These are some of the new program directions I foresee for NOAA in the years ahead. But NOAA is more than just programs. It is people.

"While we go about our essential tasks of providing the services the nation expects of us, we must always keep paramount that it takes people—dedicated people, who feel that there is challenge and opportunity provided by the organization.

"We've made some progress in our people programs since NOAA was formed, but we have a long way to go."

The "people programs" to which Dr. White refers are exemplified by NOAA's efforts in the area of Equal Employment Opportunity (EEO).

In NOAA's first year, an EEO Committee was established at headquarters to advise the Administrator on the operation and effectiveness of the total NOAA EEO Program. Since then, much progress has been achieved through recruiting efforts at colleges with large minority enrollments, EEO training programs to accomplish understanding and support of EEO goals among supervisors and all employees, and, in particular, a number of innovative upward mobility training programs. A list of a few of these programs gives an idea of the scope of EEO training efforts over the last five years: the Alaskan Native training program, the Trust Territories training program, the American Indian training program, the Computer Operator training program, the Administrative Trainee program, the Junior Fellowship Program, and Scientific Upward Mobility Training Programs (SUMTP).

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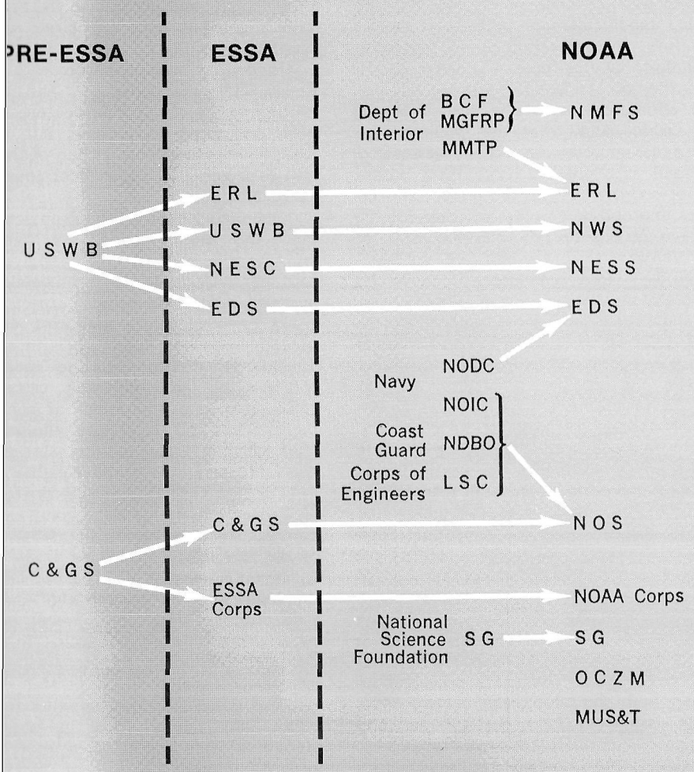

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Along with minority groups, women have found that NOAA is ready and willing to get involved in innovative "people programs." For example, the NOAA Corps has carried out an active and successful program to recruit minorities and women for its ranks of scientist/officers.

"NOAA enters the United States' bicentennial year," according to Dr. White, "young but not lacking in experience, diverse but with a unity of purpose, moving ahead aggressively to provide vital environmental sciences to meet ever-expanding national needs."

NOAA's role in manned flights was bigger than ever for

The Last of the Apollos

BY L. ERICK KANTER

It is not yet 15 years since a wiry, crew-cut Navy pilot named Alan Shepard launched the American nation, and much of the world, into what was then a fantastic, almost unthinkable new adventure by riding a rocket beyond the earth's atmosphere for a few brief moments.

A young American President then seemed almost foolhardy by declaring that it was the goal of the space program to put a man on the moon before the end of the decade. What had been an impossible dream throughout the history of mankind became reality in a few short years as a steady succession of increasingly complex manned flights led to the safe landing of two Americans on the moon in 1969.

So successful was NASA's effort that by the early 1970's the incredibly complicated and costly process of landing more Americans on the moon a couple of times each year had become commonplace to the average citizen. Even the Skylab missions of the 1970's—very valuable in testing human endurance in space and superb for scientific experiments—failed to stir much public interest.

By the time the last Apollo mission was launched from Cape Canaveral in the summer of 1975 there wasn't much left to prove. Not from a scientific or technological vantage point, anyway. There were to be some valuable scientific experiments, to be sure. And it was still going to be a complicated and demanding job to send three men into space and bring them back to earth safely. Yet this kind of effort had become routine by now.

So anticlimactic was the last Apollo mission in the summer of 1975 that it wasn't even going to the moon. It was to be a sample earth-orbiting and docking exercise —very much like the early two-man Gemini missions of the mid-1960's, which were the practice runs for the three-man Apollo moon missions.

However, there was one very important difference from the Gemini missions. Instead of docking with another piece of American space gear, the astronauts in the last Apollo were to link up with a spacecraft owned and operated by Russia—the only other nation ever to send men into space. Technically this created a few challenges, but nothing as demanding as a moon mission. In fact Donald K. "Deke" Slayton, one of the original seven American astronauts, who was now making his first space flight at age 51 after years of being grounded by a mysterious heartbeat irregularity, claimed the flight would be so routine that his 91-year-old aunt could have successfully made the trip in his place.

Photo: NASA

The American Apollo-Soyuz crew rode to Launch Pad 39-B at Cape Canaveral in their special van (above) and were then blasted into orbit, eluding threatening weather.

Nonetheless, the planned Russian connection injected interesting new complexities into the last flight of Apollo—the Apollo-Soyuz Test Project, or ASTP as it was promptly dubbed.

A new kind of "first"—more political than scientific—was planned.

Detente was to be the most interesting aspect of ASTP—not science and technology. Of course, the need for meticulous coordination of activities and the requirement for new equipment necessary to accomplish such a historic rendezvous in space would test the abilities of spaceflight personnel of both nations. But this would be more a matter of highly efficient utilization of available technology and procedures, and not a truly pioneering effort.

Ironically, the very efficiency of the international coordination effort created a potential problem, which ultimately was to result in a NOAA involvement in ASTP larger and possibly more important than in any previous manned spaceflight.

For a variety of reasons it had been decided that both nations would launch their spacecraft on July 15—Russia's Soyuz first, and then America's Apollo 7½ hours later. Specifically, the American Saturn 1-B rocket was scheduled to blast off from the Kennedy Space Center in Florida at 3:50 p.m. (EDT) This would enable it to place the Apollo spacecraft into the proper orbit for "catching up" and ultimately docking with the Soyuz craft.

It was a good launch time in many respects—except for the weather prospects. Mid-summer is a wet season in central Florida—and a late afternoon in July is a prime time for thunderstorms in the Cape Canaveral area on the eastern coast. In fact, climatology and data from launch simulations supplied by the National Weather Service indicated a 30 percent probability of unacceptable conditions at Launch Pad 30-B during the scheduled liftoff time

The danger of lightning damage to the volatile propellants and miles of delicate wiring in the rocket and spacecraft had haunted NASA launch officials ever since Apollo 12 somehow escaped disaster when it unexpectedly triggered a lightning bolt

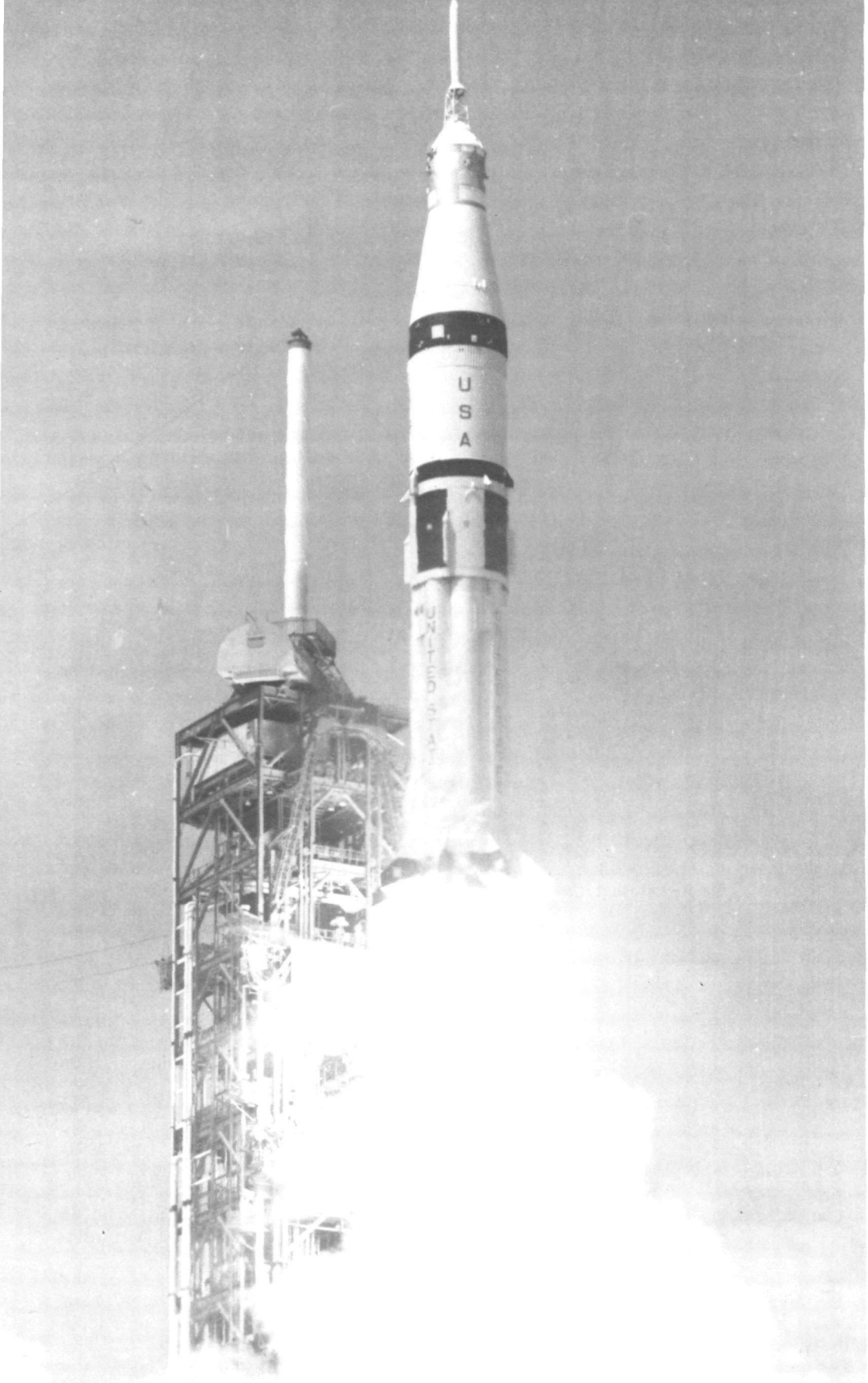


Photo: NASA

during liftoff in November 1969. Nonetheless, any launch time with more favorable weather would have meant other sacrifices in coordinating the rendezvous with the Russians. "We obviously had to make some compromises, and this was one of them," a NASA official explained to reporters on the day before the launch.

The net effect of the possibility of a weather problem was an increase in the drama on the science and technology side of the mission, thus heightening public interest in the entire project. It also resulted in increased NASA reliance on the work of two NOAA components—National Weather Service and Environmental Research Laboratories.

The NWS role was well-established. The meteorologists in its Space Operations Support Division, headed by Kenneth M. Nagler since it was established in 1960, had provided specialized forecasts for every manned spaceflight since Alan Shepard's historic effort.

ERL involvement in Apollo-Soyuz was less historical, but in a sense more exotic.

"Starting in 1970—shortly after the Apollo 12 induced-lightning event—NASA asked NOAA if we could come and help trying to work on this lightning problem," explained ERL director Dr. Wilmot Hess at a special NOAA briefing for the news media at Cape Canaveral the day before the launch.

"They assigned three tasks," he continued. "They asked if we would try to find out what threshold electric field would produce induced lightning and therefore constitute a hazard for a spacecraft. Second, could we help develop a measuring and monitoring system for measuring electric fields at the surface—and later on, aloft. And finally, could we try to help defend the launch vehicle from induced lightning by dissipating dangerous electric fields."

The weather problem was to be particularly critical because the "launch window," which is the period during which the rocket could be fired into the right orbit for a rendezvous with Soyuz, was a skimpy eight minutes. It was later widened by about five extra minutes, but it still meant that just a few minutes of bad weather on an otherwise sunny day could result in a launch delay of 24 hours or more.

Thus, not only would NOAA's weather forecasts be vital to NASA's launch controllers in planning for the final moments of the countdown; NOAA's monitoring of electrical charges in the launch area might be critical in making the final decision of whether to launch or wait until the next day. Furthermore, there was a chance that under marginal weather conditions NOAA scientists and pilots might be asked to seed the clouds above Launch Pad 39-B to reduce the electrical charges—and thereby the chance of "induced" lightning.

It is important to understand the significance of "induced" lightning, compared to the regular variety, when discussing the possible dangers to the Apollo launch. NASA's launch rules preclude launching the

Photo: NASA

More than half a million people came to the Florida Space Coast to see the launch of the last Apollo. Washington dignitaries and Hollywood stars watched from this site.

rocket through a thunderstorm. That would simply be too dangerous. It is when there are electrical storms nearby or electrically-charged clouds overhead with no natural lightning that the launch controllers face their hardest decisions. Under those conditions there would be some electrical fields in the atmosphere above the launch pad. Not the 500,000 volts-per-meter needed to trigger natural lightning, but a lesser field that could result in a lightning bolt "induced" by a long metal conductor like a Saturn rocket passing through the lesser field. That was what had happened with Apollo 12.

Thus the importance of measuring the electrical field in the vicinity of the launch pad, and the value of a capability to reduce the intensity of dangerous electrical fields by seeding.

Dr. Heinz Kasemir of ERL's Atmospheric Physics and Chemistry Laboratory is in charge of the lightning project which led to the measuring and seeding activities at the Kennedy Space Center. In 1972 and 1973 he and his colleagues sampled 28 thunderstorms over northeastern Colorado. Ten were seeded from a World War II B-26, and the other 18 were used as unseeded control storms. All 28 were comparable in intensity before seeding, but afterwards the seeded storms produced only about one-fourth the lightning of the others.

For several weeks prior to the July 15 launch date, a NOAA team led by Dr. Kasemir and Merlin C. Williams, ERL's head of environmental modification programs, made experimental chaff drops at the Kennedy Space Center from a T-29.

"The chaff consists of aluminum-coated fiberglass thinner than human hairs," explains Dr. Kasemir. "It is chopped into pieces 10 centimeters long in the aircraft and then released by the millions into the cloud, near its bottom. If the cloud contains a field of at least 13,000 to 20,000 volts-per-meter the chaff needles produce a corona effect. This means that the streams of ions opposite the polarity of the cloud charge is released by each chaff fiber, thus neutralizing the cloud charge. A faint glow at sharp metallic points such as antennas or ship masts can sometimes be seen underneath thunderstorms at mountain tops or on the ocean. This is known as St. Elmo's fire, which is a visual manifestation of corona discharge.

"In laboratory experiments we have found that each needle produces about one microamp of current—or corona. Thus a few million needles in a cloud can collectively keep up with the electrical current production of the cloud."

In addition to their seeding activities in the days prior to the launch, the NOAA team was also monitoring the electrical field in the area via a ground network of 23 electrical measuring instruments called field mills placed at key sites around the Kennedy Space Center, as well as from several field mills carried aloft at different altitudes in a variety of aircraft. These measurements were fed through a computer and then displayed in a contour map format, devised by ERL's Dr. Elemer Magaziner, on TV screens. This electronic map was monitored by the NOAA scientists in the National Weather Service offices in the Manned Spacecraft Operations Building (MSOB), a sprawling structure in a campus-like setting amidst the tropical marshes and grassy sand dunes of the Kennedy Space Center.

It was in the NWS offices on the fourth floor, where large plate glass windows afford an excellent view of the launch pads several miles away, that NOAA efforts for Apollo-Soyuz were concentrated, even though Merlin Williams and his deputy, William Mallinger, had administratively set up shop elsewhere in the massive MSOB. Here was a scene of increasingly brisk activity and tense excitement as launch day approached. Not only was this the source of vital weather data and electrical field observations for NASA's launch officials. It also developed something of the atmosphere of a control tower, with Dr. Kasemir, Dr. Magaziner, and ERL research flight group director Dr. James McFadden in direct radio contact with as many as eight aircraft, directing their electrical measuring and chaff dropping activities, and monitoring data from them.

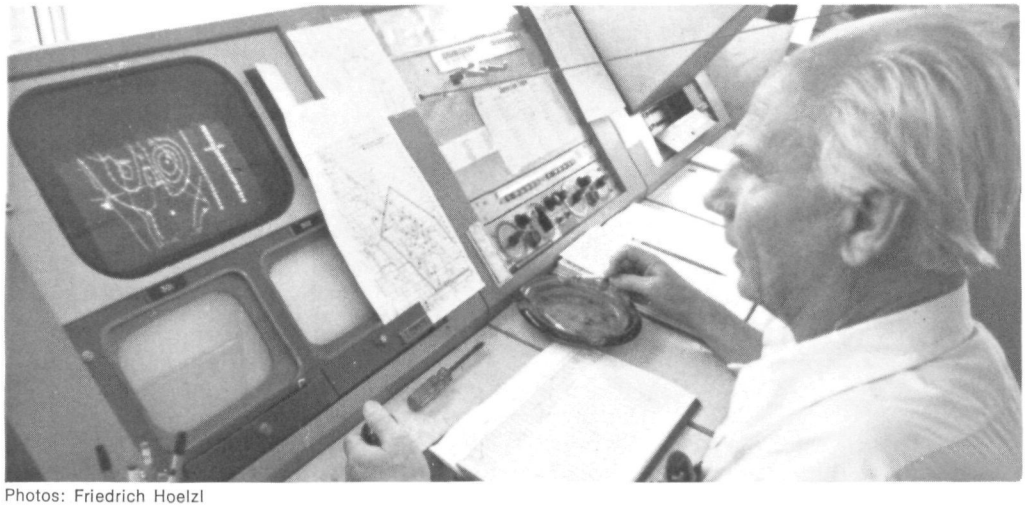
The airplanes engaged in the lightning project were a colorful mixture ranging from supersonic jets to a specially built powered glider. All were either being loaned or operated by various other organizations and agencies. The glider was a Schweitzer, which was outfitted with a turbo-charged engine enabling it to operate at altitudes above 30,000 feet. It was owned and operated by the New Mexico Institute of Mining and Technology. There were several jet aircraft: a NASA T-38, an Air Force RF4C, and a Stanford Research Institute Lear jet. Also involved were a Naval Research Laboratory S2D, a NASA C-45, an Air Force C-130, and a T-29 on loan to NOAA from the Air Force.

Despite all the commotion that had come to his normally tranquil domain, Meteorologist-In-Charge Jesse R. Gulick was not perturbed. A laconic forecaster who got his start as a Weather Bureau observer in Dodge City, in his native Kansas, 35 years ago, Gulick has also been a member of the Space Operations Support Division since its inception.

Pre-launch excitement was nothing new to him—even with the addition of all the gadgetry and flamboyancy of the ERL lightning experiment. If anything was going to get Jess Gulick excited as the launch of the last Apollo loomed nearer it would be the particular importance of weather forecasting to this mission.

During all those manned flights of the previous 15 years there had rarely been such a unique combination of circumstances to make the weather conditions so critically important. The brief launch window, the climatological averages for the season and time of day, and the fact that the Soyuz craft would already be in orbit at launch time all combined to focus great attention on weather forecasts.

As the international pre-launch countdown marched relentlessly into July without delay or interruption, the weather itself conspired to focus even greater attention on the various activities underway at the NWS offices on the fourth floor of the Manned Spaceflight Operations Building.



Photos: Friedrich Hoelzl

The NOAA lightning project airplanes (top) were directed in cloud seeding and electrical charge measuring work by Dr. Heinz Kasemir of ERL, shown above at the monitoring panels in the NWS forecast office at the Kennedy Space Center. Measuring devices, called field mills (above left) were also placed in a ground network around Launch Pad 39-B (left).

On the night of July 5 a deep trough settled into unusually low latitudes for that time of year, resulting in a deep southwesterly flow which produced thunderstorms over central Florida day after day. Many of the storms were severe, creating hail, waterspouts, and even a tornado which touched down in Titusville, just across the Indian River from Launch Pad 39-B.

The weather gave Dr. Kasemir and the ERL team ample opportunity to work on their lightning experiment. And the news representatives from around the world who were arriving for the launch cranked out dozens of stories on the weather.

But continuing bad weather before the launch did not necessarily mean it would be like that on the afternoon of July 15. In fact, the traditional five-day outlook forecast issued by the Spaceflight Meteorology Group (SMG) of the NWS Space Operations Support Division on July 10 predicted an improvement in weather by launch time based on the probable shifting of the southwesterly flow to a southeasterly flow.

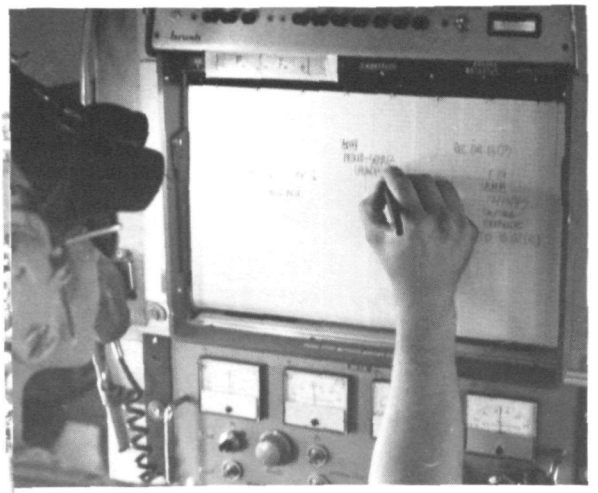
That forecast, which was to prove quite accurate, was based on guidance from the National Meteorological Center in suburban Washington, D.C., especially in the form of 500-millibar prognostic charts. The actual forecast was prepared with the participation of NMC, and the Washington, Kennedy Space Center and Johnson Space Center

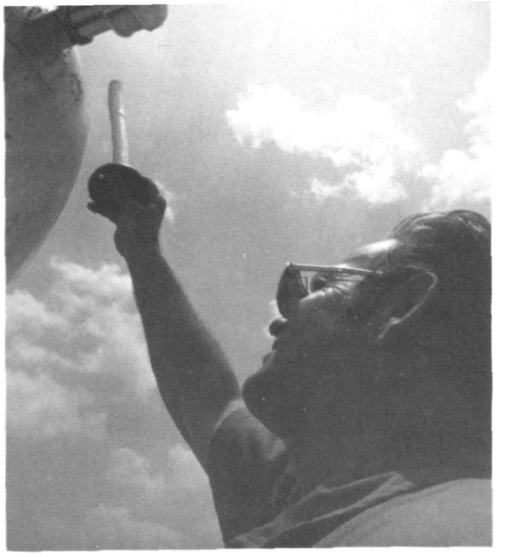
sections of the SMG under the operational supervision of Alan N. Sanderson, its Chief. His office is near Houston, along with the Johnson Space Center Section of the SMG, which is headed by M.I.C. Richard K. Siler.

The Washington Section of the SMG, which is co-located with the NMC in the World Weather Building, is headed by M.I.C. Richard A. Brintzenhofe, who has also been a member of the Space Operations Support Division since it was formed in 1960.

For all the critical importance of the launch weather forecast, many other weather predictions were being made for NASA, as Mr. Nagler explained at the NOAA news briefing on July 14: "We are very much concerned with the weather in a number of possible emergency landing areas, starting with the first pass across the Atlantic. This time of year the weather is pretty good there, but there are areas off Newfoundland where you have rather poor visibility right now. With our forecasts, there are different things they can do in different points along this first track if there should be an emergency—to make sure it splashes down in a safe area.

"Once the mission is in orbit, we will be forecasting each day for a number of possible landing areas. In case there is an emergency everybody knows the best points where the spacecraft could be brought down. We're also forecasting for the earth-oriented scientific experiments. If it's going to be cloudy over an area the astronauts are supposed to photograph, then they can do something else.





Photos: Friedrich Hoelzl

Oscillograph recordings of electrical charges are marked for later identification by Brandon Grebence aboard the T-29 (top left). The field mill on the nose of the T-29 and the chaff shredder and hatch inside the plane are shown by B. R. Caldwell (top right and center). Uncut chaff, finer than human hair, is held by Dr. W. David Rust (right).

"Finally, of course, we'll be forecasting for the main landing area, which is some 350 miles from Honolulu."

It was at that briefing, 24 hours before launch, conducted at the NASA news center in a small temporarily converted office building in the town of Cape Canaveral, that Mr. Gulick spelled out what he was later to describe as one of the best forecasts he had ever been involved in:

"In the last few days you've seen some spectacular examples of what Florida weather can do—from rather good in the morning to almost a monsoon in the afternoon.

"Well, we've had a dramatic change in this pattern in the last 18 hours. As early as last Wednesday night (July 9), computer projections were calling for a change to take place in this pattern early this week. The reservation in our minds was whether it would happen soon enough and dramatically enough to get us out of the pattern we were in—the deep southwesterly flow we have had since July 5.

"Well, it did. We were in that pattern right up to this morning. Over the past several hours the winds aloft have been swinging. Early this morning they were from the south, and I have here an upper air sounding taken at noon today by the Eastern Test Range. It shows we now have a rather deep flow of southeasterly winds. This does not eliminate the possibility of thunderstorms, but it greatly reduces the probability.

"We have a computer program for calculating the probability of afternoon thunderstorms here at the Cape (based on the work of Charles Neumann, now at the National Hurricane Center). Those probabilities were running anywhere from 70 to 90 percent over the last several days—and Mother Nature showed us it should have been 100 percent.

"As of noon today that percentage had dropped to 22 percent, and now we are quite optimistic about getting this Saturn rocket launched. With this kind of a regime, if you get any thunderstorms along the coast they're more likely to be over the Space Center in the morning. If the winds are light enough, there's always the possibility of one developing right overhead in mid-day. That scares everybody, but that sort of thing should be over with before launch time. That kind of activity should be mainly west of the Indian River by launch time, with perhaps a few isolated ones offshore. Temperature should be about 85 or 86 degrees, with surface winds southeast about 10 to 12 miles per hour. I would expect scattered cumulus clouds and probably a scattered to broken layer of cirrus clouds. Those are fairly thin and should give the viewers a break."

On that evening of the day before the launch everything about the mission was falling nicely into place. The countdown was still proceeding on time, the weather was expected to be good, and the Space Coast was packed with more tourists (over 500,000) and news persons (over 600) than had converged there for any space flight since the historic first moon landing mission of Apollo 11 way back in the summer of 1969.

Nostalgia ran high that night in the towns of Space Coast at the overflowing bars, restaurants, and motels (which had jacked up their prices, and demanded three nights' payment in advance). Over in Titusville, a stretch of several miles of the shoulder of U.S. Highway 1 overlooking the Indian River and the launch pad beyond was packed before sundown with the cars and the campers of the tourists who had come from all over the country to see the last Apollo but could not, or did not want to, find a motel room.

Not many of those sightseers, and reporters, and news commentators were awake before daybreak the next morning when Jess Gulick arrived at his forecast office in the MSOB to prepare a 6 a.m. briefing for NASA launch officials—the beginning of a long day that would reveal whether the forecast would hold.

The weather was good that morning, with only a few wispy cirrus clouds and fluffy cumulus "streets" in the otherwise clear blue sky. Later a few thunderheads began to form in the area, but the forecast had allowed for that.

At 8:20 a.m. (EDT) television viewers all over the world watched a Russian rocket blast the Soyuz spacecraft into orbit from the Baikonur space complex near the Aral Sea in Central Asia. Among the viewers was a group of high-ranking U.S. officials and diplomats from both countries, who watched the launch at a special screening

at the State Department in Washington. Later in the day, the group, which included NOAA Administrator Dr. Robert M. White and Associate Administrator Dr. John W. Townsend, Jr. were flown to Florida to watch the Apollo launch in person.

Meanwhile, everything was going smoothly at the weather forecast office. While the meteorologists and the scientists monitored data and updated their forecasts and flight plans, Mr. Nagler worked carefully on a special weather map of the entire globe. It was the personal weather chart for the astronauts. Nagler had made one up for every astronaut crew since the beginning. The one he made for John Glenn's historic first earth orbital mission back in 1962 was on display for years in the Smithsonian Institution—visible inside the display of the capsule Glenn used in his epic adventure. In the early days Nagler rode out to the launch pad with the astronauts in their special van and briefed them on the global weather situation, then handing them the map just before they were hoisted atop the rocket. But for some years now, someone from the astronaut office—usually Alan Shepard or Deke Slayton (a crew member of this last mission) came to the NWS office to pick it up.

Since the astronaut quarters, the place where they lived for the last few days and nights before a flight, were located in the same building as the NWS forecast office, the delivery of the crew's weather map was an easy matter. This time it was picked up promptly at 10 a.m. by John Young, a veteran of the Apollo 16 moon mission.

Late in the morning, his special map now in the hands of the astronauts, Mr. Nagler joined Mr. Gulick and his staff in watching the tall cumulus buildups over the Indian River.

Members of the ERL team worked steadily in preparation for the hour before the launch when they would have eight planes in the air over the Space Center, all of them taking measurements and one ready to seed chaff if called upon by NASA. The forecast of good weather had significantly reduced the probability that their efforts would be needed. But since there is always a chance on a summer afternoon of a thunder shower developing with dramatic suddenness, the plan remained in effect.

Finally, at 3:50 p.m. (EDT) a flawless launch took place at Pad 39-B. "Our weather forecast was about as close to 100 percent perfect as possible," said an elated Mr. Gulick afterwards. "The temperature was 85 degrees, as predicted. The winds were southeast at 10 to 15. There were thin, broken cirrus clouds overhead. There had been showers near the pad earlier in the day. And at launch time thunderstorms were visible a few miles to the west. But the weather was fine at the launch pad."

With the launch successfully completed, attention shifted from the Kennedy Space Center—to the two very different spacecraft moving closer to each other in space; and to the Johnson Space Center in Texas, where NASA's mission controllers would receive continuing updates on recovery area weather from NOAA forecasters in the SMG.

Photo: NASA

The Apollo spacecraft splashed down in the placid waters of the Pacific west of Hawaii on July 24, ending the last American manned flight until at least 1979.

Furthermore, all the weather of interest to NOAA scientists and meteorologists was not over Florida or in recovery areas. At ERL's Space Environment Services Center in Boulder, Apollo-Soyuz meant the stepped-up observing schedule which comes with all manned space missions, as NOAA and Air Force solar forecasters monitored activity on the sun and what it does to cosmic weather. The relatively low orbits of the two space craft, and the fact that the sun was nearing its period of minimum activity, made any threat from that quarter unlikely. Still, there was some solar flexing during the mission, with active areas on the sun producing occasional minor flares—in the end, more a salute than a hazard.

Other NOAA personnel also participated in the flight portion of the mission as members of the experiment team. These included several members of ERL's Atlantic Oceanographic and Meteorological Laboratories: Dr. John R. Apel, Director of the Ocean Remote Sensing Laboratory; Dr. Robert S. Dietz, of the Marine Geology and Geophysics Laboratory; and Dr. George A. Maul of the Physical Oceanography Laboratory. Also on the experiments team was John W. Sherman III, Chief of the Spacecraft Oceanography Group at the National Environmental Satellite Service.

The Apollo spacecraft ended the ASTP mission with a safe splashdown in the prime recovery area west of Hawaii as scheduled on July 24. Weather in the recovery area was good, as had been predicted by the NWS Spaceflight Meteorology Group.

Despite the "last hurrah" attitude of the vast crowd that jammed the Florida Space Coast for the launch, and of many of the staff people directly involved with the flight, there will be more manned missions, but not until at least four years from now, when the first Space Shuttle is expected to fly. And there will not be any more recoveries at sea—or parachutes slowing down space capsules during re-entry.

And probably there will rarely, if ever again, be a weather forecast for a launch so nearly perfect as the one which was issued in Cape Canaveral on July 14, 1975.

Sea Grant experts take on a threat to food supplies:

The Salt Menace

BY BRIAN GORMAN

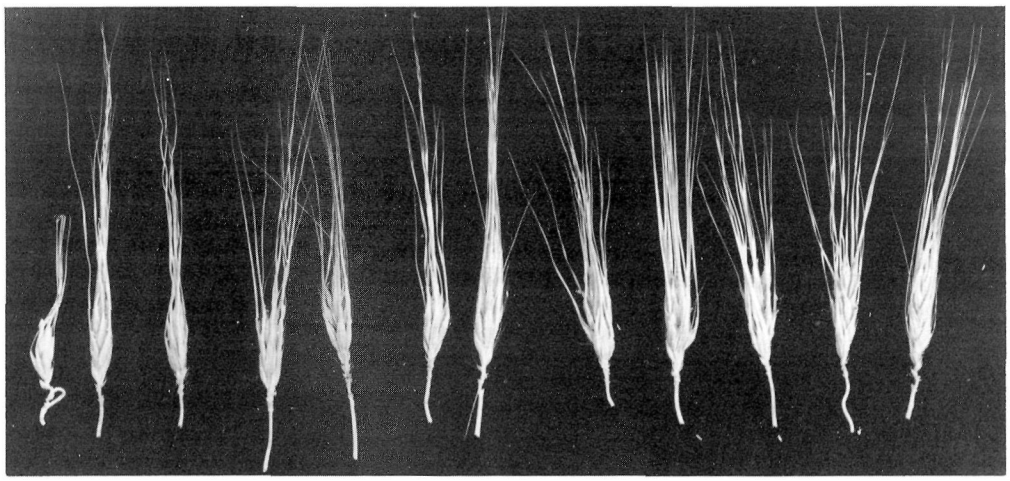
As long as man has grown food, he has worried about drought and pests. Today, with concern for the world's food supply becoming acute, another problem can be added to the list. It is salt, creeping into farmland waters at a disturbing rate.

Fortunately, many varieties of plant life can live comfortably with salt. They are known to science as halophytes, and are found almost everywhere, from the coastal wetlands of North America where the Seri Indians of the Gulf of California once used eelgrass as a food source, to the dry Australian outback where Atriplex, or "saltbush," is used for forage. A thousand years before the first European settlers arrived in North America, the Chippewas of the Upper Great Lakes harvested "manomin," or "good berry," which grew in shallow ponds and sluggish streams. It is still harvested in Minnesota under the more contemporary name of wild rice—a halophyte, which grows as well in brackish waters as in fresh.

For the past three years, a team of scientists at the University of California at Davis, with support from NOAA's Office of Sea Grant and the National Science Foundation, has been engaged in the difficult and fascinating business of trying to make halophytes even more so. Their goal is nothing less than the creation, through selection and breeding, of seed-bearing crop plants that are substantially more tolerant to salinity than the conventional varieties now available.

The ultimate aim of the Sea Grant team's research is to develop crop plants that can be irrigated with either brackish water or seawater, or can be grown directly in seawater. The latter technique, called hydroponics, involves raising plants in a nutrient solution without the use of soil.

"What we're trying to do," explains Dr. Emanual Epstein, Professor of Plant Nutrition and leader of the University of California project, "is take advantage of a simple, but paradoxical, botanical fact. Much of the globe's plant life actually depends on water that has a high salt content. This includes all the plant life in the oceans and coastal wetlands, as well as many species of plants on land that can tolerate levels of salinity even higher than the salt concentration of seawater. The irony is that most species of land plants, especially most crop plants used by man, are quite sensitive to salt."



Representative heads of plants of barley from a composite cross that flowered and set seed while growing in nutrient solution at a salinity of 0.8 seawater. The creation of strains of barley able to tolerate full seawater salinity throughout their life cycle, from seed to seed remains a challenge for future research and development.

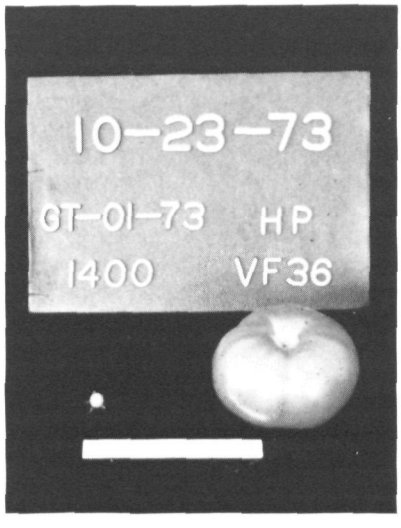
Dr. Epstein hopes to bestow on some important food crops the salt tolerance that plant life is clearly capable of possessing. The process of developing such crop strains will necessarily be a long one. But if it is successful, the results would be of inestimable value to the nation and the world. Crops could be irrigated with water that is presently totally unsuited for agricultural purposes. And the water itself could provide adequate concentrations of several major plant nutrients—potassium, calcium, magnesium, and sulfate—that are currently supplied by chemical fertilizers whose cost, in terms of both energy and dollars, is becoming increasingly high.

"There is no question that salt-tolerant food plants could benefit mankind," notes Dr. Epstein. "And it's not just a matter of bringing about a 'green revolution' in previously unarable coastal areas. Even on land already under cultivation, excessive and growing amounts of salt are intruding into irrigated regions, creating a major agricultural problem."

For example, in some areas of the lower Colorado River Valley—which has been intensively irrigated for more than 50 years—salinity has reached more than six parts per thousand. This is about one-fifth the salinity of seawater, and even the more salt-tolerant crops such as cotton now are difficult to grow there. Much thought and effort are being devoted to plans for desalinizing water—primarily by using the waste heat from nuclear generating plants—but the costs of such processes tend to be substantially greater than the agricultural benefits they are designed to achieve.

"Adapting the environment through desalinization to meet the needs of the plants can be prohibitively expensive in terms of money and energy," Dr. Epstein contends. "So why not adapt the plants to fit the environment? The primary energy source would be sunlight captured in photosynthesis and used by the salt-tolerant plants themselves in regulating the physiological process of mineral metabolism."

To date, Dr. Epstein's research has been mainly with two plants, which themselves are not naturally very salt tolerant—barley,



(Clockwise from top) *From their natural setting on the rocky Galapagos Islands, seeds from wild tomato plants were transferred to the University of California. Dr. Epstein and his research assistant, Dale W. Rush, inspect tomato seedlings early in an experiment. Tiny Galapagos tomato is compared to a "normal-size" one. Barley shoots and tomato plants grow in an unfamiliar setting.*

an important cereal, and the tomato, a valuable vegetable crop. "We purposely chose two very difficult plant species for our feasibility study," Dr. Epstein points out. "Barley was an obvious choice for several reasons. It's a monocotyledon—that is, the embryo plant has only one leaf—and already is firmly established as a food crop throughout the world. There is a large background of knowledge of both its genetics and its salt tolerance. Finally, the Department of Agronomy and Range Science on our campus can provide us with barley seeds of composite crosses embodying the germ plasm of literally thousands of strains from all over the world, including extensive saline soil areas."

The tomato was decided on, according to Dr. Epstein, for a twofold reason. It is a dicotyledon—its embryo plant has two leaves—and therefore broadens the botanical base of the project and improves its chances of success. In addition, tomatoes are a high-priced crop that can be grown economically on comparatively small plots of land. Development of a seawater culture of tomatoes, Dr. Epstein says, would pose only minor engineering problems in terms of irrigation or hydroponics installation.

The initial selection and testing of barley and tomato seeds to determine their salt tolerance was the most important aspect of the project. Several large tanks were installed in greenhouses on the Davis campus. Perforated trays were placed on the tanks and covered with a layer of coarse cheesecloth. A different test seed was put over each perforation. The tanks themselves contained a standard solution to supply the seeds with all essential mineral nutrients. The nutrient solution was then progressively salinized by repeated additions of sodium chloride—ordinary table salt—and, in other tests, with a synthetic seawater salt mix. The salinization process was continued until the sodium chloride concentration almost reached that found in seawater.

Dr. Epstein's first screening of seeds for salt tolerance lasted 120 days and involved a total of 8640 barley plants. Although only a few plants died outright, the salty nutrient solution prevented all but about six percent from setting seed. The surviving plants, however, represent a severely selected group of salt-tolerant individuals. They are now being used in further screening tests and in a selective breeding program.

Screening tomatoes for salt tolerance presented a different set of problems. The barley seeds from which the Sea Grant team could choose already exhibited a wide genetic variability in terms of salt tolerance. Commercial tomato plants, however, do not have so much variability. Instead of trying to work with commercial tomato seeds, Dr. Epstein chose a rare specimen for his experiments. From Dr. Charles M. Rick of of the Department of Vegetable Crops at Davis, he obtained seeds of the tomatoes that grow wild on the shores of the Galapagos Islands.

"By growing plants from these seeds in salinized nutrient solutions," explains Dr. Epstein, "we found that they are highly salt tolerant. There was only one hitch: these wild plants produce tomatoes that are less than half an inch in diameter—clearly not of much commercial value."

To solve the problems of the tiny tomatoes while retaining their demonstrated salt tolerance, Dr. Epstein's team cross-pollinated them with several commercial varieties and then "backcrossed" the resulting hybrids to their parent species of commercial plants. "As a result, "says Dr. Epstein, "we produced new plants that are both salt tolerant and perhaps commercially acceptable, with tomatoes the size of ordinary cherry tomatoes."

Along with the selection and breeding experiments in the greenhouse tanks, Dr. Epstein and his co-workers are trying to discover what mechanisms—physiological, metabolic, and biochemical—enable salt-tolerant plants to grow under conditions that prove fatal to even their close botanical relatives.

"Our early testing of barley led us to ask ourselves not simply what varieties can contend with high salinity but why they can," says Dr. Epstein. "This is a matter of intrinsic scientific interest and of practical value, too, since recognizing why plants respond the way they do might provide some rapid test for salt tolerance which would speed up work on the project," he adds. By measuring the extent to which a plant is able to exclude sodium and chloride from its root system and by determining how much of the chemicals which are absorbed are then forwarded to a plant's newly emerging shoot, the California Sea Grant team may be able to discover a diagnostic tool to pre-screen potential salt-tolerant plants.

Dr. Epstein and his collaborators are also carrying out more detailed diagnostic experiments with barley, tomatoes, and cotton, a relatively salt-tolerant plant. These experiments include measurements of the absorption of potassium and calcium, as well as the synthesis of certain organic compounds.

In spite of the progress that has already been made, Dr. Epstein feels that a long road lies ahead. "We have really only begun to scratch the surface," he says.

While a plant able to set seed in a saline solution is the first goal of the project, it is hardly sufficient for the production of a viable, salt-tolerant crop. The original plant must not only be salt-tolerant throughout its growth period, but must also produce fruit or seed that is large, wholesome, commercially marketable, and generally as acceptable as the salt-sensitive cousin it is designed to replace. And such a plant must be able to produce seed that will germinate and develop into a plant identical with the parent. Such events do not occur overnight. For example, the hybrid tomato produced by crossing the wild Galapagos tomato and a commercial California variety has been backcrossed to the original commercial tomato and this process will continue until five generations of tomatoes have been produced. Then, the final backcross will be crossed with itself. All along, tests for salt tolerance will be conducted.

One important discovery Dr. Epstein's group already has made, however, is that salinization of plant cultures with synthetic seawater, which is chemically almost identical to natural seawater, is considerably less harmful to the plants tested than salinization with sodium chloride only. "This augurs well for the future," Dr. Epstein says, "and is a major step toward the project's final goal."

A second finding that Dr. Epstein considers crucial to the project is the realization that salt tolerance can vary greatly in a given species, not only in different races or strains but also at different stages in the life cycle of a single race or strain. "This last point is not novel," he says. "What is novel is our recognition of both the challenge and the opportunity all these findings together represent for breeding crops that are highly tolerant of salt at all stages of their life cycle." It is this knowledge that the genetic structure of plants can be manipulated, Dr. Epstein feels, coupled with the California Sea Grant team's scientific competence and a certain amount of healthy optimism that have moved the project closer to its goal.

So far the work on the Davis campus has been conducted exclusively under laboratory conditions. Now Dr. Epstein is sufficiently encouraged by the progress of these first experiments to go ahead with field testing of plants. This fall, with the cooperation of Dr. Cadet Hand, Director of the University's Bodega Marine Laboratory, he will be setting out his most salt-tolerant barley plants in a coastal dune region at the Laboratory on Bodega Bay, California. Tomato plantings will follow in the spring of 1976. Preliminary plans call for irrigating the crops with various concentrations of seawater, using fresh water cultures as controls. "This will be the most severe test we have given our selections," say Dr. Epstein. "These experiments will be carried out under real-life conditions using seawater in a marine environment."

"We look upon this whole project as a feasibility study," he adds. "There is no guarantee that we shall reach our most cherished goal: crops able to cope with seawater salinity. But the ultimate benefits, should we succeed, could be of incalcuable value to crop production by making it possible to use the almost limitless wealth of water and plant nutrients in the sea. In a world that is growing hungrier each day, this is a possibility we dare not leave unexplored."

An ecological horror story becomes a major research challenge

The Second-Biggest Oilspill

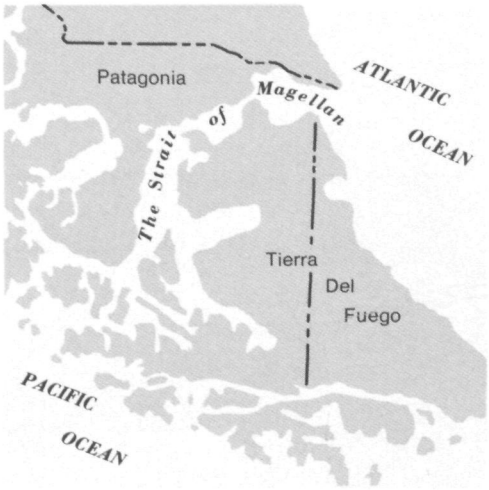
BY LOUISE A. PURRETT

On August 9, 1974, at 10:20 p.m., the supertanker Metula ran aground in the Strait of Magellan, and spilled more than 50,000 tons of oil into the cold waters between Patagonia and Tierra del Fuego. It was the second largest oil spill ever, one whose effects may be visible for years. It was also the beginning of an experiment that may have even farther-reaching effects on how and where oil is transported in the future and what is done when the almost-inevitable oil spills occur.

An international group of environmental researchers and managers met in Boulder, Colorado, recently to discuss the effects and lessons of the spill and to plan studies of its long-term effects. Hosts were Dr. Wilmot N. Hess, Director of the National Oceanic and Atmosphere Administration's Environmental Research Laboratories, and Charles G. Gunnerson, Director of NOAA's Marine Ecosystems Analysis Program Office.

The Metula had been carrying 194,000 tons of crude oil from the Persian Gulf to Chile. As she entered the first narrows of the strait, she cut a corner and plowed onto a shoal. At the request of the Government of Chile, the U.S. Coast Guard, using a pumping system developed for just such a situation, aided in transferring much of the ship's cargo of oil to two smaller tankers.

In the end, though, 51,500 tons of Saudi



(Above) The original oilspill was at the eastern entrance to the Straits of Magellan. A Coast Guard team (right) was able to pump some of the oil to a smaller tanker, but enough escaped to blacken great stretches of shoreline (below). Dr. Roy Hann (lower right), one of the investigators who studied the effects of the spill, prepares to photograph the oil slick.

Photo: U.S. Coast Guard

Photo: EPA

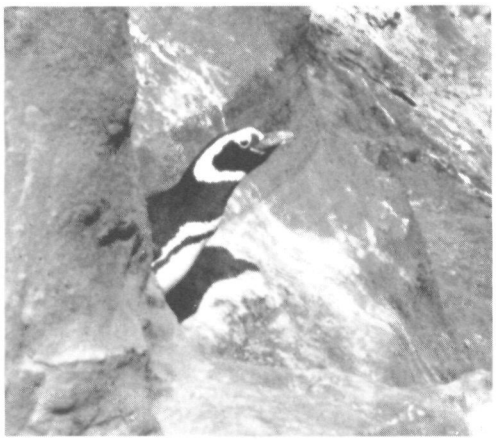
Arabian crude and another 2,000 tons from the ship's fuel supply—over 14 million gallons of oil—spilled into the narrow strait, creating the largest spill since the Torrey Canyon sent more than double that amount into the waters off England in 1967.

The narrowness of the strait, powerful tides, currents up to 10 knots and winds commonly reaching 70 miles per hour (and once clocked at 115 miles per hour) militated against the usual cleanup procedures. Cliffs 30 and 40 feet high made access to the beach difficult. Another reason no cleanup was attempted was the sheer mass of the problem. It was estimated that 12,000 dump trucks would have been required just to haul away the "mousse" (an emulsion of oil and water resembling chocolate mousse) that formed. There was also an attitude that the damage had already been done, the possibility that much of the oil would go to sea (it didn't), and fear that the cleanup might cause more damage to the environment than the oil. So the oil was left to run its messy course.

Dr. Roy W. Hann, Jr., head of the Environmental Engineering Program at Texas A & M University, and Coast Guard consultant, accompanied the Coast Guard team that helped transfer the oil remaining on the Metula and made a preliminary environmental assessment. He estimated that 40,000 tons of oil were deposited along some 75 miles (120 kilometers) of shoreline and in estuaries, mostly on the Tierra del Fuego side. As much as 5,000 to 10,000 tons of oil settled on some mile-long sections of the beach. Within 10 days, aerial observations showed the oil spread over as much as 1,000 square miles (2,500 square kilometers).

Later investigators visiting the site reported that most of the oil had apparently gone to sea. "If that were the case," said Gunnerson, "there would be even more need to worry about the Metula spill, since the local damage we could see would have been caused by a smaller amount of oil."

Long-term ecological effects of the 1974 spill remain to be seen, but scientists will be keenly observing the local fauna. (Above) Cormorants peer down from their rocky nesting grounds. (Left) Fur seals and sea lions splash together in the surf as gulls perch unconcernedly nearby. (Below) A Magellanic penguin pokes her head from a crevasse in a rock cliff near the water's edge.



Photos: EPA

But such was not the case. Last January, a team of scientists from NOAA, the Environmental Protection Agency, and the Coast Guard travelled to Chile to reconnoiter the oil spill and its effects. Members of the team were Gunnerson; Dr. Dale Straughan, a marine biologist at the University of Southern California and NOAA consultant; H. Kenneth Adams, a marine biologist with the Environmental Protection Agency; and Hann. They found that most of the oil remained on shore where it was first deposited, and that its effects were still being felt.

The team describes the Strait of Magellan area as a land of stark beauty. Hann compares it to western Oklahoma and Texas—dry, eroded, prarie-like terrain cut by deep gullies. This land drops down to the water in sharp cliffs, or slopes steeply down in coarse sand beaches that flatten out in a border of boulders exposed only during the lowest tides. These are thick with mussels —as many as 250 per square foot. Shell middens left by Indians and whale skeletons, testify to a marine resource of long standing. "The countryside could be considered bleak by some," says Hann, "but the shoreline is quite beautiful and most of the team were impressed with the overall beauty of the area." It is a land populated by penguins and cormorants, where the main human activities are sheep ranching and oil production.

"But the overriding impression that you get during your first visit," says Gunnerson, "is one of winds," winds over 100 miles per hour, winds capable of whipping up heavy surf, of carving the landscape, of molding plant life, and of blowing the Metula's spilled oil overland in globs as big as a foot in diameter.

The researchers dug pits in the oil-soaked beach for soil samples. A total of 40 sediment samples and seven tissue samples (from mussels) were collected for later analysis to determine petroleum hydrocarbon levels. The Coast Guard provided sam-

ples of oil from the Metula for comparison.

At the Boulder meeting, the principal investigators presented their findings to representatives from the United Nations, the oil industry, and other U.S. research organizations, such as the National Science Foundation, Battelle, and the Smithsonian Institution's Center for Short-Lived Phenomena.

The team concluded from its reconaissance and data analysis that "essentially all" of the estimated 40,000 tons of oil that had floated onto the shore was still there, and that the biological impact of the spill was severe. Local fisheries had become contaminated. In the nearby salt marsh, large amounts of oil were found floating on the surfaces of tidal channels, deposited on tidal flats, and in isolated patches. The wind had carried oil inland, pelting shrubs and bushes until they were black on the seaward side. The heavily oiled cobbles in some beach areas, which Hann likened to cupcakes with chocolate icing, were still slippery with oil. In some places, the oil-soaked soil had formed a hard, asphaltic crust.

In the most heavily affected area—on the southern shore of Bahia Filipe, in the first narrows, and in the salt marsh—oil was ubiquitous. Oil would bleed into footprints, forming a chain of pools, or seep up apparently spontaneously, perhaps in response to heating by the sun.

Some of the mussel beds that had been heavily oiled managed to survive, but the meat was brown and smelled of oil. One of the local fishermen told the investigators that mussel and fin-fisheries have been moved to other areas because of taste problems.

Bird losses were originally estimated at from 600 to 2,000—mostly cormorants, but including penguins, petrels, gulls, and others as well. In January, the survey team found more oiled birds landward of the shore areas in which the original counts of dead birds were made. In one spot, they found 22 dead cormorants within about a 25-yard radius that hadn't been counted before. However, there was some good news: the spill apparently did not disrupt the annual migration of some 20,000 to 30,000 penguins to two islands in the strait that are Chilean national parks, and no evidence of oil contamination was found at the penguin rookery on one of the islands.

Nor was the Metula spill the area's first taste of oil. There is a small but growing oil industry in the land flanking the strait, and on both the August and January surveys, visitors had found evidence of some pollution from Chilean sources. Hann noted residues from previous oil spills, including tar balls, "giving us an idea of what the Metula spill may look like in several years."

"Some of the life is coming back," adds Gunnerson. "Green shoots were just beginning to reappear in the marsh plants." But, Straughan cautions, these signs may not be as promising as they seem; the first year after a Canadian oil spill plants reappeared, but by the oil-soaked soil had produced an asphaltic layer that sprouting plants could not penetrate. A lot depends, he concludes, "on when you make the body count."

Much is yet to be learned about the long-term effects of the Metula spill, but a number of lessons are already obvious. The biggest, says Hann, are that ships are vulnerable, spills can happen, and when they do, the magnitude of the problem is enormous. These facts should guide decisions about oil transportation near coastlines. In planning and selecting sites for future superports to accommodate oil tankers, he continues, "we have to look at the area's other resources and consider the possibility and cost of a spill there."

Another lesson is that time is crucial. "We have seen that once the oil gets to shore, it's too late for effective countermeasures," says Gunnerson. An oil slick moves at three and one half percent of wind velocity, explains Hann. Pushed along by the high winds in the Strait of Magellan, most of the oil from the Metula was driven ashore within one or two hours. It was many hours after the grounding before word got out and help arrived. Part of the problem was the remoteness of the area, "Everything is harder to do and takes longer in a remote area like Tierra del Fuego," says Hann, "but with a spill of this size, we could have the same type of logistical problems in the United States as in Chile." The group suggests that keeping superports offshore would help provide reaction time.

The Metula spill also demonstrated the poverty of present cleanup preparations. Most spill control methods are aimed at small spills, says Hann. There is a need for more scientific information about spills and their behavior, better spill control methods, and trained cleanup crews that can be rapidly mobilized. "Tanker operations in confined waters such as the Strait of Magellan require massive contingency plans, support, and material to be maintained on constant alert," adds Gunnerson. Procedures for reporting spills in remote locations also seems inadequate, the researchers report. The Metula spill went essentially unnoticed in the United States for about two months.

All the investigators at the Boulder meeting agreed that a long-term study of the spill area would be invaluable, especially since the Magellan Strait is geographically similar to others where oil may be transported, such as the Straight of Juan de Fuca and Georgia Strait, separating Vancouver Island from mainland North America. "It is this approximate similarity to Pacific Northwest and Alaskan coastal areas that makes us want to know what happened," explains Gunnerson. "Certainly, most of the information to come from the Metula spill research will be transferable to these other areas."

The effects of an oil spill vary with the nature of the environment it touches. So any study of the Metula spill would have to be a study of the Strait of Magellan as well—its climate, life forms, and geography. For example, says Gunnerson, "the physical oceanography of the Strait is largely unknown, except for horror stories of winds, currents, and now the Metula oil spill."

Straughan adds that the area has really been subjected to three different kinds of oil—light Arabian crude from the Metula's cargo, fuel oil from the tanker, and oil native to the area that had been spilled previously during local operations. All this makes the area an ideal laboratory for comparative studies of the effect of different types of oil on the same environment. Straughan believes the need for environmental protection may vary with the type of oil.

A thorough study of the Metula spill should span at least 10 years, the Boulder group believes. Recent findings by the National Bureau of Standards indicate that traces of the oil that spilled onto the beach during the 1964 Alaskan earthquake could still be found in the fall of 1974.

Gunnerson summarizes the kind of research the group has identified as essential: "We need a better understanding of physical oceanography. Geological research can tell us how oil moves through sand—is it pulled by gravity or sucked by tides? What are the effects of seasonal and daily heating? There is a kind of circular motion in the beach area, in which oil flows through the beach sands and gravels to the water, is picked up by waves, which dissolve some of the oil, but carry most of it back onto the beach. There is also a need for biological and microbiological research, identifying the effects of oil on organisms and of organisms on the oil. Further, we doubt that much research has been done on air-sea interactions where you have sustained winds of 40 knots."

The group envisions a research program that will have national and international significance and support. U.S. research agencies such as NOAA and the National Science Foundation, regulatory agencies such as the Coast Guard and the Environmental Protection Agency, the Peace Corps, and possibly one or two agencies of the United Nations could be interested in such a project. The Patagonian Institute in Chile, which has already lent considerable assistance, and the Chilean Navy Hydrographic Office would be expected to participate.

Gunnerson believes a study of the Metula spill would also provide valuable information into major environmental studies that the Marine Ecosystems Analysis Program Office is conducting in the New York Bight, Gulf of Alaska and Puget Sound. For these projects, MESA researchers need data on chronic and acute levels, fate, and effects of hydrocarbons in marine waters to compare with those found or potentially present in the New York Bight and Puget Sound.

The grounding of the Metula may become more than the second-largest oil spill, says Gunnerson: "It is a remarkable event which has since become an enormous experiment —what happens to an oil spill when a supertanker runs aground?"

The next ten years may answer that question.

Behind locked doors, Lake Surveymen made

Maps For Victory

BY GRACE WEGNER

As they have throughout the ages, maps and charts pinpointed the way to victory in World War II. With their aid, our bombers were guided to their targets over Berlin and Tokyo; our ships landed on the beaches at Normandy and Anzio, and our foot soldiers found their way through steaming, swampy jungles and unfamiliar terrain. But this conflict was worldwide; therefore, the maps had to be different. They had to be able to stand up to the weather, geography and physical conditions wherever they were used. They had to be able to withstand the rotting heat and dampness of the jungle, as well as the icy blasts of the Arctic. Many had to be waterproof and virtually wearproof; visible in darkness, but without compromising the blackout rules; and fadeproof to withstand desert sun. Each new battleground brought new and different conditions, and special maps and charts had to match those conditions.

Skilled cartographers with the Corps of Engineers' U.S. Lake Survey—now NOAA's Lake Survey Center—played important roles in the production of many of those maps. Security checks, long lines, long hours and rationing were all part of the daily routine during World War II as a civilian working for the Corps of Engineers' U.S. Lake Survey, the official chartmaking agency for the Great Lakes since 1841. Its long association with such activities and the wealth of data and expertise garnered throughout the years enabled the agency to serve the military needs of the armed forces when called upon to do so. Its personnel, well-trained in the cartographic and lithographic arts, formed the nucleus of a skilled and able team of map makers, without whose efforts and assistance many military and naval objectives could not have been met.

Several times before during emergencies Lake Survey had been called upon to aid—notably during the Civil War and World War I—but only for minor assistance. Aside from a few maps, its main contribution to the Civil War had been in the person of its District Engineer—Captain George G. Meade—who was relieved September 1, 1861, and who, two years later, a General, commanded the Union Army that stemmed the Confederate tide at the Battle of Gettysburg.

At work on maps for the war effort, these men, under the direction of Chief Draftsman Clyde D. Tyndall (standing), were involved in a closely guarded secret project.

Lake Survey's World War I efforts included lithographic work for the armed forces in the form of several reconnaissance maps of the Panama Canal and maps of military reservations. The War Department also assigned it various miscellaneous printing jobs, including military maps and recruiting posters, dealing with the war in Europe. Col. M. M. Patrick was District Engineer at the time (in less than two years after he left he was promoted to the temporary rank of Major General, Chief of the Air Service, American Expeditionary Forces in Europe).

In 1917, a secret, detailed topographic survey was made of a route just east of and parallel to the Niagara River for a proposed "All-American Canal" in case of sabotage to the Welland Canal. A Survey aid, Robert C. Hanson, was detailed as the courier between the field party chief and the Buffalo District Engineer. He would carry papers in a small briefcase back and forth between the District office and the survey field office, his instructions being to give the contents only to the District Engineer or to the Chief of the field party. Fortunately, the need for the canal did not develop.

World War II brought out the unique value of the Survey's 100-year experience with charts and chartmaking. Here was a small but experienced ready-made team of experts in both cartographic and lithographic skills whose knowledge and experience would be used to produce, as well as to train others to turn out, thousands upon thousands of the maps and charts needed by our armed forces.

The Army Map Service in Washington took over direct control of all cartographic units after hostilities broke out. The U.S.

Lake Survey-Army Map Service Branch was established by order of the Chief of Engineers on June 1, 1942. The military line-of-command played an important part in Lake Survey's association with Army Map Service. When the Branch was formed, Col. Paul S. Reinecke—who served as Lake Survey District Engineer from December 1, 1940 to April 16, 1945—reported directly to the Chief of Engineers in Washington.

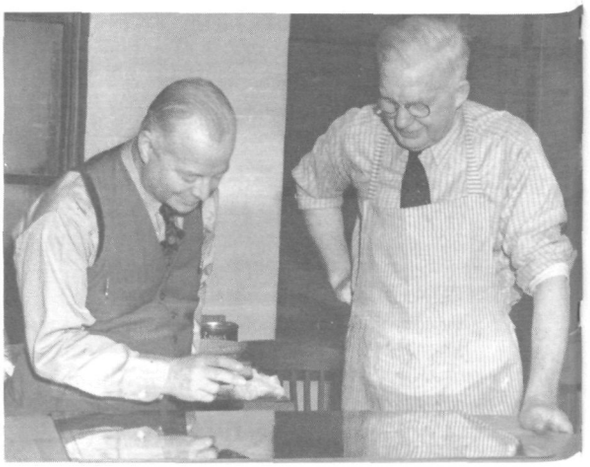
The U.S. Lake Survey's job was to "make the maps." To do this, three separate cartographic units (parts of former WPA cartographic units) were established—one each in Detroit, New York and Chicago. Training classes in cartography were set up and an intensive program was instituted to recruit recent high school graduates and college students to man the units. Almost 600 persons received cartographic drafting training. The total personnel complement for the three Units varied from 1,000 at its peak in August 1943 to just about 100 in January 1946. The average number was 450. Altogether, the units produced some 8,109 charts and maps which resulted in 9,190,000 copies being printed and distributed to the armed forces.

In addition to the supervision of these three units, the Lake Survey had contracts with and supervised the work of some private drafting companies, such as General Drafting and Sandburn Map Co. in New York City, and Rand McNally in Chicago. U.S. Lake Survey supplied these contractors with source material and specifications to compile the maps and charts which, when finished, were turned over to the Lake Survey Reproduction Plant for printing. Some of the printing was also done by private contractors in Chicago, New York and Milwaukee.

Each Unit was headed by an army officer with two assistants. A 30-inch copy camera was installed in each office to produce material to be enlarged or reduced to map scales. Each Unit had several teams, and each team had a leader, an understudy, and 10 to 20 draftsmen. The Detroit Unit continued with a very much reduced crew and was reorganized as the U.S. Lake Survey Cartographic Division. It was put on the civil works payroll, but remained under contract to the AMS in Washington.

A Mosaic Unit had been established at Lake Survey on May 19, 1941, as part of the mobilization of the military resources under the National Defense Act. It operated in conjunction with the Engineer Reproduction Plant (later Army Map Service), Washington, D.C. Its function was to prepare and reproduce true-to-scale photographic composites from vertical aerial photographs. An average of 37 persons was employed in this Unit, and they produced 885 separate mosaic maps, with over 3,128,000 copies being printed by the time they were disbanded on July 1, 1943.

On January 13, 1943, a Military Grid Unit was established in the Lake Survey's New York City office. Its duty was to create a library of astronomic and geodetic data for military usage. It had two sections, Domestic Control and Foreign Control. The latter presented some problems. It involved translation from 22 foreign languages and included many different mathematical formulas used in various countries. These two sections combined forces to produce geodetic tables and map projection tables adequate to meet the needs of military operations in foreign areas. They developed 129 tables, consisting of more than 6,500 pages. In addition, 101,895 geodetic control statistics in foreign areas were compiled, printed and distributed to the various armed forces for artillery fire control. The Unit was disbanded on September 8, 1945, and a few of its personnel, with equipment, were transferred to AMS in Washington.

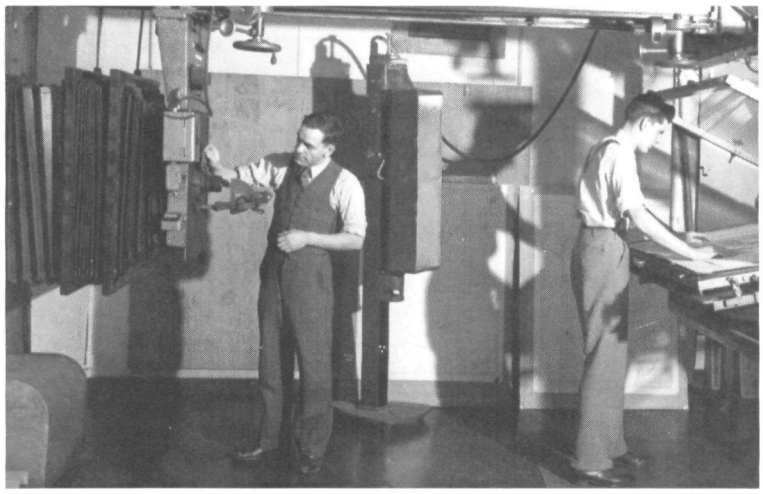


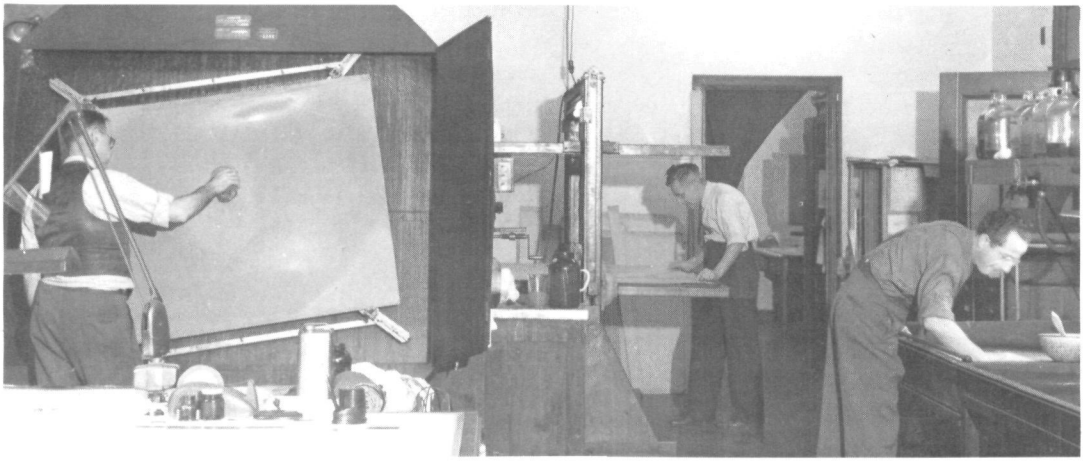
(Top) A portion of the Engraving Section. Most of the engravers were artists hired to do this specialized work. (Above) Col. Paul S. Reinecke, Lake Survey District Engineer from December 1, 1940, to April 16, 1945—the critical war years. (Above right) Reproduction personnel examine an old copper plate engraving lying on the stone from which charts were printed originally.

Due to the enormous quantities of military charts and maps being reproduced, the lithographic facility, renamed the Reproduction Division (which later became the Map and Chart Plant), with a civil engineer, John R. Hall, in charge, was split up into several sections—engraving, printing, plate making and photography. Two printing presses were operating in 1943—one a Plotter Offset Press, sheet size 38 by 52 inches, which printed charts one color at a time, purchased in 1934; the other a Harris Press, also one color, size 42 x 58 inches, obtained in 1942. Except for the adoption of vinyl sheets to produce negatives, positives, and color separations previously done on glass plates, changes in compilation of military maps and charts amounted only to a refinement of the accepted methods previously used.

Problems in reproduction of all the work being compiled by the USLS-AMS Units were solved by running three eight-hour shifts in all departments of the Reproduction Division. Military security problems were solved by hiring armed guards, posting signs, issuing ID cards, and keeping close surveillance over all personnel and contractors.

The number of persons employed during the years 1940-1945 varied greatly, from about 160 in 1940, when only regular civil work was being done, to a high of about 1,000 at a peak when much military work was being produced. The average number of civil works employees was around 150, while the average number of civilian employees on the military payroll was close to 450. When Col. Reinecke had taken charge of Lake Survey in 1940, he was the





(Above left) Offset presses in the basement of the Federal Building where Lake Survey printers turned out tons of maps for the military during World War II. (Above right) The large camera used to photograph original chart-drawings onto glass negatives preparatory to engraving. (Left) Several operations are carried out at the same time in the Lake Survey's Transfer Section.

only military officer; by 1944, the total had become 12.

Much of the work being done was secret, necessitating rigid controls. Armed guards were stationed at certain door entrances seven days a week on a 24-hour day basis. ID badges, with photographs, were required of all personnel. Security locks were placed on classified files, and security signs posted in strategic areas. Blackout curtains were installed at all windows because it was necessary to work at night, and work did not cease even for air raid drills, during which all lights in the city had to be extinguished. These precautions were taken in all USLS offices—in Detroit, Chicago and New York City. In addition to the armed military guards, there were also Civil Defense wardens and helpers on each floor to conduct Civil Defense activities. All information exchanged between individuals was done strictly on a "need-to-know" basis.

Most of the old-timers who worked at Lake Survey during the war have long since changed jobs or retired. The few still around say they knew little about what went on, other than the small part they personally carried out. One recalls, however, that in the course of the production of the maps and charts, there were some made for emergency or survival use by flyers who might be shot down in enemy territory. These maps were printed on nylon cloth to withstand water and rough handling. One of the officers at the time decided it would be nice to get some publicity for the efforts being carried out, so he had a bathing suit made out of one of the maps, and talked a shapely little trainee into modelling it for the press photographers. Unfortunately, none of the resulting pictures survived, but it is understood that the resulting publicity caused quite a bit of excitement!

A graduation party was held for each map compilation training class, with only the graduates, ranking officials, and the safety officer in attendance. Ice cream, cake and coffee were served, and an orchestra made up of Lake Survey personnel, known as the "celebrated" USLS Musical Four, provided music for dancing.

About June 1, 1945, an urgent call came to the Lake Survey from the Navy Hydrographic Office in Washington for three experienced cartographers. Determined to send nothing but the best, Col. Reinecke sent three of his top engineers to meet the request. In a day or two, they were back in Detroit. It seems that they didn't fill the bill. The Navy had many engineers; what it urgently needed was competent chart compilers. The work to be done consisted of compiling Navy landing charts from the latest Japanese charts (some of them secret documents obtained by divers from sunken war vessels) and converting these data to U.S. symbolization and names.

The assignment, which was strictly voluntary, called for those chosen to be trained in Washington and then sent to an advance base in the Pacific to carry on the operations. Three draftsmen indicated their willingness to accept and were promptly sent to the USN Hydrographic Office in Suitland, Maryland. They worked up to 12 hours a day, including Saturdays and Sundays. Then came the announcement of V-J Day, August 15, 1945, and the war was over. About two weeks later, the three returned to their regular jobs in the Lake Survey Drafting Room—without any tales of the South Pacific.

Due to its fine record in the production of the vital maps and charts needed by the Armed Forces, Lake Survey was awarded the Army-Navy "E" Award on December 12, 1942. As the War went on, four star awards were added for maintaining the record established: on September 4, 1943; March 25, 1944; September 23, 1944; and April 20, 1945.

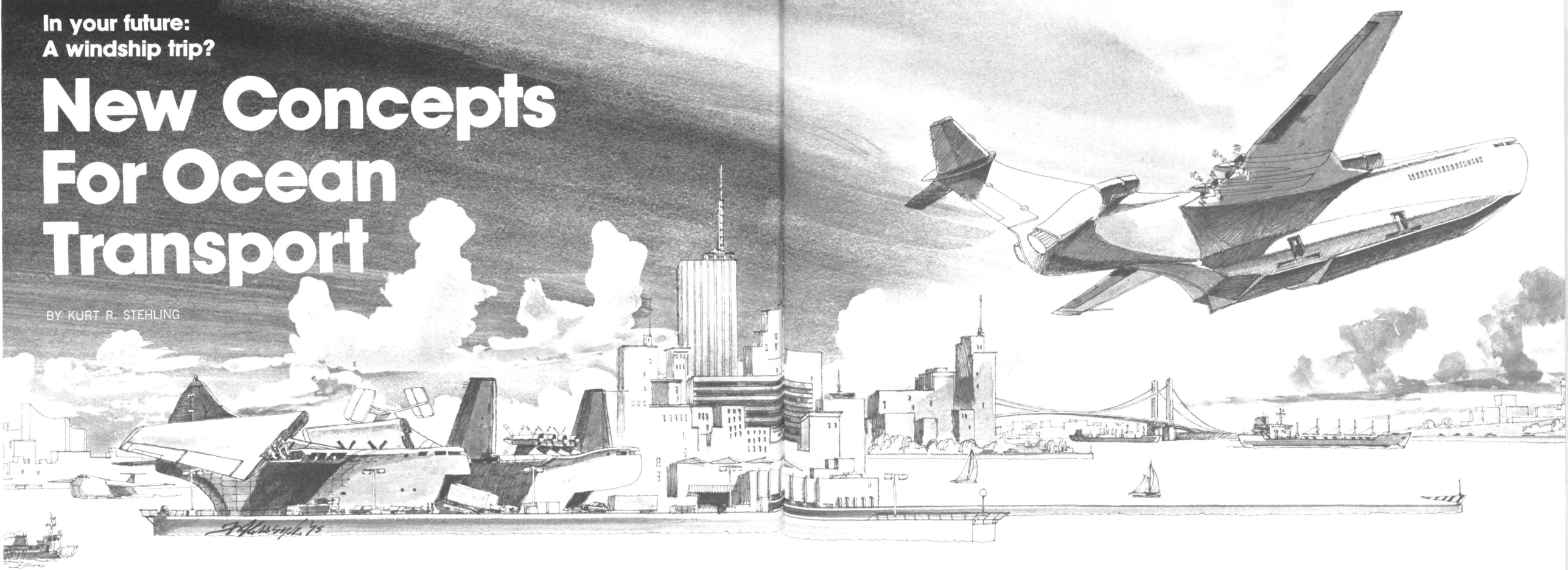
All during this period, the normal civilian mission went on virtually unchanged—revisory surveys were made, first order levels run, triangulation recovery was carried out, inshore and offshore soundings were made, and investigation of lake levels continued.

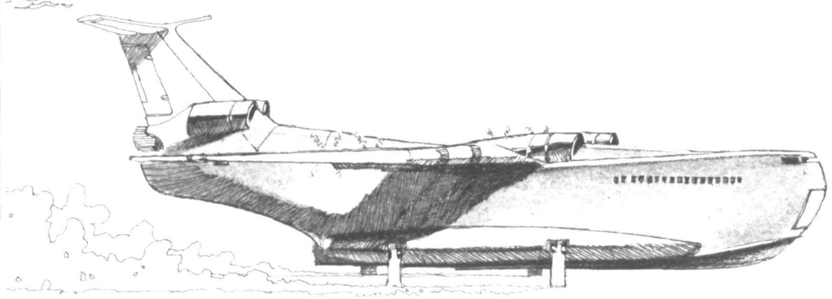
After World War II, Lake Survey's Cartographic Division operations were continued at a reduced scale in supporting the mapping needs of the Army in the Cold War. When conflict broke out in Korea and Vietnam, the effort was expanded to include a little over 200 employees. Later conditions resulted in the Compilation Branch in the main office of Lake Survey. With the transfer of Lake Survey from the Corps of Engineers to the Department of Commerce, a number of the trained cartopographic personnel were transferred to the National Ocean Survey offices in the Washington, D.C. area.

In your future:
A windship trip?

New Concepts For Ocean Transport

BY KURT R. STEHLING





Ocean transportation today may be at a crossroads. The insecurity of important canals, the competition of cheap, fast air travel and cargo transport, increasing labor costs, competition from foreign shipbuilders, all have whittled away at shippers. But the biggest blow has been the doubling of fuel costs, even bunker oil, since 1973, and the possibility that the per-barrel price could triple by next year.

The time has come to search for innovative schemes, for supplementing existing means of ocean transport—transport not only on but under and above the surface of the world oceans.

For generations, until the 19th century, wind constituted the prime propulsive agent. There seemed no need for anything new; mariners were apostles of conservatism. Most ships, for example, could have been steam-powered by the end of the 18th century. But labor was cheap and abundant, and there was no real incentive. Had the British and French navies, as they could have, converted to steam in Napoleon's time, industry would have followed shortly. But even when confronted in mid-century with the inevitability of steam power, they continued to hybridize their warships with "auxiliary" sails.

It remained for the young American Union and Confederate Navies of the War Between the States to usher in the all-steam warship era. That began it. What really moved it into the commercial world was the Industrial Revolution, especially in Great Britain. Abolition of press gangs and better wages and working conditions in factories made low-wage sailing ship jobs less attractive. But the better living also priced the sailing ships out of business for most commercial and routine operations.

This process was accelerated by the development of cheaper, more reliable marine steam engines fueled by coal—mined, ironically, under incredibly hard, dangerous and squalid conditions by underpaid men who wanted to avoid the low pay, danger and misery of sailing ships.

The era of cheap oil after World War I and marine diesel engines phased out the coal and reciprocating steam engines, leaving steam turbines and motors as prime movers. Most technical advances were found in lower-drag hulls, cheaper building techniques, slightly improved engines, sophisticated navigation and innovative means of docking and cargo handling, as in container ships. This condition persisted until the 60's, when the technical and geopolitical changes began building up, and accelerated during the 70's, until the oil crunch made it really serious.

Where to go now?

The answer may lie both in going forward with the atom and backward with sail, if oil prices continue to rise. If ship fuel oil reaches, say, $15 a barrel, the nuclear merchant ships begins to make economic sense, especially if compact and more efficient gas-cooled reactors and power conversion systems are developed. But these considerations must be present: consider the decline of the U.S.-built N.S. Savannah, idle in her home port since July 1970 after a shorp career of 11 years.

This handsome ship was plagued by labor and jurisdictional problems, the rapid technical obsolescence of its reactor power plant, and a cold shoulder from many foreign nations which wanted no part of an atom-powered ship in their harbors.

Funded by the (then) Atomic Energy Commission and the Commerce Department's Maritime Administration, a sister agency to NOAA, she cruised almost a half-million miles and carried 261,000 revenue tons of cargo before she went home indefinitely.

The U.S. has no firm plans for starting a nuclear merchant fleet, but a panel of the prestigious National Academy of Sciences has recommended that the government be alert to opportunities for suitable application of commercial-type nuclear engineering to ships—icebreakers and drilling ships were singled out as examples. The U.S.S.R. has built a nuclear-powered icebreaker, the Japanese and Germans have built nuclear merchant ships, and the French are planning them. So the stage is set, if events dictate it, for wider-scale nuclear shipbuilding.

How about operation under the surface? (Submarines do it all the time.) Contrary to intuitive feeling on the matter, a submarine can actually operate with lower drag than a surface ship. And it can operate where the others can't—under ice. Imag-

inative planners, such as William Kumm of Westinghouse (formerly NOAA and NACOA), have proposed very large or crude-oil carrying subs, for years. Then, large areas of the Arctic regions would be accessible by sub-tanker, obviating, for one thing, expensive pipelines. Subs are also fairly immune from weather and sea state problems, a factor of some importance to surface ships. A large body of submarine design and operations technology exists and most designers believe viable cargo transports of 10,000-50,000 tons are feasible, and not even dependent on nuclear propulsion.

Earlier, we noted that large cargo and passenger sailing ships disappeared about 100 years ago because, among other things, of high labor costs. Think of all that sail trimming, rope knotting, gear hauling and so on! But the wind, unlike the ships, has not disappeared. Why can't we find a way to use the vast energy potential extant—just as the windmill proponents are thinking about these days?

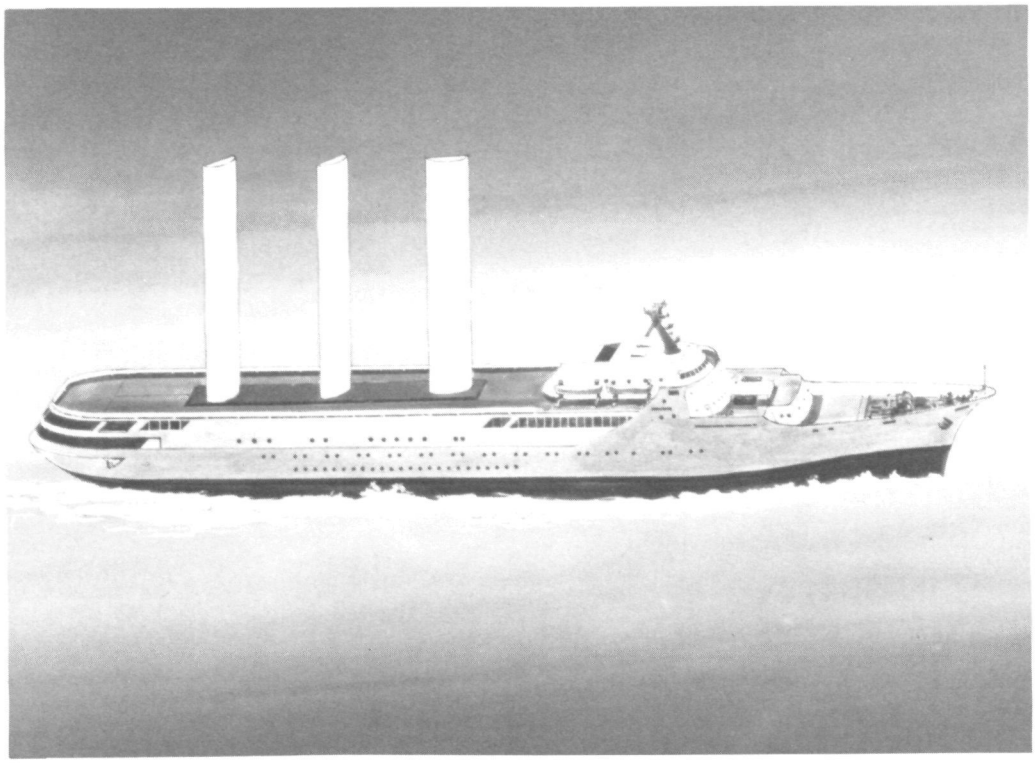
The notion of bringing back the old square-rigger sailing ships, even with motorized sail trimmers, is a romantic illusion. A much better idea is to be clever, and apply theories and principles of aerodynamics unknown 100 years ago. A sail is, in a sense, related to an airfoil, as in an airplane wing, so why not have the wind force applied to airfoil shapes of modern design? For several decades a few maverick ship designers have in fact proposed aerodynamic rotors and others devices to act as "sails" for wind driven ships and even buoys.

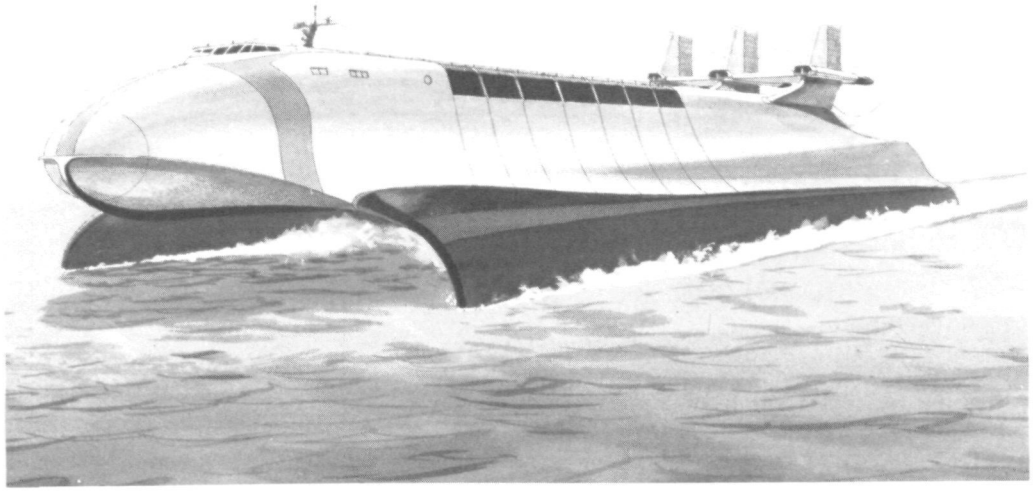
I propose that some of these ideas be jelled into a modern wind vessel, with computer-controlled vertical "wings", or airfoils, and a very small crew, with most operations controlled by electronic data feedback and motor servo systems.

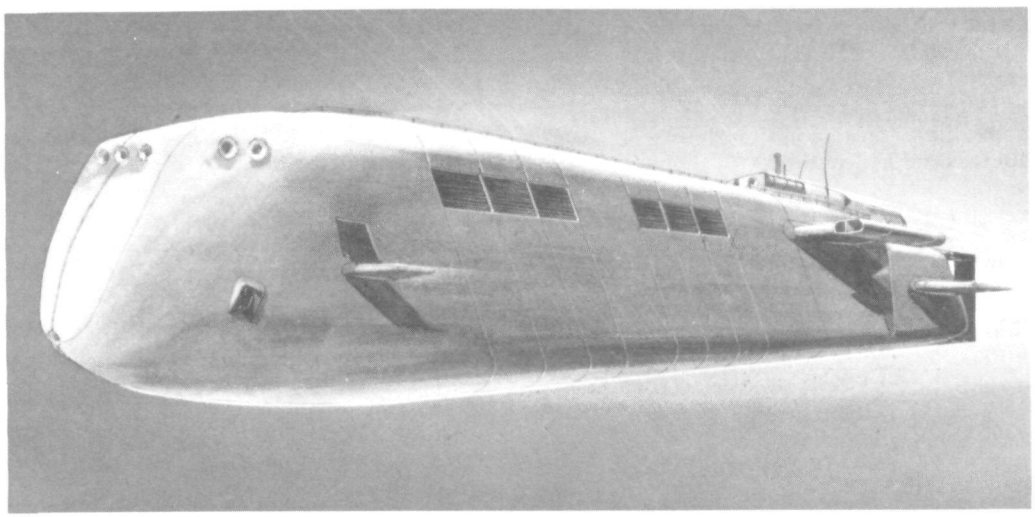
The last, and fastest of the U.S. clipper ships, during the 19th century often made as good, if not better time than their steam successors, except of course in the doldrums. Our modern airfoil vessel could use an auxiliary diesel engine in wind-scarce regions, and still be ahead in terms of total propulsive energy requirement for a given trip, versus an equal tonnage motor ship. German government marine research and development groups have concluded that a north transatlantic wind ship trip would use only 20 percent of the fuel of an engine ship, assuming the most pessimistic state of wind flow for any given year.

Raising the operating height of ocean transport ever so slightly above the surface is another intriguing possibility. What if we got away from the high viscous surface drag of a "regular" ship and skimmed over the water? A fairly old idea, of course—it's been tried with air-cushion vehicles (ACV's) or Hovercraft and hydrofoils. Any water skier is a skimmer at high speeds. And high speeds can mean as much as 60 knots (but not for water skiers).

Such vehicles could, in theory at least, provide trans-ocean service at three times normal ship speeds—still a long way from







For futurists of the transportation world, the "Helium Horse" (above), a contemporary dirigible, offers possibilities for fuel saving efficiency, as do new design sailing ships (left above), surface effect ships or hydrofoils (center), and huge civilian submarines for passengers and cargo (below).

aircraft but appealing to a wide variety of users, including passengers fond of sea travel but not the tedium accompanying it. Then why don't we have such machines for other than occasional lake, river, estuary or channel use? Speed exacts a price. These vessels must operate at high speeds to skim over, or just under, the water. This means powerful engines, in fact aircraft-type propeller propulsion for the ACV's, and therefore fuel guzzlers. Moreover, ACV's and hydrofoils give something less than a smooth or efficient ride in very rough seas.

If we still want to use the skimming principle for long ocean journeys, a hybrid mixed ACV/Hydrofoil vehicle called the Surface Effect Ship suggests itself. Two "webs" or parallel structural fins ride in the water, like a foil, but a cushion of air confined between the webs lifts the ship above the water. Speeds to 50-80 knots for very large vehicles (by ACV/Hydrofoil standards) should be possible, even in rough seas, and with propulsion efficiencies high enough to permit economical operation. If the government and industry can ever produce a large SES, three-day travel from the U.S. to Europe may well become a reality.

Elevating our sights somewhat, let us remember the potential of the airship—a vessel which moves in the fluid atmosphere rather rather than water.

The NOAA article "Helium Horse" (October 1973) showed a variety of dirigibles or airships which could haul passengers and cargo. It was presumed then that trans-ocean travel is the most obvious arena for an airship, which usually would, most efficiently, fly at lower altitudes, say below 5000 feet. If trans-ocean journeys are naturals, where would such a vehicle dock? At an abandoned, underused or redundant wharf or dock, at least one of which exists in most U.S. harbors.

A modern dirigible need not tie on to a classical airship mooring mast. It could, with vestored propulsion and stress-distributing mooring points, probably be held securely against its nemesis—high winds—in the lee side of a large dock warehouse or shed. The giant cargo/passenger dirigible, possibly carrying 800 tons of cargo and 1000 passengers, could be maneuvered into the harbor, while low over the water and then pulled alongside the dock, by a tug, supplemented by its own engines. Loading into the vehicle's belly could be conveniently done from the side, just as with a seagoing ship. While high winds might delay its arrival or departure, it could much more easily make up for lost time than a sea-ship.

For certain kinds of high-value medium-dense cargo and for tourist travel at, say 100 knots, such a dirigible with costs per ton-mile not far above those of ships and about 1/10th of those of such cargo aircraft as the C5-A, could well become competitive and cost-effective, especially if the recoverable costs of using expensive but otherwise idle dock facilities are considered.

Can existing cargo heavier-than-air vehicles make further inroads into sea surface cargo hauling? Probably not at this time, except for military emergencies. While the relatively primitive fuel for modern steam turbine or even diesel, vessels is expensive enough, the voracious gulping of super-spec jet fuel is accruing in hair-raising costs for air shippers.

How can marine technology help? First, let us consider that a modern jet aircraft needs very expensive airports, with long runways, very expensive and hard-to-protect cargo storage facilities, passenger terminals, navigation equipment, etc. Secondly consider that most cargo aircraft, except for a few military ones, are passenger vehicle derivations, and thus, in terms of loading and storage, rather less than 100 percent efficient.

If airplanes are to really move into the trans-ocean, or even trans-continental,

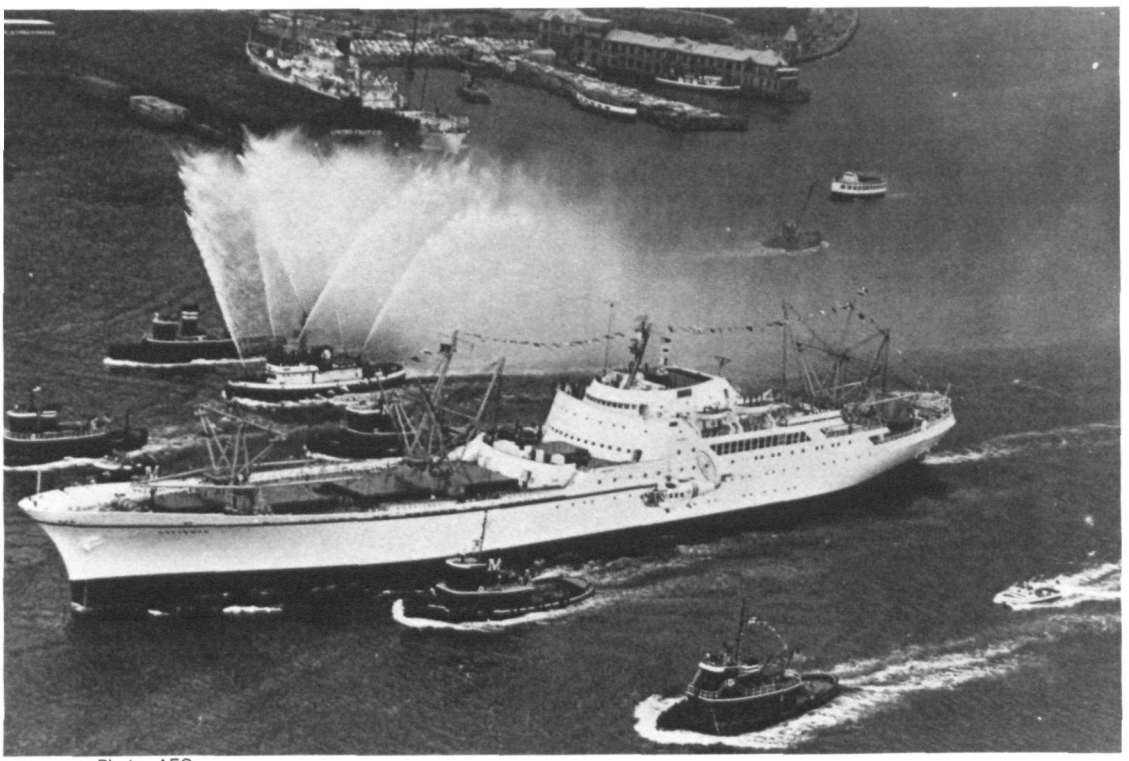


Photo: AEC

Escorted by a flotilla of tugs, small craft and fire boats spouting their traditional greetings, the Nuclear Ship Savannah moves up the Hudson River. She cruised almost a half million miles before being laid up.

freight hauling business, the costs and efficiencies of the aircraft and their ground facilities must be reduced. At some large airports, especially overseas as in Australia, a large aircraft may be charged $3,000-$5,000, just to land. So why not eliminate airports, or not use existing ones, and why not use instead idle sea-port facilities?

Since landing a 747 freighter on a dock or in the water nearby is not considered safe or elegant practice, we must turn to a flying boat. Hasn't that disappeared, along with the Great Auk and other historical curiosities? Yes, if you're thinking of the giant 4-engined British Sunderlands or U.S. Clippers, or the British Saunders-Roe Princess (a giant 10-engined machine, of which three were built soon after World War II), or the one-of-a-kind Hughes 8-engined wooden Hercules or the Martin jet-powered experimental machines of the 1950's. For reasons of excessive engine cost, lack of continuing government support, accidents, and an active landplane and airport lobby, the very large machines were abandoned. A few 4-engined flying boats are still active in the South Pacific and here and there in remoter maritime regions and in the U.S.S.R.

But in the opinion of some authorities, the flying boat is a much underrated class of aircraft, which suffered from conservative design, excessive weight and a lack of understanding by civil and military authorities of the most efficacious use of seaplanes. Actually, at least a thousand smaller machines, usually amphibians and float planes are in service in Canada, the U.S. and Scandinavia, where lakes and rivers and coastal waters provide ready landing areas.

The domination of military and civil aviation by land plane technology is almost total. Also, many billions have been invested in airports and their facilities and land-based navigation and aviation weather systems.

But perhaps, those very factors may spark a revival of the flying boat. Airports are, in the eyes of many environmentalists and urban planners, a drastic intrusion into the ambience of the shrinking rural areas surrounding cities. Noise and smog pollution, land acquisitions much of it for non-beneficial airport boundary or isolation use, traffic jams, expensive access roads and rapid transit to the urban centers have made new, large airports about as welcome to cities in industrialized countries as an adjacent artillery or bombing range. Yet many of the large travel-hub cities of the world are at, or near water: Chicago, Montreal, Los Angeles, San Francisco, Seattle, Washington, D.C., New York City, Miami, St. Louis, Rio de Janeiro, Sao Paulo, Buenos Aires, London, Paris, Frankfurt (on the Main River), Geneva, Stockholm, Karachi, Sydney, Wellington, and so on.

A large modern seaplane—perhaps 3-engined (turbo-prop or jet)—designed to be more "flying" than "boat" using perhaps, hydrofoil or ski-type initial landing surfaces, could well service these cities, and very conveniently too. Most industrial and commercial areas are normally located near the water. A flying boat, undemanding of any airfield, could land in or near a harbor (all-weather approach control and cleared water-ways or "runways" would have to be established) and deposit its cargo of goods or passengers close to their destination. Presto: no colossal airport investments, no weary trip to and from the airport, and, as with the Helium Horse, existing wharfage and dockage could be used. Or, at most, a slender jetty could be built, for permitting servicing and mooring.

A modern flying boat would need accurate ground-painting radar to prevent collisions with boats, ships and debris. During the landing approach, and for takeoff, a warning launch could assure cleared water and the plane could vector itself in by using existing land radio facilities. The high water drag would assure a short landing path, although on take-off air cushion techniques and some engine thrust vectoring downwards would reduce take-off paths.

Some not-inconsequential fringe benefits accrue from flying boat use. They include less noise for inhabited areas and smog pollution, reduced approach control requirements, presuming the aircraft operations can come to terms with ship and boat traffic. One cannot, of course, deny that marine aircraft operations would present new technical and logistic problems, but these would probably be by no means as intractable as those of airport construction or expansion.

Design-wise, a modern flying boat would benefit from the development and application of composite structures, turbo-prop or other Brayton cycle propulsion including annualar jet combustors, thrust augmentation* and vectoring, new concepts of hydrodynamics and high resolution anti-collision and ground scanning radar. Aeronautical engineers are not unaware of the virtues of large seaplanes. The military services, besides still using smaller machines, have studied, from time to time, the application of very large seaplane transports for servicing Far Pacific island regions. If some of the military and commercial needs can coalesce, we may well see, not a revival but an expansion of seaplane technology and use with giant aircraft hauling hundreds of passengers and many tons of freight between the major cities of the world.

Interest, private and governmental, is growing in the problems of ocean transportation as they become more acute. The Maritime Administration, for example, works diligently and progressively on the matter. Its budgets and mandate of necessity narrow the scope of its studies and support. Nevertheless, it has encouraged and supported a variety of developments in the areas we have just discussed.

It is clear that this is a time for looking into every possibility—even those which would appear to have been outstripped by modern technology. Witness the renaissance of the windmill, the electric car, and solar power.

With new requirements, changing geopolitical realities and modern systems technology, we may yet find a substantial part of our transportation future resurrected from the shadows of yesterday.

* Thrust reversal would not be needed for water landings.

A visit to a unique NOAA Center:

Weather Tech, U.S.A.

BY EDWIN P. WEIGEL

Photo: Edwin P. Weigel

Training Director Richard Myers has 16 years' experience as a college professor; taught ecology, biology and geology; is active in numerous scientific societies.

In the welcoming booklet issued to students entering the National Weather Service Technical Training Center at Kansas City, Mo., a statement of purpose sets the inspirational tone for this unique organization. It reads:

The Value of Training

A *plain bar of iron is worth $5.00.* This same bar is worth $10.50 when it is made into horseshoes. If made into needles, it is worth $3,285. But if it is turned into balance springs for watches, it becomes worth $250,000. . . . The raw material is the same, but it takes more time, effort and money to make needles than horseshoes, and much, much more to make watch-springs. . . . It is what we put into the product that increases its value. Your value depends on what you make of yourself. The more time and effort you expend in improving yourself, the more valuable you become."

The sincerity of this ideological underpinning is unmistakable when you tour the immaculate classrooms and laboratories of the Technical Training Center and talk with its 44-year-old Director, Dr. Richard F. Myers.

Myers is an ecologist, not a meteorologist. But his real profession is teaching, the craft of teaching anyone about anything—no matter what their individual background and no matter what the complexity of the subject. He was hired for the job in 1972 because of the teaching expertise gained from 16 years as a college professor and because Weather Service Director George P. Cressman believed Myers's philosophy and fresh approach were what the Center needed.

A lot of what Myers says and does in his job is focused on motivation: how to motivate people to do the things that will bring credit on themselves and their organization. This shows dramatically in the criteria he applies when selecting the instructors to teach the hundreds of electronic technicians and meteorological technicians who pass through the Training Center each year.

"I look for three things in a prospective instructor," says Myers. "First is technical competence; he's got to know his subject matter backwards and forwards. Then he must have a desire to teach, to proselytize. And third, he must have some ham in him; be able to cut up a bit, tell jokes, make his students laugh."

Summing up, Myers adds: "I look very carefully for instructors who are interested in people and who believe in people."

The team of 36 instructors and supporting personnel who staff the Technical Training Center do credit to this philosophy. Their dedication and enthusiasm are contagious.

Broadly speaking, they teach two major subject areas to two major groups. To electronic technicians they teach how to install, maintain and repair the electronic equipment the Weather Service uses. To meteorological technicians, they teach how best to conduct a Weather Service office, including operation of radar. The trainees are mostly veteran employees of considerable experience, who come to the Center to add a new skill or sharpen an old one. Their average age is 41 years.

More recently, the Center also has been teaching basic weather-observing skills to groups of students in what is called the Upward Mobility Program. Here, deserving Federal employees who have been caught in dead-end jobs are given a 12-week course which boosts them to the first rung in the career ladder for meteorological technicians. Many of these trainees are women and members of minority groups.

There also is a special course on Basic Meteorology for young Alaskans fresh from school or military service. Many of these are Eskimos, Aleuts or Indians. After they complete the course, they return to their rugged home state and start brand-new Weather Service careers there.

But the biggest part of the Center's job remains the training of electronic technicians in the care of vital equipment and of meteorological technicians in operation of a weather office. It's a never-ending task.

The Training Center had its start as a sort of graduate school for electronic technicians—journeymen already skilled in their trade who needed down-to-earth instruction on the care and repair of specific items of equipment. Much of the instruction given to them then and now involves painstaking familiarization with detailed electrical circuitry—and how to troubleshoot it. This training still comprises two-thirds of what the Center does.

It began in Columbia, Mo., in 1955, in a very small way, according to William Barth, Senior Instructor and unofficial historian. The first course was for maintenance and repair of equipment used in launching and tracking radiosondes, the small instruments carried aloft by weather balloons to furnish data on temperature, pressure, humidity and winds up to 100,000 feet. At the Center it's called training in "upper air" equipment.

Instruction in the care of Weather Service radars and of surface-observing instruments was added in 1958.

The training facility in those early years was a modified gasoline service station, said Barth. The service station's office was the classroom; its grease pit was the laboratory, planked over to make it serviceable. There was one class at a time, with about eight students.

In 1962, the Training Center was moved to its present location at the Federal complex on Hardesty Street in northeast Kansas City. The area is an old, stable part of town populated largely by Italian-Americans—an industrial section 20 minutes by auto from downtown Kansas City.

Staff at Training Center consists of 36 instructors and supporting personnel. At top left is Don Whitman, former Assistant Training Director for Meteorology. At right: Instructor Federico Para-Torres, on stool, guiding student Felipe Velasquez through a minicomputer diagram. At bottom: Instructors Michael Coffin, Harvey Pointer and Larry Burns during a coffee break.

The Federal complex is a cluster of venerable buildings next to a railroad track. First quarters for training were on the third floor of 12-story Building 1, which long ago was the catalog-sales warehouse for Bellas Hess, a mail-order firm. Now, the building is the distribution center for all of the Federal Government's paint.

Those were definitely not the good old days, according to Charles M. Webster, Assistant Director of the Center for Engineering Training, whose division supervises instruction of electronic technicians. "We had only three or four classrooms and five instructors. Didn't even have a secretary much of the time. The floor was black tile, the walls were green—pretty dismal. Although the classrooms were air-conditioned, the laboratory was not.

"Needless to say our present quarters are a vast improvement."

There can be no argument about that. The new quarters for the Training Center, dedicated in February 1973, occupy 29,000 square feet of the main floor of Building 9 at the Federal complex. At a cost of a quarter of a million dollars, this former warehouse for Internal Revenue Service records was remodeled into a dozen comfortable classrooms, an 11,000-square-foot laboratory, a row of office spaces for instructors, and a snack bar. It is decorated in bright colors and air-conditioned throughout. Although the building is undeniably plain on the outside, it's delightful on the inside, as many of the students have attested.

Photos: Edwin P. Weigel

New quarters opened in 1973 are a vast improvement over the old, according to Charles Webster, Assistant Training Director for Engineering. At top, Webster chats with Staffers Sylvia Braden and Larry Burns, and, at left, with Instructor Dan Collis. At middle right is Senior Instructor Bill Barth, and at bottom right, Student Glen Cochran, studying in snack bar.

It was during the years in Building 1, however, that periodic trips to the Technical Training Center began to evolve into a way of life for the 425 electronic technicians of the National Weather Service, as they began to work more and more on increasingly complex kinds of equipment. To the courses on upper-air, surface-observing and radar equipment have been added courses on radar-remoting equipment, teletypewriters, hydrologic instruments, automatic weather stations, flash-flood alarm systems, facsimile machines, APT satellite antennas, and minicomputers, among others.

During the fiscal year that ended last June 30 the 13 Engineering instructors at the Center taught two dozen courses to 400 trainees in 81 classes. "Altogether," said Webster, "we have 38 different equipment courses on our books that we can be called upon to teach." Actual teaching is just part of the job.

"Much of the Engineering instructors' time is spent reworking diagrams provided by manufacturers—4,000 man-hours last year—so that details are complete," said Myers. "Factory manuals don't provide enough information. Circuitry of some parts is taken for granted. So we provide trainees with our own big books for a piece of equipment. They take these home with them."

To keep up with the continuous stream of new devices entering Weather Service facilities it's not unusual for an electronic technician to visit the Training Center two or three times in a single year. Said Myers: "It's considered part of his job." Courses last from several days to several weeks; usually cover one piece of equipment at a time.

One of the newer functions for the "el techs" is servicing the complex "upper-air minicomputers" now used to digest information from balloon-borne radiosondes. By processing this upper-air data the minicomputers do in a fraction of the time and with great accuracy a task formerly done manually by meteorological technicians with an unavoidable amount of human error.

Minicomputers are key elements in the Weather Service's future. Those now in use and others to come will be an integral part of the revolutionary new AFOS system of data-processing and storage to be introduced in about 300 offices of the Weather Service, nationwide, during the next five years or so.

AFOS—for Automation of Field Operations and Services— calls for the present time-consuming transmission of weather data by teletypewriters and facsimilie machines and the huge quantities of paper they generate to be replaced by an all-electronic system of on-site minicomputers and TV-type displays controlled by typewriter-like keyboards. It will be a new way of life for weathermen.

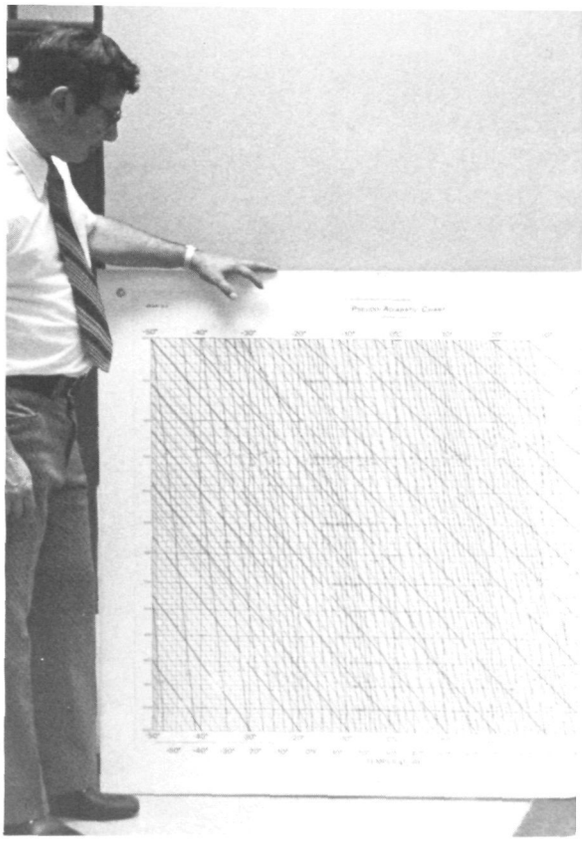
AFOS will greatly speed and improve the handling of weather data. It also will undoubtedly call for a considerable amount of training for electronic technicians and meteorological technicians on how to service and operate the new equipment. Already, however, instructors at the Training Center are confident the vast majority of Weather Service employees will take the new equipment in stride.

"There was a difference of opinion here at the Center on the degree to which minicomputer maintenance was within our capabilities," said Myers. "Estimates ranged as low as 30 percent on the proportion of electronic technicians who could be trained to work with them. We're happy to say this was far too low. The survival rate has been well over 90 percent since instruction on minicomputers was begun in late 1973."

Said Engineering Division chief Webster: "It's going to take some time, effort and money, but I'm confident it's well within our electronic technicians' capability to maintain AFOS minicomputers and their peripheral equipment, if given the proper training."

Continuous upgrading of individual employee performance through in-house training has reached its present vigorous level of activity largely through nurturing by Weather Service Director George P. Cressman. He is a staunch advocate of regular visits to a classroom for all levels of employees.

One result is the training program for the Weather Service's 2,000 meteorological technicians, begun at the Center in 1969. Before that, the training they had they either brought with them from previous assignments in the military, or gained on the job, in somewhat haphazard fashion. Yet "met techs," as they are called, consti-



Classrooms and labs in the Training Center are air-conditioned, clean and comfortable. Training devices are constantly being improved. Above: A Weather Radar class learns about electromagnetic waves. Near right: Student Hugh Greenan works on assignment at work table in main laboratory. Far right: Senior Instructor Larry Burns examines new training chart for upper-air measurements.

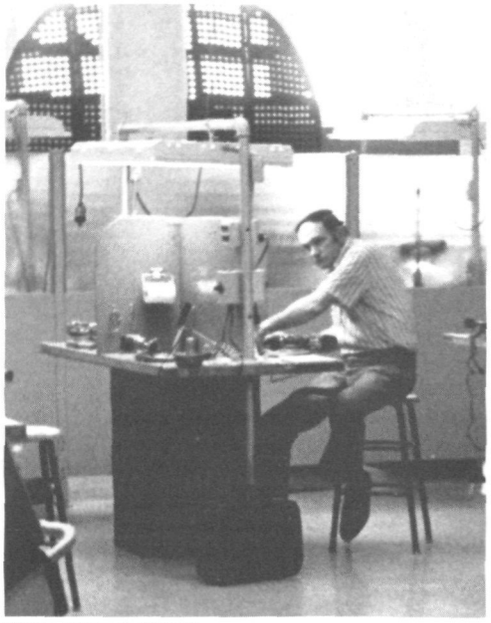


Photo: Edwin P. Weigel

tute the largest single job group in the Weather Service (and in the Department of Commerce, for that matter). Dr. Cressman felt their opportunities for self-improvement were woefully lacking.

So a new division was created within the Technical Training Center, on an equal basis with the Engineering Division, with its own instructors and curriculum. One of the first instructor-recruits was Don Whitman, who later became the Center's Assistant Director for Meteorology and Management Training.

"At first we had just two courses," said Whitman, "Weather Service Operations and Weather Radar. One was a kind of liberal-arts course on how to run a Weather Service office, and the other was a course on how to interpret the cloud and precipitation echoes on a radarscope. Since then we have added a course in Basic Meteorology for Alaskan natives and courses on Surface Observing and Upper-Air Observing for students in the Upward Mobility Program. We also have a team of instructors who visit the regions to conduct a three-day Writing and Broadcasting Seminar, and we have begun to teach an Air Pollution Meteorology course to meteorologists."

Dr. Myers became Director of the Training Center in early 1973. His arrival on the scene was early enough for him to put his stamp—based on years of college teaching—on the evolving program for meteorological technicians.

"What we are establishing," he said, "is a graduate program of instruction. Our trainees are veteran employees who know who they are and what they are. Many of them have 10, 15 or 20 years' experience. Some of them have been out of a classroom for a decade or more.

"To be where they are they've been screened already. So our job is not to pass judgment on their competence, but to help them do their jobs. We do give tests and the tests are graded. But we don't broadcast the results. We use the tests to measure our teaching ability as well as to measure a student's progress. When a student graduates, he gets a certificate stating he has successfully completed a course, and there's no grade on it. Failures are almost nonexistent."

Myers said, however, that his staff quickly learned it was wrong to assume the old timers were well versed in the complete spectrum of activities in a weather office, even though this would seem a logical assumption. So they arranged their classes accordingly. For example:

"We divided our Weather Service Operations classes into two groups. WSO-1 is for meteorological technicians with less than five years' experience; WSO-2 is for those with more. This gives experience compatibility and improves class participation—the give and take between students comparing notes on how their stations do certain jobs. Very healthy."

The other major meteorology course, Weather Radar and how to interpret it, "is almost a compulsory thing now for 'met techs' who are on stations that have a radar," said Assistant Director Whitman. "Well over 50 percent in this category have taken the course. The goal is 100 percent." Weather Radar rates high on the curriculum because it is so important for warnings against severe weather such as damaging thunderstorms, tornadoes and hurricanes. It is worth noting that there are only two Weather Service criteria for issuing a tornado warning—a visual sighting by a spotter and radar.

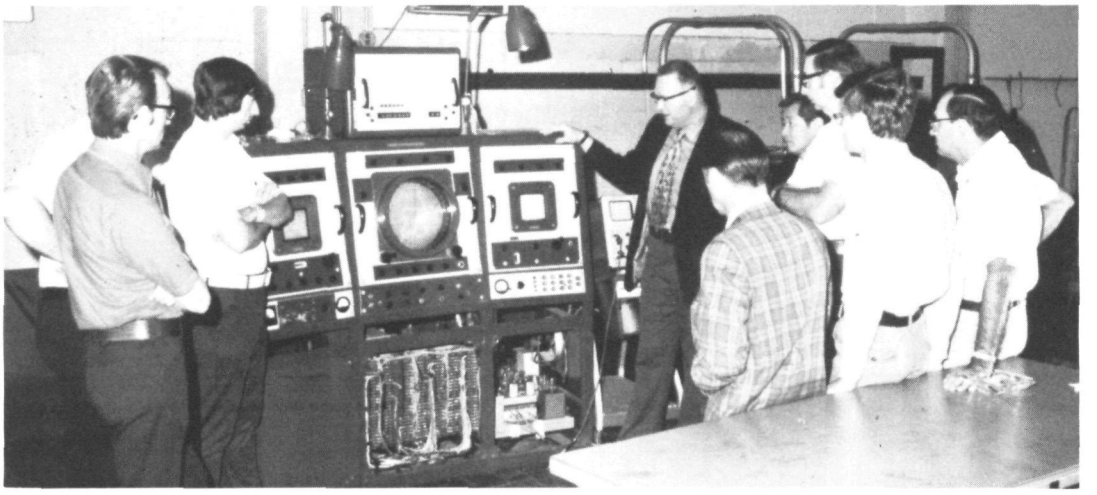
Head of the Weather Radar instruction unit is Larry Burns. It would be difficult to find a better choice. Burns comes by his respect for radar warnings first hand. Early in his Weather Service career, he was stationed at South Bend, Ind. He was on duty on the afternoon of April 11, 1965—Palm Sunday. On that date, three dozen tornadoes blitzed five States, killing about 250 Midwesterners. South Bend's area of responsibility was hit hardest of all.

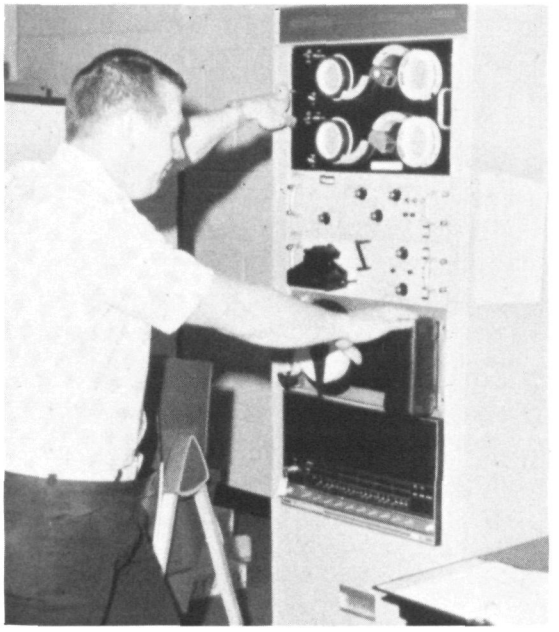
Said Burns: "It was on the basis of a hook echo spotted by Chicago radar over Michigan City, Ind., that the South Bend office issued its first tornado warning of the day, even though the tornado was not yet on the ground.

"After that warning, things began happening very rapidly. Tornadoes followed one another in rapid succession. One trailer court was hit twice in half an hour.

"The investigation that followed showed every tornado that hit in South Bend's area of responsibility had a tornado warning out ahead of it."

Palm Sunday made a believer in radar out of Larry Burns. In his current role he instructs trainees in things to look for to spot a tornado-producing thunderstorm





Radar and minicomputers are among the more complex devices for which operation and maintenance courses are taught. Above: Joel Wertman instructs a class of meteorological technicians about operation of a WSR-57 radar, standard equipment in many weather offices. At left: Instructor David Hughes checks out a minicomputer used to process data from balloon-borne radiosondes.

early, such as height of cloud tops, area of maximum reflectivity, and of course the hook echo.

One problem that disturbs him is the lack of realistic training devices. "We don't have an operating radar here. We have consoles, on which we can produce still pictures. But even if we had an operating radar it wouldn't serve our purposes, because severe weather doesn't occur often enough for an operating radar to be useful in the classroom. Hook echoes are actually very rare.

"Videotape presentations have been tried, but they don't offer the student an opportunity to manipulate the scope. If he feels a need to search the vertical, he can't do it. The biggest thing we have to teach students is how to make decisions in a real situation. We are looking around now for ways to do this.

"One possibility is a radar console linked to a computer which is programmed to allow a student to manipulate the radar controls and analyze a storm much the way an airline pilot manipulates the controls in a cockpit simulator to get realistic exercises in instrument landings and emergency procedures."

The goal of making training just as specific as possible underlies everything the Center does. Says Myers: "We try to find out exactly what a person needs to know on the job, then do nothing more than train him for that. We try to leave off things 'nice to know.' Those make training expensive."

Among the new ideas for stretching the training dollar are correspondence courses. These are available to anyone in the Weather Service, with their supervisors' approval. They fall into two categories. One group consists of a wide variety of courses from International Correspondence School, a large firm specializing in engineering and electronics instruction. The Weather Service subscribes to these courses at a group rate, and handles its own paperwork. Among subjects available are basic electricity, basic electronics, math, physics, plumbing, electrical repair, carpentry and refrigeration.

The newest correspondence course is a series programmed by IBM to teach automation. Said Myers: "This is a sequence of at least four courses that will get people ready to interface with AFOS, and take them into very preliminary programming procedures. There also is a Bell & Howell course we have used as a prerequisite to the computer program."

All told, the Center has processed 2,200 correspondence courses in the 14 months the program has been in existence.

Myers feel that the Center should accept constant change as a way of life. "Our instructors spend 40 to 50 percent of their time preparing for classes and revising their presentations. If an instructor feels the class he teaches is perfect, something is wrong."

One new idea under experimentation is self-paced instruction. Said Myers: "Under this system the student is provided with units of material carefully prepared and arranged by instructors. The student may progress at his own speed, but instructors are always on hand to respond to questions. Institutions which have used this approach claim a 20 to 30 percent reduction in time required for training. The faster students are not held back by slow ones, and the method permits more-efficient use of the physical plant via longer operating hours."

A promising new apparatus for self-paced instruction combines an illustration and a voice recording by an instructor. Myers demonstrated: "The lesson is this sheet of paper with an illustration on it—in this case a logic diagram for a computer component. The paper has a magnetic field on the back with a voice recording on it that can be played aloud while the trainee studies the diagram. It talks him through the lesson. Besides its obvious advantages for electronic diagrams, this system also could be useful for self-paced instruction in the Upward Mobility Program: to teach students how to take a rawinsonde observation, for example. How to tie the instrument package to the balloon, what pitfalls to avoid, and so on.

"If Weather Service field offices were to purchase the necessary playback equipment, we could mail them the lessons."

Another new system for improving training is videotape. There is a player-recorder in the laboratory for the Weather Service Operations Course. "We ask students to give daily weather briefings," said Myers. "They do this in groups of four. We tape them each week, and then play the tapes back before the whole class, for comment. This is good for getting rid of funny little mannerisms a person may not even know he has. You should see the difference between the first tape and the fourth. It's amazing. We use this system to help our instructors, too, on occasion."

By the time this article is being read, Myers and his crew of enthusiastic instructors undoubtedly will have gone on to still more interesting new ideas and experiments.

Along with change has come impressive growth. The Meteorology and Management Division of the Center last year gave instruction to 326 students in ten courses in 17 separate classes. The Center as a whole instructed 726 trainees in 34 courses in 98 different classes. These ranged from three-day seminars to a 12-week course for Upward Mobility students.

In the past three years, the Center has just about doubled in everything but floor space. This includes staff, now 36; budget, now about $700,000 annually; and number of students, expected to be nearly a thousand this year.

Like all planners, Myers likes to draw growth curves. His curve shows that, if the past growth rate continues, he will have a staff of 65, a budget of more than a million dollars a year, and an enrollment of more than 1,600, by 1979 or '80.

Says he: "At this rate it's obvious we're going to need more space."

REFLECTIONS OF A NOVICE AQUANAUT

BY HOWARD W. POLLOCK

Photo: World Wide

At approximately 10:00 A.M. on Monday, 4 August 1975, Senator Lowell P. Weicker, Jr., of Connecticut, Congressman Bill Alexander, of Arkansas, Robert I. Wicklund, a veteran aquanaut, fisheries biologist, and manager of the Hydro-Lab underwater habitat for the Perry Foundation, and I donned our scuba diving gear, checked every item of equipment to insure that it was in proper operating condition, then we slipped into the sea for what appeared to be a routine scuba dive. But, it wasn't routine. We didn't return to the surface in the normal forty minutes or an hour. We didn't return to the surface all that day, nor the next. As a matter of fact, we didn't re-enter the natural realm of man at the surface until Wednesday afternoon about 2:30 P.M., fifty-two and one-half hours after we disappeared beneath the surface of the sea on Monday morning. During that time we were making an extended saturation dive. When we commenced our dive, we swam down to live in the Perry Hydro-Lab underwater habitat located on the ocean floor 50 feet below the surface, little more than a mile off shore from Freeport, Grand Bahama Island; and, during our stay, we made a number of scuba diving excursions from our underwater home to conduct experiments and to observe the flora and fauna in the surrounding marine environment.

The objective of the saturation dive was two-fold: To make the Members of Congress more intimately aware of the problems faced by marine scientists and technicians as they probe the mysteries of the briny deep, and concomitantly to make these members more keenly aware of our many ocean potentials for utilizing, managing and conserving our renewable living and nonrenewable nonliving resources, for finding marine sources of energy, and for developing other potential uses of the oceans, such as facilities for human habitatation, for air fields, offshore deep water ports, aquaculture farms, power generation sites, ore reduction plants, and the like.

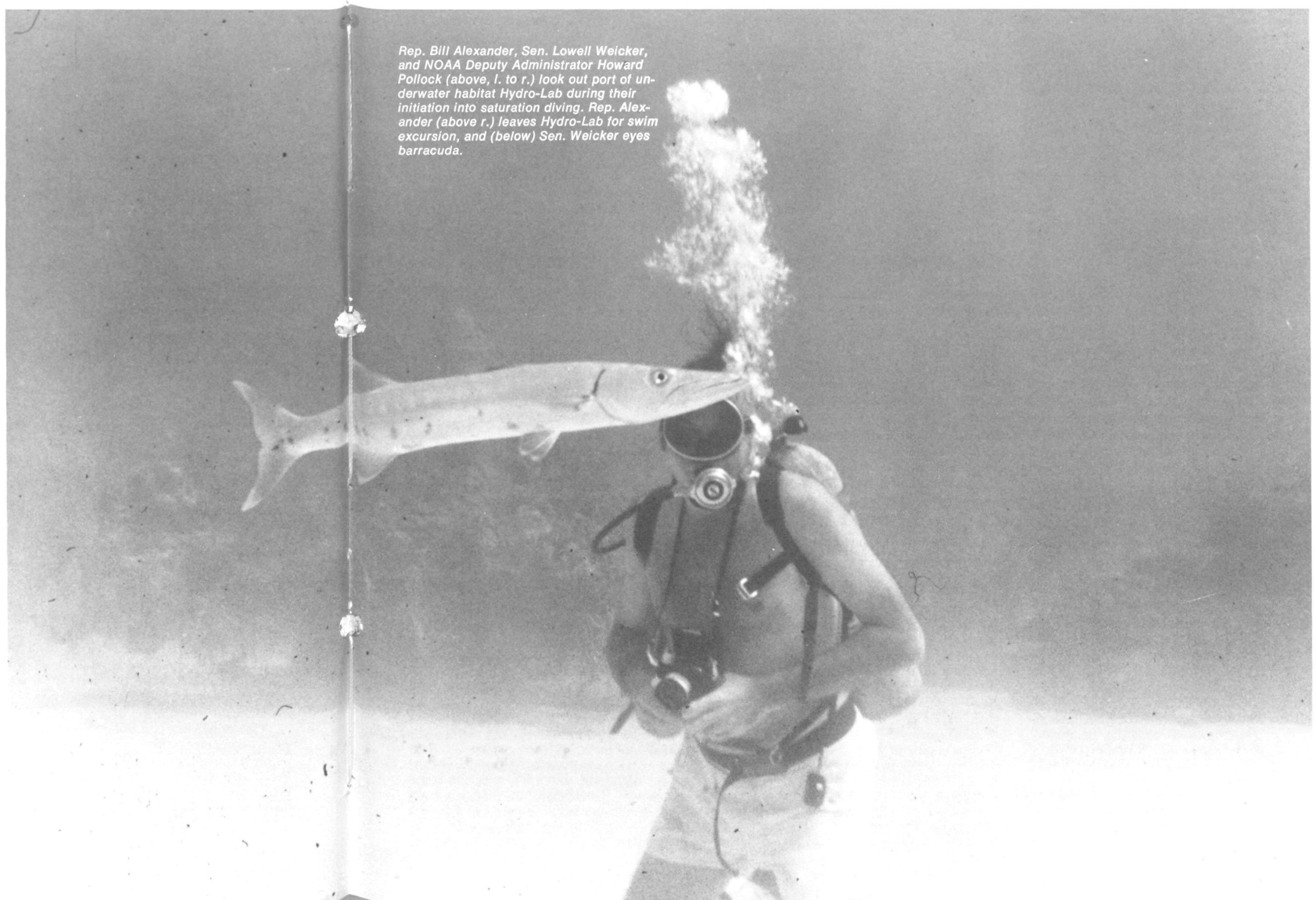
The Hydro-Lab underwater habitat is a cylindrical chamber 16 feet long by eight feet in diameter with rounded ends, one of which contains a 4-foot oval window or port. The habitat contains two bunks (two of our Congressional saturation diving team members, one of whom was Senator Weicker, slept on air mattresses on the floor), and a dehumidifier, an air conditioner, communications equipment, a fresh water hose with spray nozzle for our drinking and cooking requirements and for taking a shower or after-dive fresh-water rinse in the diver lock-out chamber, an electric pot and pan for cooking freeze-dried or other dehydrated foods and for making coffee or tea, and other spartan accommodations.

The air and fresh water for the habitat are provided by an unmanned life support buoy floating on the surface above. It contains an air compressor and a 250-gallon tank of fresh water. The underwater habitat reposes on four stout, round, spreaded legs attached to a heavy concrete slab on the ocean floor. There is a vertical diver lock-out chamber or trunk which opens into the ocean at the bottom of the habitat and extends well into the Hydro-Lab at the top for entry and exit. At either end of the lock-out chamber are hatches to seal off the chamber when necessary. However, during the saturation phase both hatches are left open. The air pressure in the habitat prevents the water from entering through the open lock-out chamber, so that one can breathe freely in the habitat, without any special apparatus, just as he or she might do at the surface.

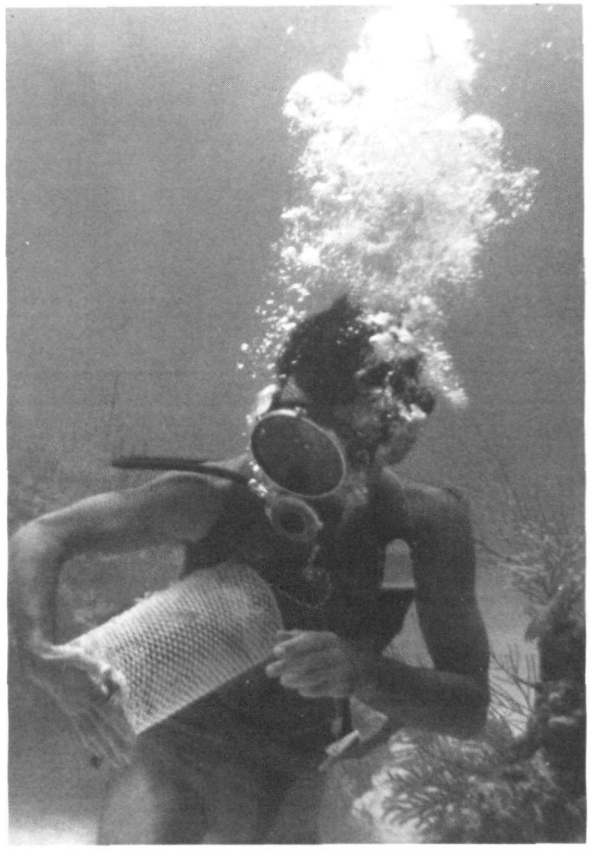
Incidentally, immediately outside of the Hydro-Lab was a small metal building or compartment with open sides, and containing a supply of free-flowing air and an

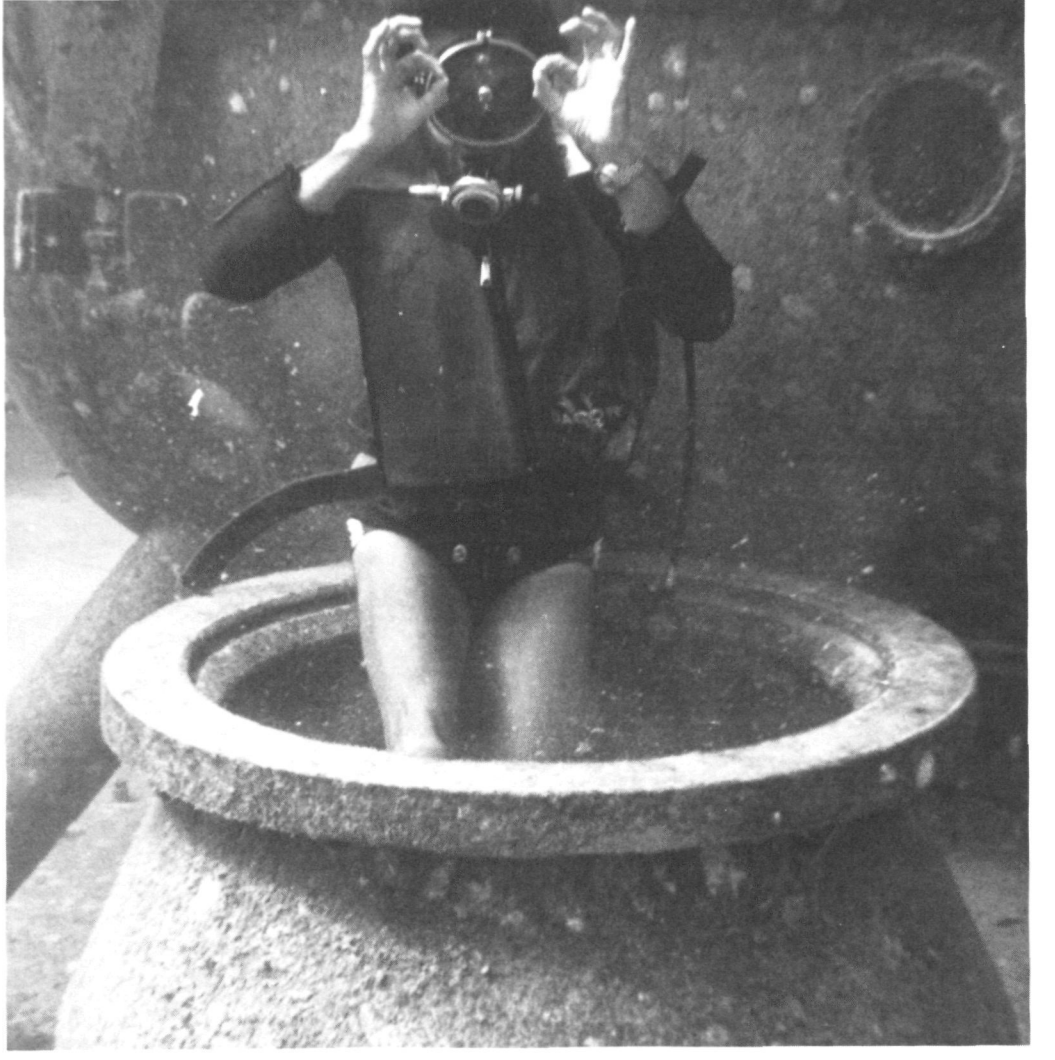
**A NOAA Aquanaut is a certified scuba diver authorized to participate in an official NOAA-operated, -funded, or -involved undersea program utilizing an underwater habitat or laboratory, and requiring the diver to remain underwater for a minimum continuous period of 24 hours in connection with the experiment or program.*

***Howard W. Pollock is the Deputy Administrator of the National Oceanic and Atmospheric Administration and a former United States Congressman for Alaska. Mr. Pollock is active in both national and international ocean affairs and is an experienced scuba diver who has vigorously supported increased efforts to tap the ocean's resources and energy potential for the Nation's benefit. He is the founder and chairman emeritus of the Congressional Underwater Explorers Club.*



Rep. Bill Alexander, Sen. Lowell Weicker, and NOAA Deputy Administrator Howard Pollock (above, l. to r.) look out port of underwater habitat Hydro-Lab during their initiation into saturation diving. Rep. Alexander (above r.) leaves Hydro-Lab for swim excursion, and (below) Sen. Weicker eyes barracuda.





Rep. Alexander (l.) works with fish trap in scientific experiment; support diver (r.) gives the all O.K. signal to the first Congressional aquanauts.

emergency bank of air cylinders. This little facility is known as a "puts" (portable underwater talking station). The air is captured in the inside of the long sloping roof of the puts, so that we could enter, remove our masks and regulators and talk to each other about things we had seen or were doing. It also provided us with an opportunity to free-dive from the habitat (with mask, weight belt and fins, but no tank) and then enter the puts for a lung-full or two of air.

We engaged in a number of experiments, studying aspects of the coral reef, the kinds and distribution of the corals themselves, the fish and plant life that inhabits the reefs, the effect of pollutants on reef life, the metabolism of individual living organisms and of the reef community, and a host of other aspects. We even herded fish into small nets which we had stretched underwater to capture them so as to explore the possibility of removing air from their bladders to see if they would remain sufficiently dormant to be herded, as a fish-farming (mariculture) potential. It occurred to me that some of these experiments might appear to be on the periphery of the possible today while having a potential for being the routine or common-place practice tomorrow.

Over the period of the saturation dive we made eight research "excursions" from the habitat using scuba gear, four on Monday, and four on Tuesday, one each evening after dark. Each time we made an "excursion" dive we used double tanks of air, and were out an average of an hour per dive, so that of our total saturation time of 52 hours and 30 minutes under water we were on diving "excursions" approximately eight hours; and each of us consumed 16 tanks of air. That means, of course, that we spent some 44 hours in the chamber during our saturation/decompression exercise, but this included time for sleeping, eating, studying and communicating with each other, and a total of 16 hours and 17 minutes were consumed in the decompression phase alone. All in all it was a very comfortable, most enjoyable, and very educational experience.

At the surface at sea level the atmospheric pressure is 14.7 pounds per square inch (psi). In the ocean environment, every 33 feet in depth increases the pressure by one atmosphere, or an additional 14.7 psi. Thus, the absolute pressure at 33 feet depth in the ocean is 14.7 psi x 2, or 29.4 psi. For ease of computation we can round off the 14.7 to 15 psi. Accordingly, at 33 feet we can conveniently assume the ambient or surrounding pressure to be 30 psi; at 66 feet, we can assume the ambient pressure to be 45 psi, and so on, in a linear progression, increasing 15 pounds per square inch for every additional 33 feet of depth.

Although the Hydro-Lab habitat is on the ocean floor at 50 feet, the atmospheric pressure inside the habitat is the same as the pressure of the water level at the lower hatch. The lower hatch happens to be 43 feet from the surface (above the concrete slab and legs). If my mathematics is correct, that is two and five-sixteenths atmospheres of ambient pressure. Thus, 14.7 psi x $2\frac{5}{16}$ths equals 34.95 or 35 psi of absolute pressure in the habitat, except as it might fluctuate by reason of changes in actual depth of the habitat as influenced continuously by the changing tides, which have a range of 3.3 feet variance in that location.

The air we breathe is approximately 20% oxygen content and 80% nitrogen. Under the increased pressure of several atmospheres as a diver submerges, the nitrogen and oxygen of the air he or she breathes goes into solution in the tissues and blood. After about 24 hours at our Hydro-Lab and diving depth under the ambient pressure—roughly two and one-half times atmospheric pressure—saturation occurred, which means that the blood and tissue in our bodies absorbed all of the nitrogen and oxygen they were capable of holding. Once saturated, a diver can safely stay at that depth for an indefinite period of time. To go back to the surface, a slow period of decompression is required that permits the nitrogen and oxygen to be returned to their gaseous state and then be released from the body without forming bubbles in the blood and tissues. If bubbles form, they can cause what is commonly referred to as the "bends". Going to the surface without decompression during saturation would cause

Howard Pollock and Sen. Weicker (l. to r. at left) swim out to observe scientific work; (above) support diver adjusts Sen. Weicker's equipment.

a massive and probably fatal case of the "bends".

Because it was critically important that we stay submerged once we were saturated, all normal scuba diving "essential" equipment used for going to or staying on the surface was discarded. Thus, I made the dive without my snorkel, or buoyancy compensator (inflatable jacket) or lift bag (device for filling with air to lift heavy objects off the ocean floor). I even put my summer wet suit aside after my initial entry, as the water temperature was mild, although I had adequate weights on my weight belt to overcome the buoyancy of the wet suit.

It would seem that the inside of the Hydro-Lab habitat would be damp, with high humidity, and be very hot. Actually, thanks to the dehumidifier and the air conditioner, it was quite comfortable and dry. Of course, we were always careful to keep our swim trunks and dive gear in the lock-out chamber or behind it in the habitat. Thus, we kept our rug and living area dry.

Speaking of dry things brings to mind the use of transfer pots for delivery of dry clothes, dehydrated foods, bread and other food items, books, cameras, paper and pens, etc., from the surface to the habitat and back. The transfer pots are cylinders of various sizes with heavy lids that are sealed by "O" rings or gaskets and bolted shut, and are provided with venting valves to accommodate changes in pressure. When a transfer pot is lowered from the surface, the sealed air inside exerts less pressure than the surrounding denser air in the habitat, so that even without being bolted down the lid is held securely closed. The venting valves must be opened to let the outside air enter the transfer pots and equalize the pressure before the lid can be removed.

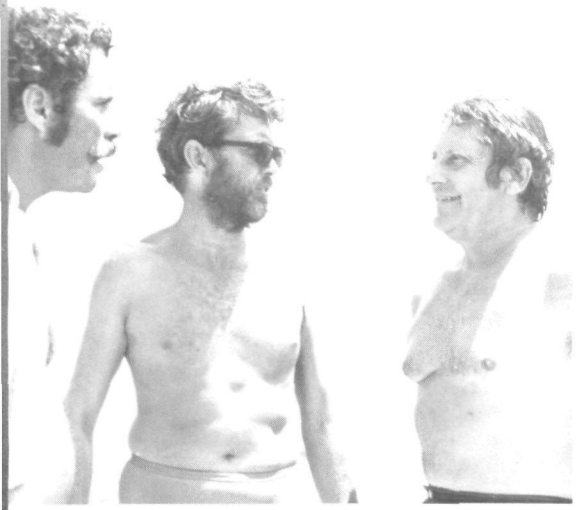
If the transfer pot is closed and sealed in the habitat at a pressure of 2½ atmospheres and is then raised to the surface—and this was done on one occasion during our saturation dive—the excessive inside pressure will bleed off slowly through the "O" ring or gasket as the outside pressure decreases during ascent. At the bolts are loosened on the surface, the excess internal pressure will quickly escape and the lid will readily open.

Cameras are a special problem. They must be taken apart before being placed in the dry transfer pot, whether going to the bottom of the sea or back up to the surface, if the camera is to be opened for loading film or otherwise taken apart in the habitat while it is subjected to ambient pressure. Because the air inside the camera is at surface or atmospheric pressure, it would be impossible to open the camera for reloading in the habitat, as the outside pressure exerts too great a force. On the other hand, if the camera were taken apart and placed in the transfer pot for lowering into the habitat and were thereafter opened, the air pressure inside the camera would then be ambient (2½ atmospheres of pressure in our situation). If the camera were then not dis-assembled and were placed in the transfer pot for ascent to the surface, the front window of the camera and the exposure counter window on the bottom would be blown out, and the lens unit, including the iris and other elements, would be distorted, damaged and ruined.

It is interesting to note that the camera is much like the habitat itself when it comes to withstanding external or internal pressure. Both can withstand greater pressure exerted from the outside than from the inside. As a matter of fact, if the Hydro-Lab habitat were sealed and lifted from the ocean floor to the surface, the pressure inside would soon exceed the decreasing ambient pressure outside. When the inside pressure exceeded the outside pressure by little more than two or three psi, the windows would be blown out of the habitat and it would fill with water. (The more one contemplates the great wealth of knowledge and understanding required to properly construct a habitat such as the Hydro-Lab, and its constituent components, the more one can appreciate the genius of John H. Perry, Jr., the designer and builder.)

Congressman Bill Alexander, currently the president of the Congressional Underwater Explorers Club in Washington, D. C., provided all of us with a vivid demonstration of the effects of pressure at different depths. He took a small plastic bottle down on the dive with him partially filled with shampoo or lotion, thus having ample air space left in the bottle. The cap was screwed on tightly before the descent, so it contained a volume of surface air under one atmosphere of pressure. At depth the air space in the plastic bottle was severely compressed as if crushed by the grip of a giant hand. Bill decided not to open the bottle down at the bottom of the ocean, which would have allowed the denser air to fill it, so as to discern if the original shape of the flexible bottle would be restored during the decompression phase (which is equivalent to swimming back to the surface with it). And indeed it did. As the pressure was reduced, the volume of the air inside the bottle increased until it had expanded the bottle back to its original size and shape.

As I observed this phenomenon, I recalled my early scuba diver training and the need to understand Boyle's Law of physics: "For any gas (nitrogen and oxygen of the air) at a constant temperature, the VOLUME will vary INVERSELY with the absolute pressure while the DENSITY will



Dr. Morgan Wells of NOAA's MUS&T, Dr. Donald Beaumariage, MUS&T head, and Howard Pollock (l. to r. above) compare notes following dive. At right, displaying NOAA Aquanaut patches, are (l. to r.) Don Beaumariage, Rep. Alexander, Mr. Pollock, Sen. Weicker, and Tim Keeney, former Navy UDT "frogman" and now assistant to Sen. Weicker.

Photos: Friedrich Hoelzl

vary DIRECTLY with the absolute pressure." To say it another way in layman language, at TWO atmospheres of pressure (33 feet) the volume of the air is REDUCED to ONE-HALF; at THREE atmospheres of pressure the volume is reduced to ONE-THIRD; at FOUR atmospheres of pressure the volume is reduced to ONE-FOURTH, and so on. Of course, conversely, when a diver ascends, the volume of air increases in the same proportions. Also, when the increasing pressures at greater depths compress and reduce the volume, the air one breathes is denser, that is, there is a greater quantity of air per unit of volume, and the diver thus gets increased amounts of nitrogen and oxygen in his system in a shorter period, and uses up his air supply much sooner.

An exciting moment occurred during one of our "excursion" dives out to the reef. We had just exited the Hydro-Lab, when a massive hammerhead shark swam by us overhead at great speed, immediately above the habitat. He didn't seem to be interested in us, but appeared to be on the chase after something beyond our vision. We saw one very large and several smaller barracudas, several large sting rays, and many other varieties of fishes, and learned the common names of many of them.

Speaking of observing fishes, from the inside of the habitat through the four-foot diameter port or round window in the end of the Hydro-Lab (near the bunks and opposite the end where the diver lock-out chamber or trunk is located), we could unobtrusively watch the panorama of myriad exotic and common fishes, some very large, some quite small, in every imaginable color and hue. At night the stage would change, and our floodlight would attract untold thousands of fishes of all conceivable shapes, sizes, colors and markings. We constantly consulted our fish manuals to seek out and identify each species observed.

By the way, there are no toilet facilities in the Hydro-Lab. To answer nature's call, it is a unique experience to put on one's mask, weight belt and fins and exit the habitat nude, and either swim over to the puts and hang out to go while breathing inside, or, in the alternative, stick the regulator in one's mouth and tuck the double scuba tanks of air under arm to venture out on a "potty excursion". Solid waste, also subject to ambient pressure, often sinks to the ocean floor and is almost immediately devoured by anxiously waiting angel fish and yellowtail snappers.

Decompression time for our saturation dive at the 43 to 50 foot depth was scheduled to be 15 hours, but actually took 16 hours and 17 minutes, because of a problem we encountered in controlling our decompression schedule during the quiet hours of late Tuesday night and early Wednesday morning. We all stood watches of two hours or so through the full decompression period, operating the pressure control valves to safely vent off the air in the habitat pound by pound or fraction of a pound, and observing the equivalent reduction in depth foot by foot, under precise and tightly controlled conditions, until the ambient pressure in the habitat on the ocean bottom was ultimately reduced to an equivalent of the atmospheric pressure at the surface. Because of the tidal fluctuations, it is necessary to begin the decompression phase with the actual depth and absolute pressure at that precise time. The process is slow and tedious and I recall, as an example, that our decompression table provided for a full 68 minutes of decompression at the last foot before reaching surface pressure.

It is interesting to note that, because decompression takes so long, we could, in fact, have flown to Tokyo from the Bahamas in less time than we could safely travel from the habitat to the surface, only 50 feet away.

The lock-out procedure and re-entry to the surface was a particularly interesting and exciting aspect of the saturation dive. Only one aquanaut can enter, be locked into, and exit through the lock-out trunk or chamber at any given time. At the beginning of the decompression phase the top hatch of the lock-out trunk is securely closed and locked, after which the habitat pressure is reduced. The lock-out chamber itself, with bottom hatch open, is at the ambient pressure of nearly 2½ atmospheres. In order for an aquanaut to manage an escape or departure from the habitat, the bottom hatch must temporarily be held closed by an outside diver (why not a hydraulic gear operated from inside?) until the air in the lock-out trunk is vented off and reduced to the surface pressure which is now inside the decompressed habitat. Thereafter, the outside ambient pressure of the sea against the bottom hatch will hold it securely shut.

At this stage the top hatch of the lock-out chamber is opened and the aquanaut climbs in with his mask, fins and weight belt on, after which the top hatch is closed over him and locked securely, leaving him quite alone inside the lock-out escape chamber. At this juncture air pressure is immediately introduced into the lock-out chamber to force an increase in the pressure there to equalize again with the ambient pressure of the ocean outside the chamber. This introduction of suddenly-increased pressure causes a high-pitched, ear-splitting whistle in the closed lock-out

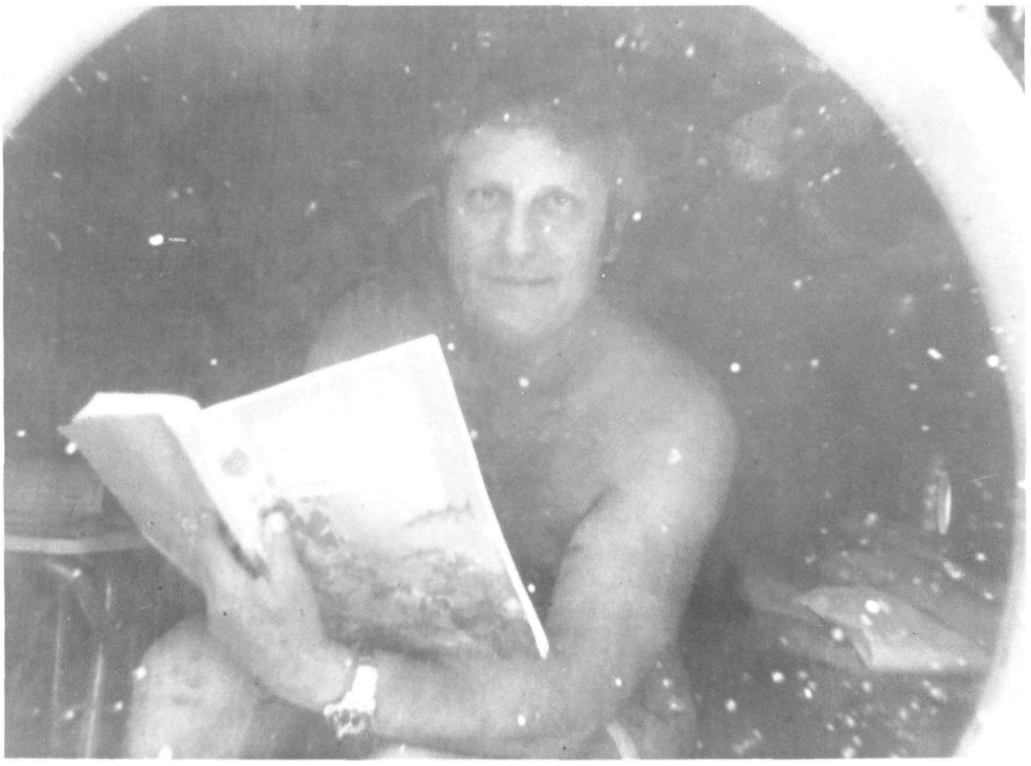
trunk. The aquanaut must pinch his nostrils closed and blow firmly to open the eustachian tubes to his ears so as to equalize the pressure (and this incidentally, makes the shrill whistle all the louder). In about a minute the pressure in the lock-out trunk is equal to the ambient pressure at the sea floor, and the bottom hatch falls open automatically. The aquanaut immediately slips out through the bottom hatch, and is greeted on the ocean floor by a scuba diving buddy who presents him with a second regulator on his octopus rig (both regulators attached to the scuba diver's single tank).

Since the decompressed aquanaut must immediately be removed from the increased pressure to avoid speedy absorption of nitrogen and oxygen in solution in the now-more-receptive tissues and blood, the escort diver takes hold of the arm of the aquanaut and leads him directly to the surface, where the aquanaut climbs aboard the waiting boat amid the cheers of his compatriots and the filming of the event by the news media. And so the saturation dive ends, but the effects of the dive do not. The aquanaut cannot fly for 36 hours, nor can he scuba dive for at least 24 hours. Otherwise he's back to normal.

As a reflect upon it, no one in our Congressional aquanaut team smoked—no cigarettes, no cigars, no pipe, no tobacco. How fortunate! Smoking by one individual would have quickly polluted the air for the others in the close and confined quarters of the underwater habitat. Too, the terrifying possibility of a fire in the habitat when it is all but impossible to leave the underwater "home" to return to the surface is a sobering thought indeed. Of course, when divers are using mixed gases instead of air, for diving at greater depths, and there are tanks of oxygen in or connected to the underwater habitat, the danger of fire or explosion is all the greater. Perhaps the likelihood of fire in the habitat was not appreciable, but I personally felt safer knowing no one would be striking matches in the Hydro-Lab. As a matter of fact we found a book of matches when we first entered the habitat, and Bob Wicklund quickly threw them down the lockout trunk and into the sea.

One more reflection—Bob Wicklund, our mentor, guide, diving buddy, advisor, scientist, technician and friend was superb. In charge of the Perry Hydro-Lab, this quiet, capable, confident and unassuming man literally brought us back alive. He is an outstanding aquanaut and I blush at the thought of sharing with him such a cherished qualification and distinction. You see, by virtue of our unique underwater-world experience together, Bob Wicklund, Senator Lowell Weicker, Congressman Bill Alexander, and I have qualified to be officially designated as NOAA Aquanauts. Lowell and Bill are the first Members of Congress in history to be so designated.

And while I'm passing out accolades for exceptional services rendered, I am compelled to commend the excellent support services rendered on our behalf by Bob Wicklund's very capable associate and alter ego, Richard Clarke, of the Perry Foundation, Dr. Don Beaumariage, Director of NOAA's Manned Undersea Science & Technology (MUS&T) programs, Dr. Morgan Wells, also of NOAA's MUS&T Office, and Senator Weicker's able Congressional Assistant, Tim Keeney (a former Navy Underwater Demolition Team diver). These gentlemen all provided extraordinary support and dedicated service to our mission. They made numerous scuba diving trips down to the habitat area, brought in needed supplies or repair parts, took underwater pictures, and manned the monitor radio at the Hydro-Lab home base quarters at the facilities of the Underwater Explorers Society in Freeport. During the saturation phase, one or the other of these gentlemen on watch called by radio phone to check with us around the clock at least every two hours and, during the decompression phase, every half hour. We always called into the base headquarters when we departed on a scuba diving "excursion" and immediately notified them upon our return.



Mr. Pollock takes a moment off during the long saturation stay in Hydro-Lab to consult the new NOAA Diving Manual.

All of us are cognizant of the severe energy shortage for our nation and are aware of the critical need to find new energy sources through geophysical exploration and through scientific research and technological innovation. Thus, perhaps it was not altogether surprising that while I was down under I wondered whether it were possible to harness the enormous energy source potentially available through utilization of the pressure differentials in the ocean depths. There is almost one-half pound change in pressure for each additional foot of depth in the oceans which cover about 70% of the earth's surface; and with ocean depths varying from sea level down to beyond 30,000 feet, the energy supply would literally be inexhaustible for the use of mankind on this planet. Of course, finding the means to harness this energy is a fantastically difficult problem; but, then, the potential rewards for achieving success in this extraordinary venture boggle the mind.

In looking back upon the whole saturation dive experience, I feel quite fortunate to have been a mmber of the team, especially with such outstanding men. We were compatible and jovial, and intermittently exchanged good-natured jibes and kidding. Yet, Senator Weicker and Congressman Alexander were quite serious about this project and wholly dedicated to full and untiring participation. It was certainly an intensive learning process for them, and for me.

The Senator and the Congressman have been interested in the marine environment for most of their lives, but they are now true and dedicated ocean enthusiasts more than ever. At first hand, down in "Davy Jones' Locker" they have seen the living and nonliving treasures of the deep. Now, as never before, these discerning lawmakers are acutely aware of the enormous potential of the oceans, the monumental challenges mankind faces in transforming the marine resources into economic benefits, the desperate need to protect the great marine environment from pollution and other degradation, the obligation we have to all mankind for broadening our marine scientific and technological horizons and the critical requirement for substantially increased funding for the ocean programs of our Nation.

It's time for a critical crossover in coastal management

From Processes To People

BY MILTON SLOANE

A revolutionary concept in state planning is taking shape along the nation's coasts with the purpose of reducing increasing conflicts upon the seashores. For the first time, coastal states and territories are developing a master plan for logical shoreline growth and development. They hope to achieve a balanced sharing of the coasts by competing groups for industrial development (such as factories, power or waste treatment plants), commercial construction (harbors, hotels, beach homes), conservation, aquaculture, mineral mining, oil and gas drilling, swimming, boating, fishing, and other activities.

To do so, though, the state and territories —along with local governments—must make a number of critical decisions on the final plan design in the next two years; defining their coastal boundaries; identifying permissible land and water uses and state controls over them; designating areas of particular concern and priority uses; and determining the organizational network needed to implement the plan.

Technical help in making those decisions is given by NOAA's Office of Coastal Zone Management, which also provides financial aid to the states in the form of grants. Each state may receive three yearly grants to develop its plan—called a coastal zone management program—under the federal Coastal Zone Management Act of 1972. That Act also allows states to receive supplemental funds to implement their programs once they have been approved by the Secretary of Commerce. OCZM is charged with administering the Act in NOAA and coordinating state efforts in program development.

Most states and territories are close to the halfway point in developing their programs, having recently received second-year grants from OCZM, but a few, like Washington State, are nearing completion primarily because of early planning before the Act was passed.

Late last spring, OCZM sponsored a national conference to examine some of the major issues facing states as they formulate coastal management programs. More than 400 experts on marine affairs attended the conference held in a log-cabin park overlooking the ocean in Pacific Grove, California.

By the turn of the century, an estimated 80 percent of the nation's population will live within 50 miles of the seashore. Such a density of people will add a heavy burden to a coastal land mass already strapped by overpopulation, high-rise housing, beach home construction, and shrinking sewage treatment facilities. Achieving wise coastal land use is a job for state planners, coastal zone managers, and the general public.

Theme of the conference was "Coastal Zone Management: From Planning to Practice." Keynote speaker was John Biggs, director of the Department of Ecology for Washington State. Biggs outlined the basis for coastal zone management when he rhetorically asked: "What phenomena caused humans, after living in this world for thousands of years, to suddenly become concerned about the environment? To start to talk about it, and to talk about doing something about it?

"In my opinion there were three reasons. First of all, we have experienced a period of long and great affluence. One of the products of this affluence was the ability of ordinary people to educate their children in much better ways than they had been educated.

"As part of that learning, younger people learned to place some value on natural resources that their predecessors had not realized. They began to understand that the earth, the water, and the air were the things that gave life to all of us, and that these things were not limitless.

"The second is a part of our economic well-being: shorter work weeks, higher incomes. People have an opportunity for much more leisure time for recreational activity, and they turn to the outdoors as a way of using that time. And they began to place a value on a lake, a stream, a forest, a mountain that those before them had not realized."

The third reason, Biggs said, "was the so-called 'rights movement;' the right of people to speak out more openly for something that was of interest to them.

"All of a sudden the constraints that many people had felt about speaking out on the subject of human rights were removed, and a great many people felt the right to speak out in defense of the environment, to understand that the air and water were in the ownership of all society, and that society had a right to permit use of it, or to deny it, or to control it."

Turning to his own state for a moment, Biggs recalled Washington's experience in passing its Shorelands Management Act, perhaps one of the nation's broadest. He said that Washington's environmental laws were of long standing, but too often they

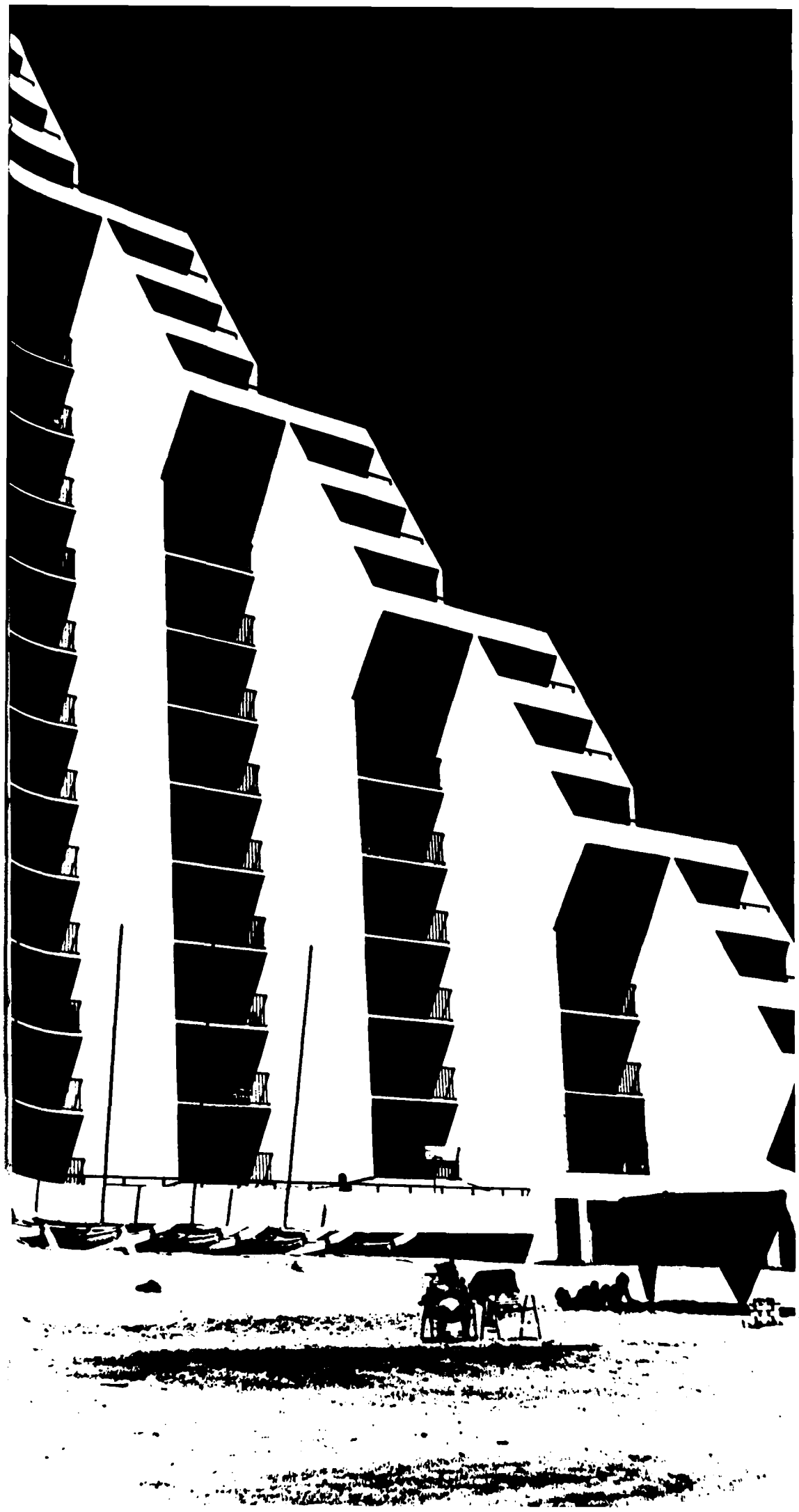


Photo: Joanne David

were separated, at times fragmented. Then, in the mid-60's, groups concerned about the environment formed the Washington Environmental Council and petitioned the legislature for stronger shorelands control.

"The proposal that the groups sponsored," Biggs remembered, "called for strong state control of the shorelines and a minimum of local control. The legislature responded with a bill of its own which was a balance between state and local control.

"It was interesting, and I think an environmental lesson, that 74 percent of the people in the state voted for one or the other of the acts, despite very strong opposition from vested interests" which felt that passage of either bill would encroach on their prerogatives, Biggs said.

The act which was passed provided that:

- a survey be made of all shorelines;
- the development of all streams and lakes over 20 acres in size, floodways, deltas, and wetlands would come under the purview of the Department of Ecology;
- the state have authority to control excessive actions under the act;
- local governments administer permits to use the shorelines, with the state having a right of appeal against those not conforming to regulations.

Biggs said that of more than 3,000 permits issued by local governments, only 180 have been taken before the appeals board, and only 60 of those have actually been contested. The remainder have been resolved by negotiation.

Biggs intimated he seriously doubts that a similar law could pass in Washington today because of constant criticism, but added that "there does not seem to be a tenor in the legislative process that would indicate we should do without it or substantially modify" the present law.

In closing, he urged coastal zone managers to solicit wide citizen participation in developing their programs, which he said contributed substantively to Washington's program success.

It seemed fitting that Biggs should keynote the third annual conference since on the opening day his state became the first to receive preliminary approval of its coastal management plan. In the Nation's Capital, Commerce Secretary Rogers C. B. Morton awarded the approval, recognizing that Washington had complied with most of the criteria for final approval, lacking only development of a network for implementing the program. Final approval is expected in early winter.

In remarks kicking off the conference, Robert W. Knecht, NOAA's Assistant Administrator for Coastal Zone Management, gave an overview of the first two years of coastal zone management and set a perspective in which to view the program today.

"The first year that we had a grants program, it amounted to about $8 million," he explained. "During the current year ending June 30, I think it will be $10-$11 million. We anticipate for the fiscal year that begins July 1, 1975, that we will have available

Photo: Friedrich Hoelzl

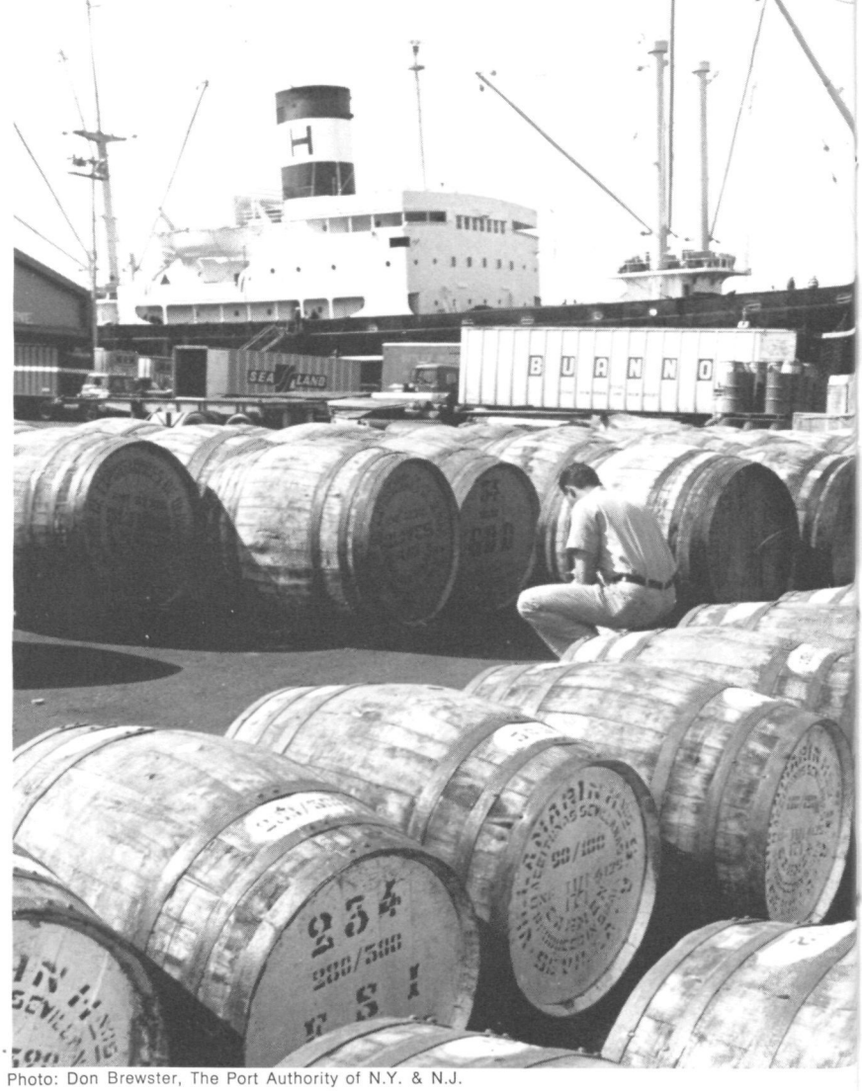


Photo: Don Brewster, The Port Authority of N.Y. & N.J.

An integral part of each state's coastal zone management program is considering the national interest in siting power plants, docks and harbors within the coastal boundary. A few states are considering developing deepwater ports to accommodate super tankers and to help meet local and regional energy needs.

between $18 million and $20 million in federal grants to assist states in various phases of the coastal zone program.

"While this could be called satisfying, it is by no means grounds for complacency. The hard work is still ahead."

Since the last conference in Charleston, South Carolina, Knecht said, no national land use legislation has passed, ("and I think months ago we would have predicted that"); the economy has been in a serious downturn—forcing states to re-examine their priorities; and accelerated offshore oil and gas drilling has produced a sharp federal-state conflict on a very visible issue.

"The problems that caused the program to be developed are, if anything, more pressing now than they were before. The emergence of the energy problems has driven home the point to at least 14 Atlantic coastal states and California and Alaska that effective coastal zone management programs in place are essential if these states are to cope successfully with the impacts of offshore oil and gas drilling on their coastal lands and water."

Plainly and simply, Knecht said, there is no alternative to coastal zone management on the immediate horizon. Having said that, he added, the time has come to move from processes to people.

At the state and national levels, he said, coastal zone managers are in danger of drowning in a sea of processes. The federal act, he noted, mandates processes to states, which lay down processes to local governments, which in turn, apply processes to the land developers.

"We are now at the point where the program needs to leave the back rooms of state planning offices" so that "we can start talking about the real problems of our coasts, the problems that the people we are serving are concerned about. Not in terms of holding federal feet to the federal consistency fire, but in terms of improving coastal water quality; reviving sports fishing; improving coastal recreational opportunities; and siting energy facilities.

"I think that the successful incorporation of energy facility siting into comprehensive coastal management programs will continue to be a major concern over the next year or two," Knecht said.

It was, in fact, destined to be the conference's major discussion topic. Dr. James S. Cross, vice president of the American Petroleum Institute, led off the discussion with remarks centered on the waste of time, money and environmental progress brought about by delays in developing offshore energy.

He declared that a national goal, and one that should have the highest priority, must be to scale down our dependence on foreign oil, as much and as quickly as possible. And there are only two ways to do it, he stressed.

One is to conserve energy and the other is to increase our domestic supply. "Every day that we delay development of offshore oil and gas means one more day of heavy dependence on costly foreign oil." And at today's prices, Cross added, the country will have paid out more than $600,000 for imported crude "in the 20 minutes I will be speaking here this morning."

Cross believes the biggest reason for the delay is the Santa Barbara oil spill of 1969, which killed a large number of birds and, for a while, left beautiful beaches coated with gunk.

"That oil spill has become the spearhead of opposition to further drilling anywhere off the coast of California and elsewhere" Cross said. "The Santa Barbara spill is recited as religiously and respectively by opponents of offshore drilling as a small child saying his nightly prayers.

"Less well known is the fact that every day 10 times as much oil is being safely produced offshore California than the total amount of oil spilled from the Santa Barbara accident."

Photo: Mobile Oil

Photo: Friedrich Hoelzl

Once a virgin territory, the coastal zone is now a hub for commercial industries vying for a finite strip of resources. Reducing soil erosion and planning for balanced sharing of the coasts among competing user groups is the keystone of effective coastal zone management programs.

He added that "concern for the environment is not the exclusive property of card-carrying conservationists. The petroleum industry is also deeply interested in improving the nation's environment, and we have backed up that concern with the commitment of billions of dollars.

"Between 1966 and 1973, petroleum companies invested more than $5.5 billion in air, water and land conservation" and "oil companies have made great strides in improving offshore exploration and production technology safety equipment and monitoring techniques."

Cross predicted that even if oil companies were permitted tomorrow to explore for energy on the Outer Continental Shelf, it still would be years before oil or gas would be actually produced, allowing enough time for coastal zone management plans to move forward.

Darius Gaskins of the Interior Department spoke on the controversial issue of separating oil exploration from development.

He explained that under the present system, oil companies which have been awarded leases to search for oil in federally owned waters (beyond the first three miles) also have the right to produce it and bring it ashore. The feeling now is to delay production until it is determined, first, how much oil and gas there is, what the environmental effects will be, and where to locate onshore pipelines and facilities. This would permit states to plan rationally for the onshore impacts.

Said Gaskins: "State and local communities are very upset by the notion that there is currently inadequate data for them to plan fully for the offshore impact of oil and gas. We don't know whether there are oil and gas out there or not. So it's literally impossible for us to provide specific information which will enable them to plan pipeline corridors and offshore facilities."

Pamela Baldwin agreed. A staff member of the Senate Commerce Committee, she said, "it is impossible to assess the likely onshore impact until the magnitude of the oil find is known. For this reason we should strongly endorse some mechanism for separation for exploration from production, and a full-scale review of development plans with an impact statement at that point."

Gaskins said the Interior Department is considering such a proposal, but cautioned that does not mean the problem is resolved. He urged those interested to think further about such matters as the data necessary for profitable offshore planning, a mechanism which can accommodate onshore and offshore developments, the role of the environmental impact statements, and compensation for affected oil companies if their production plans are not approved.

Ms. Baldwin recently co-authored a book with her husband on onshore planning, based on a study of Scotland's North Sea oil experiences and intended to provide insight to problems which could affect U.S. "frontier" areas.

Major conclusions from their study, she said, were that impacts seemed to occur in a bell curve pattern with a peak occurring during the development phase. They also concluded that the oil industry had created a labor shortage in other industries by being able to attract workers through higher pay.

In addition, she said, "we found that the population impacts have direct results in housing and supply. Aberdeen, Scotland (since oil development) is now the most expensive place in Britain to buy a house. Outside of London, the house and manor prices there have more than tripled since 1970."

Ms. Baldwin confirmed that major impact also comes from oil support industries, such as platform construction companies and firms that run the vessels to and from the offshore facilities.

Speaking of energy facilities, Barton House of the Federal Energy Administration said "the problem in developing energy

Photo: Harold M. Goodman

Photo: Friedrich Hoelzl

Clusters of private beach homes and cottages dotting the coastal landscape have helped to create limited access to the shore for surging public recreational pursuits.

facilities is somewhat like: 'Lord, give me chastity—but not just yet!' Everyone wants, even demands, energy, but many won't let the producer move into their neighborhood."

House outlined for the conferees the Energy Facilities Planning and Development Act of 1975, a bill to solve short- and long-term problems.

He explained that the act is "compatible with and complements coastal zone management and will be a source of both data and analyses that can assist ongoing program planning in the coastal zones."

As House outlined it, the bill in draft form contains similar features of the Coastal Zone Management Act in that it:

- encourages states to develop an energy facilities siting program,
- allows states to determine program specifics,
- provides matching grants to states of two-thirds federal, one-third state funds,
- gives states authority for reviewing and approving applications,
- ensures public participation in the planning process.

Said Barbara Heller of the Environmental Policy Center: "It's absurd to ask states to plan for development when they have no idea of the amount of oil off their coasts and its impact on existing resources.

"A baseline of information should be developed to assist in decision-making to determine whether, in some areas, the value of other resources is so great that perhaps development shouldn't occur at the present time."

She complained that states have not been adequately involved in making energy decisions and that pending amendments to the CZM Act "talk a lot about state involvement, but do very little. There is no provision for a state to object to all or part of a leasing proposal or a development plan which results, and no assurance that if a state does object, its objections will be heeded."

Ms. Heller emphasized that she is not suggesting a state veto, but creation of a system which "could prevent rather than cause delays in production."

About the "separation" issue, Michael McCloskey, executive director of the Sierra Club, said: "I think we are confronted here with something of a Catch 22 situation. If the exploration yields little prospect of successfully developing the oil, of course they (the oil companies) won't go forward and the question is moot about cancelling the development.

"But, if they come with findings that suggest there is a major field," does anyone seriously believe that at that point the government would ever cancel such a sale, he asked skeptically.

Panel chairman Matthew Connolly of the Massachusetts CZM program concluded the energy talks with the fervent hope that "coastal zone management does not get derailed in states which are to be impacted by OCS development. We should not forget about the other pressing matters that coastal zone management provides us with —an enormous tool to manage better for future generations."

One of the "other matters" Connolly may have had in mind was more local government involvement in state management programs. The pervading feeling of the conference was that without positive local contributions, the chance for successful pro-

grams are markedly reduced.

San Diego Mayor Pete Wilson told the audience that "local governments must be involved in coastal zone management. I think that when we speak of coastal zone management that the involvement of local governments is, in fact, basic."

There must be a role, he said, where basic responsibility must be directed to local governments for planning and making decisions, and that any attempt to change those decisions "should be exercised with the greatest care."

Mayor Wilson recalled that as a state lawmaker, "I introduced what was to be the first legislation on coastal zone management" in California. "At that time, there existed a difference of opinion between those concerned with coastal development as to what the role of cities and counties should be. There were those representing environmental interests, whose distrust of both the competence and conviction of local government was so great that the last thing they wanted was any significant role for local government in coastal zone management."

That was in 1970, he recounted, but since then California has established a statewide coastal commission and six regional bodies to prepare for submission to the legislature a comprehensive coastal zone plan.

"What we have seen in the interval has been a very healthy process, where local government has come to have some very definite feelings about what should be its role in coastal zone management, "Mayor Wilson explained. "I hope local government is given the chance, because that is an absolute necessity."

By week's end, conference-goers had heard pertinent comments on other issues that states should consider in developing coastal zone plans; issues such as related federal program on land management, natural disaster areas, socio-economic effects of coastal zone management, recreational use of the coastlines, interstate coordination, legal issues facing coastal management, pending Congressional legislation, other state approaches to CZM, and finally, the role of citizens in shoreline planning.

At the same time of the coastal zone conference, OCZM was host to two workshops sponsored by its sister agency, the National Sea Grant Program. Sea Grant Lawyers held their annual meeting simultaneously with the CZM conference, while the NOAA Marine Advisory Service met to discuss public participation in state coastal management programs.

Knecht adjourned the conference by noting that "while energy-related pressures may be an awesome function for coastal management, it by no means will be the whole story."

If, as expected, the U.S. adopts a 200-mile economic zone, he said, "greater attention will be paid to management of the fisheries and marine minerals, of sand and gravel and oil in this vast area, with the corresponding increase in pressures on the adjacent coastal area."

Knecht said that "the lemming-like migration to the shores for recreation will very likely accelerate" and force coastal zone planners to become more water oriented.

"The onshore aspects of our work must be seen to be only a beginning. I believe that state planners will soon have to join hands with their marine counterparts and get their feet wet in the water dimension of coastal zone management."

No matter how states decide to use their coasts, it's evident that through the Coastal Zone Management Program, they will at least have given their decisions very serious thought.

A Woman Tackles the Weather

Huge spinning tops are just the beginning

BY VALERIE ANDERSON

Spinning like huge invisible tops beneath the surface of the oceans are mysterious eddies. These transient creatures, their origins, behavior, and effects have intrigued and baffled navigators and scientists since their discovery in 1940 by renowned oceanographer Columbus Iselin in the West Sargasso Sea.

They also baffled Diane Moravek, a Meteorological Intern at the National Weather Service's Oceanographic Office located at Headquarters in Silver Spring, Maryland. The 5′3″, 25-year-old blonde recently returned from a three-week experiment studying eddy circulation in the Gulf Stream, a warm ocean current in the North Atlantic Ocean that flows out of the Gulf of Mexico.

Diane was the only NOAA representative on the study, which was conducted under the auspices of the U.S. Naval Oceanographic Office. Two other women—from Cape Fear Institute, Wilmington, N.C.—were also members of the four-person party that departed Norfolk, Virginia, aboard the USNS Lynch. Oceanographic aircraft were also used in the experiment.

The objectives of the study were to locate and map eddies, and test their acoustic properties—as well as those of surrounding waters. Diane stood watch with other scientists taking expendable bathythermographs (XBT) and water samples. Her work aboard ship contributed to the preparation of an article on the voyage's findings for "gulfstream," a new NWS publication, of which she is editor, formerly published by the Naval Oceanographic Office.

Diane attended the cruise hoping to gain some knowledge about her job:

"I am in the oceanography department and I think it's good to get first-hand experience. When you're in a job like this, you see the papers go by but you don't really understand what's happening unless you also get out and do experiments in the field."

Locating the eddies from satellite pictures, the group of scientists used expendable bathythermographs to measure salinity and temperature and depth. Working the 8 p.m. to 4 a.m. watch, she assisted in lowering and launching the XBT into the water. She explained, "inside there is a recording device that measures temperature and depth. The salinity instrument was keyed into a computer that printed out the depth, salinity and temperatures of the water."

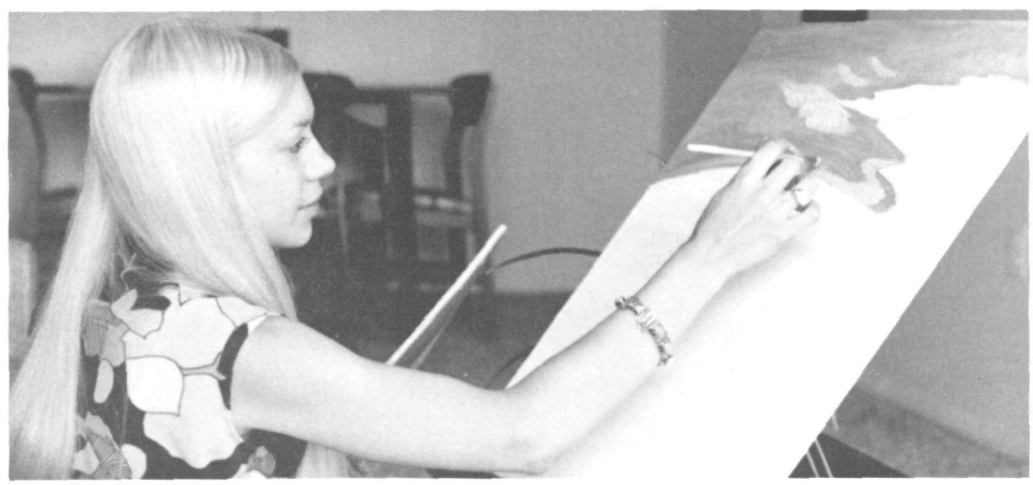


Photo: Harold M. Goodman

During these experiments, Diane and the other scientists aboard the Lynch experienced rough seas with swells up to 25 feet. Diane, frightened at first, enjoyed the ride:

"It was exciting and fun, like being on an amusement ride—continuously. You sit at the table to eat and hold on with one hand and eat with the other. You can tell immediately before the ship is going to roll, so you can grab onto your coffee cup and hang on."

How did Diane get into this situation? She says her stepfather, who was a forecaster in the Air Force during the war and is still very interested in meteorology, first interested her in the subject.

"I was ready to graduate with my BS in math and I felt like I was prepared for anything. So he said 'why don't you try meteorology' and I said 'why not!' Since then I've really liked it."

A native of Warren, Pennsylvania, she attended Penn State University and obtained her masters degree in Meteorology. She was a member of the University Honor Society and the Math Honor Society. She speaks Russian and has been interested in computer programming. She likes to golf and ski when she gets the chance.

Hoping to break the tradition that only men go to sea, Diane considers herself a career woman and somewhat a woman's libber. Working in a male-dominated field—"up until now" Diane hastens to add—she finds being a woman has its advantages.

"I don't think women should be pampered or given special privileges just because they are women. Unfortunately, they sometimes are. But I don't ask for it. Men are just used to treating you that way."

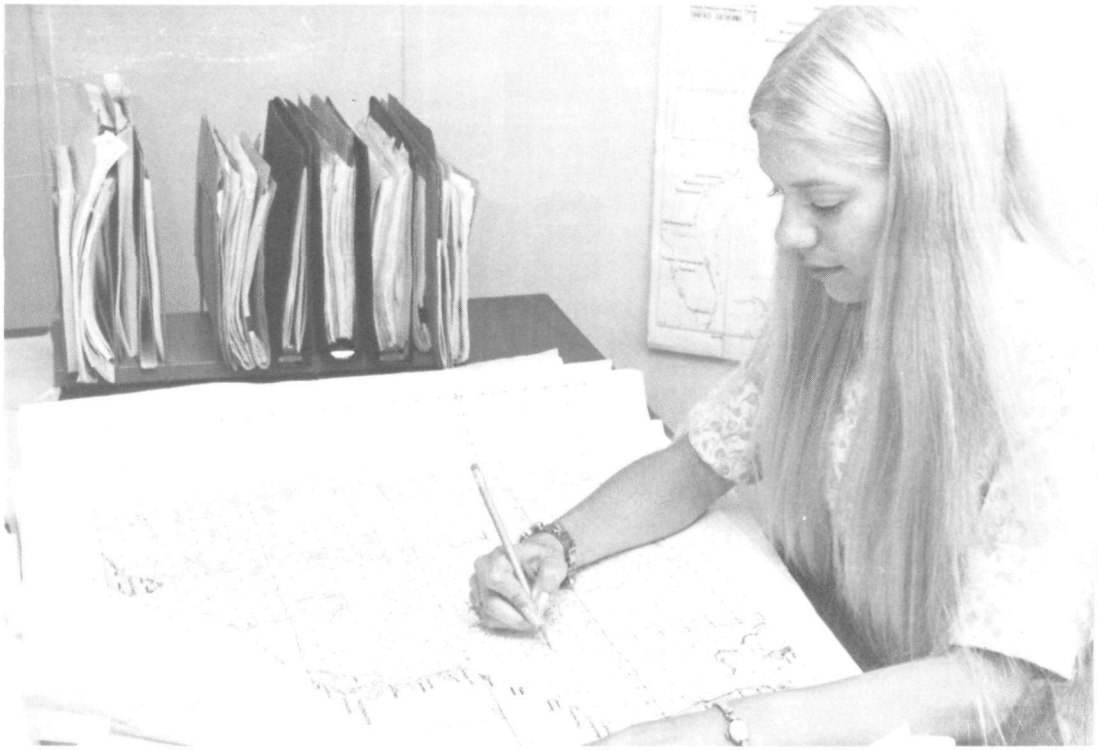
She hopes to enter a forecast office as soon as she can. She feels she needs the training that can be obtained only in the field.

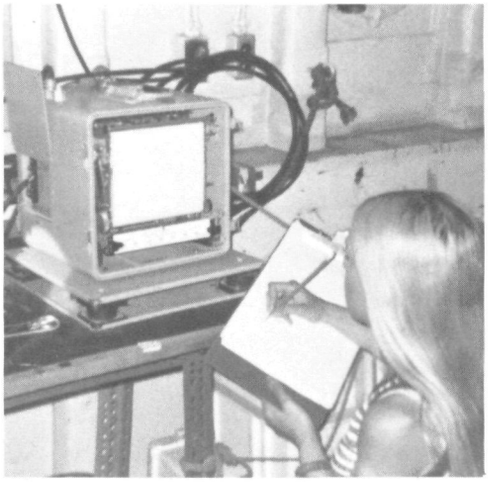
"Its not like sitting in Headquarters and pushing papers. If you're interested in meteorology or oceanography, it is best to get out where it's all happening."

From here, Diane will enter a forecast office until she completes her internship, which generally takes three years. She then hopes to become an assistant forecaster with the goal of some day becoming a Lead Forecaster.

Dr. Glenn Flittner, Chief, Ocean Services Division, National Weather Service, says Diane is quiet, unassuming, and committed to her career. He feels she "will be a welcome addition to any forecast office."

Diane feels this experiment has been important to her career. But . . . she's only just begun.





Photos: Harold M. Goodman

Diane on and off duty displays a remarkable diversity in taste and talent; (far left) she enjoys painting in her spare time; (upper left) Diane loads an expendable bathythermograph to be lowered into the water to record temperature and depth; (upper right) she plots the Gulfstream on a wall position chart to be used in "gulfstream," of which she is editor; (center) she logs information from the bathythermograph; (above) on her way to a game of golf; and (left) relaxing at home with her needlepoint.

NOAA scientists seek

Elusive Ingredients in the Stratospheric Storehouse

BY JOAN VANDIVER FRISCH

While cauliflower clouds and azure sky formed a backdrop over the hot dry plains of Wyoming this past summer, a group of scientists from NOAA's Environmental Research Laboratories were busily preparing an unusual instrument package for its maiden balloon voyage—a search for extremely low concentration gases in the stratosphere's storehouse.

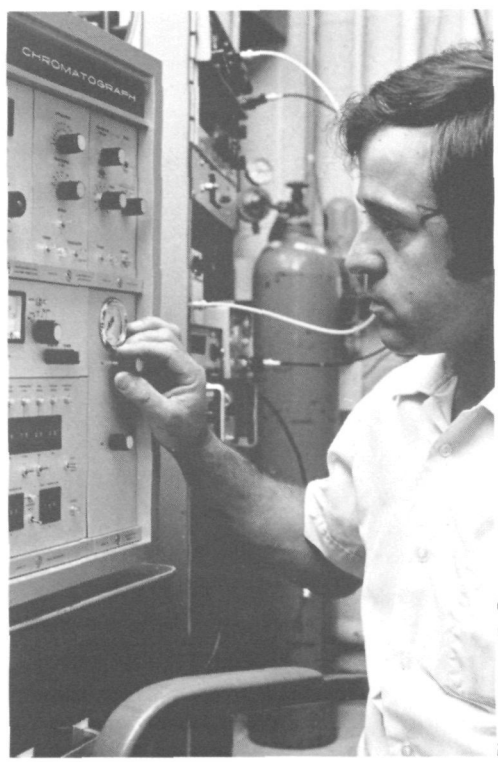
The research experiment was designed to gain better knowledge of the minute concentrations of certain trace gases in this quiet, almost weatherless region of the atmosphere—an essential factor in understanding the earth's ozone balance.

"The thin stratospheric ozone layer provides us life-saving protection from the sun's most harmful ultraviolet rays," says Dr. Arthur L. Schmeltekopf, leader of the Aeronomy Laboratory's stratospheric sampling program. "Since scientists now postulate that photochemical processes involving chlorofluoromethanes—commonly used in aerosol sprays and refrigerants—nitrous oxide, and other trace gases, may result in a significant ozone loss, there has been widespread interest in the question. But stratospheric concentration measurements of trace gases are very limited."

Scientists need much more information on the distribution of chlorofluoromethanes and other trace gases at all levels in the atmosphere—from release point at the earth's surface, through the troposphere where gases are mixed both vertically and horizontally, up to the stratosphere where very little vertical mixing takes place, and the gases may be stored in layers for years.

Any gas which is either too inert to react in the troposphere—the region of winds and storms which exists directly above the earth—or too insoluble to fall out in rain gradually diffuses upward into the stratosphere where it can contribute to any chemical changes taking place there. Chemical compounds dispersed by aerosol sprays and refrigerants and nitrous oxide can take as long as 10 years to reach the stratosphere. At that altitude the sun's ultraviolet radiation decomposes these compounds and the resulting chemical constituents then react with the ozone.

"Chemical processes differ at various altitudes," Schmeltekopf explains. "The altitude profiles of these trace compounds from the troposphere into the stratosphere are critically important as a validity test for our present understanding of the ozone loss processes. Because consideration is now being given to regulating chlorofluoromethane releases in aerosol sprays, the research is somewhat urgent."



Photos: Harry D. Covey

Dr. Paul Goldan adjusts the input flow of purified nitrogen to the gas chromatograph used in the ERL air sampling program.

Since remote sensing techniques have not been developed for sampling all atmospheric gases, the NOAA scientists were faced with developing the equipment for "trapping" trace gases by the only inexpensive method possible—flying balloons directly into the stratosphere.

Schmeltekopf and colleagues used metal sampling flasks, made from ordinary kitchen mixing bowls which were attached to large helium-filled weather balloons in their initial gas sampling research experiments over Wyoming during the early part of the summer, obtaining stratospheric air samples at 58,000 feet (18 kilometers), 72,000 feet (22 kilometers) and 85,000 feet (26 kilometers). The metal sampling flasks were connected to a mini-computer which continually sensed the altitude and condition of the weather balloons and controlled the opening and closing of each flask's valve for one 15-second interval, allowing the stratospheric sampling to take place.

A single-engine aircraft, equipped with a radio "tune-in" to the electronic beeps emitted by the instrument package, tracked the flasks and enabled the NOAA scientist to recover the samples after the instruments performed their crucial duties.

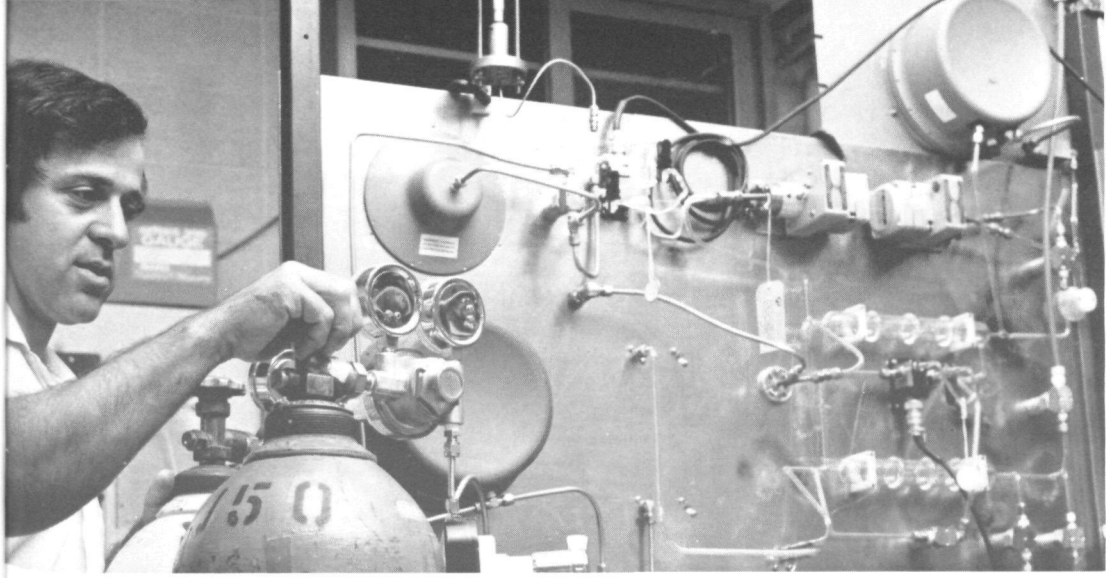
To supplement the data returned by the stratospheric experiment, the Aeronomy Laboratory scientists must also test the atmosphere at lower regions.

"We plan to take samples at ground level as part of the research experiment to determine the amount of chlorinated gases and nitrous oxide being injected into the stratosphere," Schmeltekopf says. "For example, chemical fertilizers are now thought to be a possible source of nitrous oxide which will eventually reach the stratosphere where it could weaken the ozone layer, but few tests have been made yet."

While soil produces a certain amount of nitrous oxide from bacterial action, chemical fertilizers containing nitrogen enable the soil to produce much more. Dr. Michael McElroy of Harvard University has estimated that 20 percent of all nitrous oxide produced today is from chemical fertilizers.

"Theoreticians have found no grounds to reject the theory that chemical fertilizers cause nitrous oxide to be injected into the stratosphere," Schmeltekopf says. "If agriculturally producing countries continue increasing the use of chemical fertilizers, they increase the production of nitrous oxide, and according to McElroy's theory, reduce the ozone layer in the stratosphere."

At the same time, the NOAA scientists need to know whether chemical fertilizers significantly alter the rate at which nitrous oxide is produced naturally. To accomplish this task Schmeltekopf and his colleagues want to obtain atmospheric samples over



Dr. Goldan starts dicholoromethane to a mixing machine which makes gas samples used to calibrate the detection system (top). Jerry Harder (left) views a chromatogram used in measuring atmospheric trace constituents. Dr. Arthur D. Schmeltekopf (above) inspects the sampling spheres (made from ordinary stainless steel mixing bowls) used to collect trace gases in the stratosphere.

regions not normally under agricultural production, land using manmade chemical fertilizers, and soil using organic fertilizers.

"We are capable of doing dramatic things to the atmosphere, so we must look more carefully at the possible effects," Schmeltekopf says. "When we obtain accurate values for how much chlorofluoromethane and nitrous oxide have been released at the earth's surface in the past, and accurate measurements of how much reaches the stratosphere, we have the opportunity to test the calculations and from these tests gain the confidence to predict what the release of other compounds will do to the stratosphere."

By comparing the computerized model of the amount of chlorofluoromethane which should be in the stratosphere at this time—derived from industrial release rate histories over the past 25 years—with actual trace gas amounts brought back by the Wyoming experiment sampling program, Schmeltekopf and his colleagues have found that the mathematical model agrees very closely with the actual amounts found at present.

"One of the real problems is that we are looking for almost inconceivably small amounts of trace gases," explains Dr. Paul D. Goldan, who is is charge of the Aeronomy Laboratory's analysis of the trace gases. "It's akin to searching for a single fish in the entire ocean."

Goldan has improved a very sensitive measurement technique for determining parts per trillion from the trace gas samples. He also has developed a double dynamic dilution technique to calibrate the gas chromatograph, the instrument used for making such sensitive measurements. So far Golden has perfected techniques for measuring trichlorofluoromethane, dichlorodifluoromethane, nitrous oxide, and methyl chloride, as well as other compounds which are possible atmospheric constituents.

"The double dynamic dilution technique can be used to provide calibrated gas samples for any research laboratory making similar measurements," he says. "The difficulty in providing such samples is that any surfaces coming in contact with the gas may interfere with the calibration."

Before the chromatograph can separate the different gas constituents in a mixture introduced into the instrument, it must undergo an intricate series of cleaning procedures which collectively take almost a week.

"The cleanliness necessary for identifying these trace gases makes a surgical room in a hospital seem filthy in comparison," Goldan says.

The trace gas detector must first go through a process of electro-polishing in which an electric current is passed through an acid solution containing the instrument. Afterwards the detector is washed in a series of very high purity reagents and baked in a vacuum oven at extremely low pressure—on the order of a billionth of an atmosphere—to drive off any remaining material stuck to the surfaces. The detector is then put into operation in the chromatograph and an ultra high purity gas is passed through the instrument for several days before the detector is operable.

When the detector has been thoroughly cleansed and put into operation in the chromatograph, an atmospheric sample containing an unknown mixture of gases is injected into a stainless steel column of tubing, packed with a special sterile sand-like material, and pushed through the column by pure nitrogen. The various gas constituents come out the other end of the steel tubing at different intervals of time and can be identified by their arrival time at the other end of the column.

For example, a gas mixture pushed through the column may contain oxygen, nitrogen, water vapor, and carbon dioxide—the normal constituents of air—and some undesirables such as chloroform, chlorofluoromethanes, and carbon tetrachloride.

"We have to guard very carefully against contamination during the actual sampling process and in the laboratory if we are to obtain a true representation of what exists in the stratosphere," Golden explains. "For example, the balloon itself may be a significant source of contamination.

"One of the ways to avoid unnecessary problems is to take trace gas samples only as the flasks are descending in flight so that no contaminants are picked up in the wake of the balloon's ascent. And we must avoid carrying our own sources of contamination when preparing the flasks for sampling. Styrofoam canot be used as a packing material because it is inflated with chlorofluoromethanes. Teflon instrument parts also exude chlorofluoromethanes and other compounds. And numerous other plastics are potential sources of problems."

When the NOAA scientists complete the necessary preliminary tests and calibrations, the Aeronomy Laboratory research may help answer some of the serious questions about the future impact of trace gases now released in Planet Earth's atmosphere.

QUICK FREEZE
FROZEN SEAFOOD

From codfish boats to computer rooms

Numbers, Numbers Everywhere

BY GERALD D. HILL, JR.

The National Marine Fisheries Service's Statistics and Market News Division operates the largest and most extensive fishery data service in the world.

This is a distinction earned over nearly a century.

In the northeastern United States NMFS reporting specialists conduct "sea sampling" trips to collect some of the voluminous data the division needs to provide authorative information on fisheries and fishery products.

This sampling is done by going to sea on the fishing boats and gathering special and routine data as the fish are caught. This is done about twice a quarter, year-round, to provide detailed data to the Northeast Fisheries Center on total removal of stocks and biological assessment work.

"These trips really give you a taste of the life of a New England fisherman," says Jack Mahoney. Mahoney, a reporting specialist who works out of Gloucester, Mass., has been gathering statistics for over 22 years.

"When you go out you become just like one of the crew," he says.

On a typical trip the fishermen will work about 12 hours a day. The trawl is out for two to three hours and then brought abroad.

"While the trawl is out, time may hang heavy. Most of the fishermen in this area are of Norwegian, Portuguese, or Italian descent and a lot of them speak those languages. If you get with a crew like this, then you really have a long trip because you don't have anyone to talk to."

"A lot of the fishing grounds are in the main shipping lanes between the U.S. and Europe," says Mahoney, "and often it gets very foggy out there. It's a strange feeling to be sitting out there in the fog with the fog horn bleating and know that there is a possibility a large ship may be heading your way. It really gets scary sometimes."

When the trawl is brought aboard, the fish are dumped on the deck and the sorting process begins. "You see almost everything when they dump those trawls," Mahoney says. "Sharks, skates, shellfish, and almost any kind of finfish you can imagine. Sometimes there will be as much as two tons of fish on the deck."

As the fish are sorted, those of value are separated by species and placed in the hold of the ship, and the rest are thrown over the side. "This is really the best means of getting data because you really know what is being caught and what is being discarded," says Mahoney.

"Most of the fishermen don't mind taking you with them," he says, "but they don't like it when you get seasick. Most of our people don't get sick, but some do and have tried all kinds of things to avoid it. One fellow I know heard that eating popcorn would prevent seasickness, so on his next trip he loaded up with popcorn. It didn't help."

"Sea sampling is really good for both the fishermen and our own people," says Mahoney. "From our standpoint it gives us an insight into what their life is like. We see what their problems are and can really appreciate the work of the fishermen. It helps us do our job better, too, because the fishermen can see what we do and have a better understanding and appreciation of our job and realize that we are working to help them."

Mahoney's enthusiasm for his work is shared by a number of other statisticians for the NMFS whose job is to provide the answers to some difficult, but economically vital questions.

What is the most valuable fishery in the United States? How many people are employed as fishermen in the United States? How much catfish is produced in ponds in the United States? How many saltwater recreational fishermen are there in the United States? What was the amount of tariff duties collected on U.S. imports of fishery products in 1974?

"These are some of the many questions we get from private citizens, students, industry, members of Congress, and from other government agencies," said Dr. Hoyt Wheeland, Chief, Statistics and Market News Division which is responsible for statistics on fisheries and fish products as well as fishery market news reports. "Never before has public interest been so focused on marine activities and the statistics and information that we gather on these activities."

The National Marine Fisheries Service supplies the general public, industry, and government the information needed to make policy and decisions in the management of fishery resources and the production and marketing of fishery products. It also provides the basis for responding to international treaty requirements. Biologists, economists, technicians, and others in the Service conducting market research or working in such areas as market analysis or fisheries management depend on the information gathered by the division.

A recent survey of users' needs for commercial fishery statistics and market information revealed that users in the "management decision" group had the greatest subscription rate among the different primary use categories.

International fishery management organizations are among the primary users of fisheries data in determining catch limits and enforcing treaty provisions among participating nations. Members of 20 international fisheries agreements or commissions are currently using U.S. fisheries data. The mailing list for the statistical bulletins includes educational institutions, libraries, and special commissions in addition to fishermen, processors, wholesalers, and Federal and State Government officials.

More than 300 monthly and annual statistical reports are published each year. Directories of processors and dealers of fishery products and the principal species handled are also published for each State having a commercial fishery.

Most of the statisticians who work in the Statistics and Market News Division are in the major fishing ports of the United States —46 offices in all, each staffed by one to three people. They interview fishermen and fishing craft owners, talk to fish and shellfish dealers, and obtain data from the records of wholesalers, processors, fishermen, and others. Cooperation by fishermen, wholesalers, and others is voluntary, usually given without question, because the statistics they gather are vital to the economic health of the people who provide the data.

"There are, for example, about 4,000 fish processing and wholesaling firms," said Dr. Wheeland. "Those firms, in turn, get from our compilations information that is very important to their own decision-making

Fishery Reporting Specialist Ken Harris (with sunglasses) collects information from Paul Bierman of the Sea Bird Fish and Oyster Co. of Beaufort, N.C. Harris' rounds take him past picturesque shrimp trawlers at the busy North Carolina fishing port.

—what to buy and how much to pay, what the market trends are likely to be, and how much to charge for their products."

The information sought by NMFS statisticians is incredibly detailed. They want to know how much fish and shellfish was landed by commercial fishermen, how much it was worth, what part of the ocean it came from, and what kind of gear was used to catch it. They want to know how much of each species was caught. They ask about prices, both exvessel (how much the fisherman was paid for his catch) and wholesale. They are interested in the quantity of production of processed fishery products, employment on fishing craft, and employment levels in the wholesale and processing industries. They want to know how many boats took part and information.

Back in Washington, D.C., the division headquarters obtains data from the Bureau of the Census on the volume and value of fishery imports and exports, and one a month it canvasses some 300 freezing and cold storage companies for their holdings.

Collecting data and information from fishermen is quite a job and requires many miles of travel. O. H. Farley, supervisor of four agents on the Gulf coast, estimates each of his agents spends three and one-half days per week on the docks and contacts up to 15 fishermen and wholesale buyers three to four times each week. In a year's time, Farley estimates, each agent will talk to 2,000 to 3,000 people, board 500-600 vessels, and travel 20,000 miles.

"The Northeast Region has an extensive program," says Frank Riley, Chief of the Statistics and Market News Division in the Northeast Region at Gloucester, Massachusetts. "Last May almost 2,400 trips were made by the fishermen in this region, and we were involved in interviews and/or sampling with almost 63% of them. This not only involves talking to fishermen, packers, and wholesalers, but it involves taking biological samples as well.

"We not only work very closely with our own groups within the region," he continued, "but we are very active and work day to day with the Canadians on their quotas for areas in ICNAF by making reports and obtaining samples. We also do extensive work on the Atlantic bluefin tune for the Miami lab, and on the menhaden for our Beaufort, N.C., lab."

"To this vast amount of information, we are now adding long-needed statistics on marine recreational fishing," according to Wheeland. "We are in the initial stages of developing a program to collect statistical information on catch and effort in the marine recreational fisheries on an annual basis." Before October 1970 recreational fish statistics were collected on a national basis only every five years.

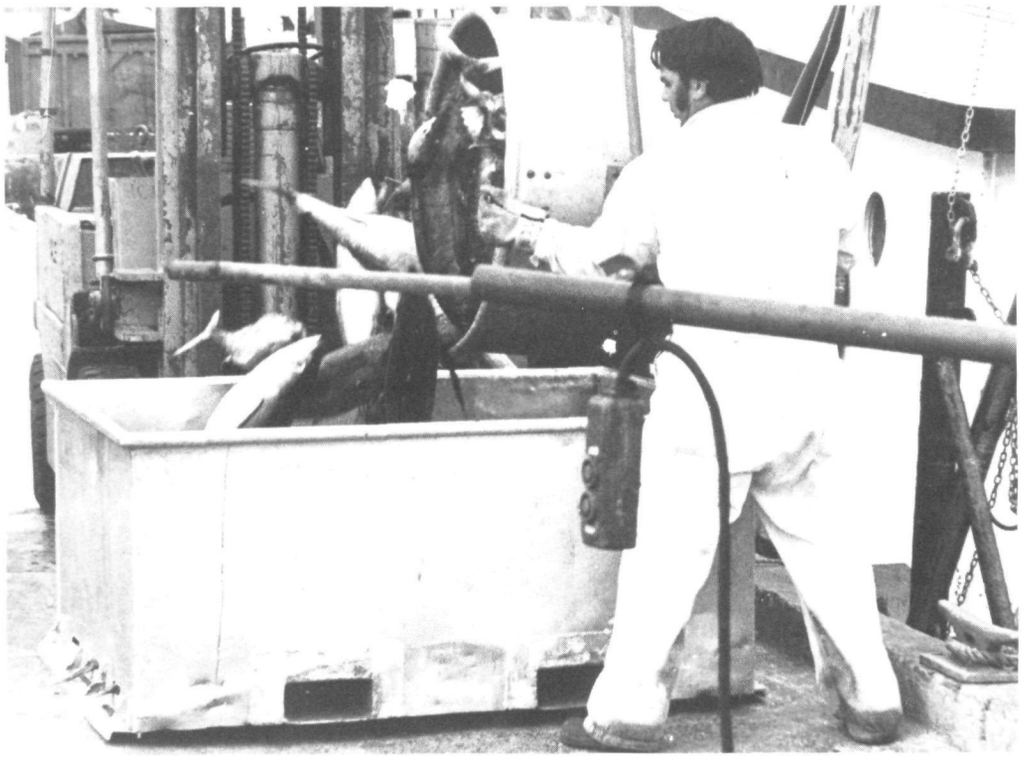
The Federal responsibility for marine sport fisheries was transferred from the Department of the Interior in 1970 to the National Marine Fisheries Service when this agency was created within the Department of Commerce. Saltwater angling has grown rapidly. The number of saltwater anglers has more than doubled in 15 years, with more than nine million fishing in 1970.

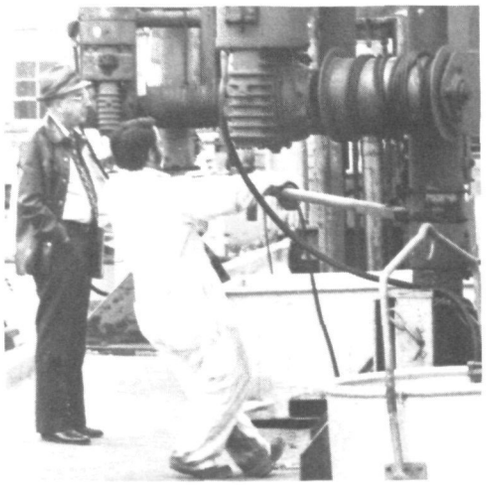
Until recent years, the commercial fisheries accounted for the greatest part of the total marine finfish catch in the United States. However, most species of fish which occur in inshore and estuarine areas are presently taken by both recreational and commercial fishermen. Catch and effort statistics of the marine recreational fisheries are presently needed to provide total fisheries harvest, to determine that portion of the resource taken by commercial and that portion by recreational elements, to aid in determining allocation of fishery resources.

The collection of statistics for the marine recreational fishery has been attempted only in recent years, primarily because of the complexities of collecting such statistics. Anglers are dispersed all along the coast, fishing from boats, piers, jetties, docks, and shore. They may fish day or night, many days a week throughout the year. The few coastal States that occasionally collect catch statistics have used a variety of methods and most surveys have been incomplete. Only the Pacific States collect data on a continuous basis, although information for only part of their marine sport fisheries is collected.

Last year a pilot survey was taken of almost 11 million people in 13 northeastern States and the District of Columbia. This was a combination telephone and mail survey conducted by a private company under contract to NMFS and included the District of Columbia, Connecticut, Delaware, Maine, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont, Virginia, and West Virginia. The 10,856,000 people surveyed represented 4,986,000 households, or a little more than two people per household surveyed.

Information gathered by the telephone survey is available in an NMFS publication, "Participation in Marine Recreational Fish-





Photos: Barbara Jones

Ellis A. Nickson, a Supervisory Fishery Market News Reporter in the NMFS' Northwest Region, covers the Seattle, Wash., waterfront gathering statistics to be used in the Market News Reports so valuable to processors, wholesalers, and the fishermen themselves. In the series above, Nickson watches dockside salmon and tuna unloading operations and waits to question workmen on details of the catch, and visits a retail fish market to check on yet another step on the catch's journey from ocean to dinner table.

Ted Flowers, a Fishery Reporting Specialist in the NMFS Statistics and Market News Division's office at Port Tampa, Fla., at his desk (above) and showing fellow employees John Hinman and Janice Cousins a local shrimp boat (far right). The voice with a smile in Beaufort, N.C., is Diane Natale who telephones daily commercial fishing reports to local radio stations.

ing Northeastern United States 1973-74." The results of the mail questionnaire, parts of which will be available in the fall of 1975, will include information on how many and what kinds of fish and shellfish were caught and how much time and money was spent for saltwater recreational activities.

A similar telephone and mail survey is now being conducted in the southeastern United States and will eventually include the Gulf and west coast States.

The collection of these marine recreational statistics is the most recent development in a relatively long history of the Statistics and Market News Division.

Statistics on the commercial fisheries of the United States were first collected by the Federal Government in 1879. In 1880, as part of the Tenth Census, an investigation of the United States fisheries was undertaken by the U.S. National Museum with the cooperation of the U.S. Commissioner of Fisheries and the U.S. Bureau of the Census. The first complete statistical canvass of the entire United States commercial fishing industry was made in 1908 by the U.S. Bureau of the Census. Others were made by the former Bureau of Fisheries and the Fish and Wildlife Service for the years 1931, 1950, 1954-60, and for each year since 1962. General surveys of varying degrees of completeness for a number of States of limited areas of the United States were made for various years since 1880.

A cooperative agreement between the Department of Tidewater Fisheries of the State of Maryland and the U.S. Department of the Interior in 1942 was the first of a series of State-Federal cooperative agreements in fishery statistics. By 1961, monthly landings bulletins were being published for 15 States through this same cooperation. In addition to working with the States, advice on fishery statistics is obtained from the Atlantic States Marine Fisheries Commission, the Gulf States Marine Fisheries Commission, the Pacific Marine Fisheries Commission, and from industry groups such as the Statistics Committee of the National Fisheries Institute.

"State-Federal cooperation has always been one of the cornerstones in the collection and tabulation of fishery data," said Wheeland. "Creating a stronger State-Federal relationship in the collection of statistics is paramount to broadening and improving the fishery statistics program," he said.

"All data collected by NMFS is on a voluntary basis. Thus, it is evident that the success of the statistics collection program and the completeness and timeliness of the market information depends entirely upon the cooperation of all participants contacted."

A review of the statistics and market news program over the past 50 years reveals a tremendous change in data handling methods from hand tabulation and summarizing without machines, progressing to key-sort cards, then to machine tabulation with punch cards, and later to third generation computers. Currently, the data received on forms from the field offices are key punched and stored on magnetic tape or disc file for archiving and preparation of summary reports.

The major categories of data processed are: monthly shrimp catch statistics, monthly fish and shellfish catch statistics for 16 States, annual catch statistics for all States, anual fishing effort information data on fishing vessels, amount of fishery products processed annually, holdings of frozen fishery products, and import information. Computer programs, varying in completeness from simple listings of data to programs that produce a copy for photo reproduction and printing, have been written and are in use.

Market information on fisheries products was first collected in 1937 when the fishery market news service office was opened in New York City. In 1938, additional offices were opened in several major cities across the United States.

The market information is published in fishery market news reports which contain information on landings; exvessel and wholesale prices; imports; holdings of fishery

"Getting Better All The Time"

Madeline Bailey questions Edwin Price, skipper of the shrimp boat Madame Blackie, out of Sabine Pass, Tex.

"I like what I'm doing and my job is getting better all the time," says Madeline Bailey, Fishery Reporting Specialist in Port Arthur, Texas.

Madeline is a pert, 23-year-old, 5'1" redhead, who collects fishery statistical information for the National Marine Fisheries Service in the major fishing ports from Port Arthur, Texas, to Cameron, Louisiana.

Her job is to go down to the docks when the fish boats come in and interview the skippers or the crew to determine what they caught, where they caught it, and what kind of gear they were using.

"I was a little nervous when I first started this job about two months ago," said Madeline, "but I soon found out the guys don't mind talking to me at all. Everyone is real nice and real polite to me.

"I soon realized, too, that a lot of the people were hesitant in talking to a government representative until I took the time to explain to them what my job was and what was done with the information that I got from them. After that I didn't have any trouble at all."

Madeline was born in Port Arthur, Texas, and grew up in nearby Bridge City. "I come from a family who loves the outdoors; my father owns and manages a fishing camp in the summer and runs traps in the winter," says Madeline, "and my mother is an Audubon Warden in the Sidney Island Sanctuary at Sabine Lake close to Port Arthur."

Madeline collects data on the shrimp catches in the area primarily and does some work with the finfish and crab fishermen. When the weather is good and the boats are able to get out, she will do over 80 interviews a month.

She worked for a couple of years in the Washington area for the FBI and the Post Office Department but decided that life in the area was just too hectic and moved back to Texas.

When asked about her plans for the future, she says, "I like the work I'm doing; I know a lot of shrimpers in the area, understand their problems, and can sympathize with them, so I hope to continue what I am doing. I also want to continue my studies in biology at Lamar University in Beaumont, so it looks like I've got a busy future."

products; developments in gear and processing equipment; rail, truck, and air movements of fishery products; and information on foreign, international, Federal, and State actions; and regulations affecting the U.S. fisheries.

A survey of market news readers showed that they feel exvessel and wholesale prices of fish are of prime importance, followed closely by landings of fish at various ports and Congressional and other Government actions concerning the industry. Cold storage operators, processors, importers, and wholesalers found wholesale prices most important to them, followed by landings.

The fishery market news reports are published in five cities: Boston, New York; New Orleans; Terminal Island, California; and Seattle, on Monday, Wednesday, and Friday. In addition to the daily information, a weekly summary for each of the cities is published on Fridays.

The New York report specializes in wholesale prices and other market information on fresh and frozen fishery products traded in New York merchandising centers. The Boston report carries the Boston fish auction prices, the New Bedford Auction prices, exvessel prices, landings in selected New England ports, Chicago market receipts, and frozen wholesale prices for the New England and Chicago areas. The New Orleans report emphasizes the gulf shrimp market, and the Terminal Island report specializes in data pertaining to the tuna industry. The Seattle report contains information on the halibut, salmon, groundfish, king crab, and shrimp fisheries in the northwestern United States as well as Alaska. The Seattle report also publishes data on British Columbia fisheries.

Something new is being tried in the NMFS Southeast Region to encourage consumer interest in the seasonal abundance of freshly-caught seafood in coastal North Carolina. Diane Natale, sponsored by the Coastal Plains Commission, North Carolina Department of Natural and Economic Resources and NOAA collects timely news of fish and shellfish landings and distributes the information by radio and other news media. She is supervised and assisted by Harry Davis, Ken Harris, and Linda Hardy of the NMFS Division of Statistics and Market News and provided space at the Atlantic Estuarine Fisheries Center, Beaufort, North Carolina.

Diane calls participating seafood dealers every weekday morning to learn the kinds and amount of seafood landed during the previous 24 hours. This information is compiled for a report on the situation in North Carolina and supplied to the North Carolina Department of Agriculture for inclusion in their daily products report to news services.

Diane telephones a daily "Commercial Fishing Report" to three participating radio statinos—WMBL (Morehead City), WKLM (Wilmington), and WEEW (Washington)—which they tape and broadcast during the day. She also tapes a weekly summary report that she mails to WCDJ (Edenton), WNCB (Shallotte), WOBR (Wanchese), and WHSL (Wilmington). Several television stations are planning to use the report on their daily news telecasts.

Summary reports are mailed weekly to participating newspapers and news media food editors in North Carolina. This information also appears in NMFS Market News Reports from New Orleans and New York.

The one-year trial project is off to an excellent start. It is too soon to measure the effects of the program but the initial response by the public and news media has been encouraging.

Incidentally, says Wheeland, in answer to the questions posed earlier, there are about 140,000 people employed as fishermen in the United States. The most valuable fishery in the United States is shrimp. There are an estimated 50 million pounds of freshwater catfish grown in the United States. There are approximately 30 million recreational saltwater fishermen in the United States. The United States collected $29.8 million in tariff duties on fishery products imported into the United States in 1974.

From sea to shining sea - 25 weeks a year

The Survey's Seagoing Troubleshooters

BY RAYMOND WILCOVE

Two men with permanent shore duty go to sea regularly to keep the NOAA Fleet shipshape.

They are the NOAA Fleet Inspector and his deputy, the two permanent members of the NOAA Fleet Inspection Team which is now observing its third anniversary.

Since the first inspection of a NOAA ship was made in September 1972, the two-member team, assisted as needed by special technicians, has inspected all 25 ships of the NOAA fleet, some two or three times.

The team zigzags about the country about 110 days of the year, covering tens of thousands of miles, with a goal of inspecting each ship once a year.

As a result the fleet is now considered to be in better operating condition than ever before, with all vessels required to be maintained according to a uniform code of standards established by the Office of Fleet Operations.

Purpose of the inspections is to provide up-to-date information to the top echelon on the operational readiness of ships to meet their scheduled workloads. This also facilitates planning what resources and time will be required to keep the ships safe and as nearly continuously operational and trouble-free as possible.

The annual inspection was the brainchild of Rear Admiral Allen L. Powell when he headed the Office of Fleet Operations. Now Director of the National Ocean Survey, which manages the fleet for NOAA, he maintains a continuing and keen interest in the activities of the inspection team. After each inspection, the team reports to him its findings and a proposed plan to correct deficiencies.

Most ships, when found to be in need of repairs, can continue their missions without danger to the safety of the ships and its personnel. The deficiencies are such that they can be rectified at sea by the ship's personnel or taken care of upon completion of the mission.

"We don't pull our punches," said Lieutenant Commander Merritt Walter, who headed the inspection team during its first two years. "We call them as we see them. We have no enforcement powers, but when we bring to light what's wrong with a vessel, action usually follows, at least on the critically needed items requiri' g repairs." Walter said remedial actio.. ,nay be postponed on other items until funds become available, but added that if they have not been taken care of by the time of the next inspection, the team points them out again. It is the responsibility of the Commanding Officer, the Director of the marine center where the ship is homeported, the Associate Director of the Office of Fleet Operations and the Director of the Survey to determine which of the team's findings require remedial action and to see that it is carried through.

Walter and Herman Frome constituted the original fleet inspection team. It was their task to establish a system of inspections, including a set of rules. Both were well equipped for the task. Commander Walter holds a Coast Guard issue Master's license, and has served aboard eight ships. Prior to taking the assignment, Commander Walter has commanded the NOAA Ships Rude and Heck. He has since received a new assignment as Commanding Officer of the NOAA Ship Townsend Cromwell.

Frome was a naval technician with 32 years of experience in ship construction and repairs. Prior to joining the inspection team, he had been associated with the NOS Director's staff during the construction of 13 ships which today form a large part of the NOAA fleet. Those ships, in the order built, are Pierce, Whiting, Oceanographer, Discoverer, McArthur, Davidson, Dude, Heck, Mt Mitchell, Fairweather, Rainier, Ferrel, and Researcher. All were started and completed within the 9-year period from 1961 to 1970. Frome has a unique knowledge of these ships and is invaluable to the inspection team.

Commander Walter and Mr. Frome, as the original team members, worked hard to get the inspection program started. Two years after its birth, Admiral Powell presented the NOAA Unit Citation to the team which he had helped initiate. Commander Walter also received a Bronze Medal for his work in establishing the inspection program as a viable influence in the fleet and a valuable tool for the Admirals.

The two men are the authors of the fleet inspection program's "bible," the "Requirements for Safety and Material Condition of the NOAA Fleet." The 67-page loose leaf manual includes a 26-page check-off list of items to be inspected.

The check-off list is furnished each ship before it is inspected, usually two to four weeks before the team arrives. It contains over 500 items subject to inspection covering six general categories—hull, engineering, electronics, bridge control, casualty control and sanitary facilities.

On small ships, such as the Rude and Heck, the inspection is handled entirely by the two-man team. On the larger vessels, such as the Oceanographer and the Surveyor, personnel are added to the team. To inspect the engineering aboard a ship, Ray Schmitz, a retired Coast and Geodetic Survey engineer, is called in as a consultant. Schmitz, who lives in Kent, Washington, near Seattle, and makes most of the trips to inspect the engineering on west coast ships, and flies east to inspect many of the east coast ships as well. Chief Schmitz, who sailed for the Coast and Geodetic Survey, has over 40 years of experience as a marine engineer throughout the fleet.

Sven Svensson, a licensed marine engineer, who is presently the Ship Administrative Supervisor, Southeast Fisheries Center, Pascagoula Laboratory, Pascagoula, Mississippi, often joins the team on east coast assignments. On occasion, an engineer from one of the Marine Centers is added to the team when neither Chief Schmitz nor Svensson is available.

An electronics inspector is generally chosen from the Marine Center to which the ship is attached. Occasionally, an inspector is chosen from the Rockville office Electronic Systems Branch, Marine Engineering Division, of the Office of Fleet Operations.

"Each ship is given a thorough examination from stem to stern, from top to bottom," said Walter. Each of the 500

Lieutenant Commander Robert Smart, NOAA Fleet Inspector, checks the masthead range light aboard the Mt Mitchell.

items on the check-off list is examined. A report is then prepared by the team and copies furnished to the Commanding Officer of the ship, the director of the Marine Center, the head of the Office of Fleet Operations and the Survey director.

Prior to submission of the report, the team discusses its findings with the ship's commanding officer and her executive officer and with the others to whom the report will be furnished.

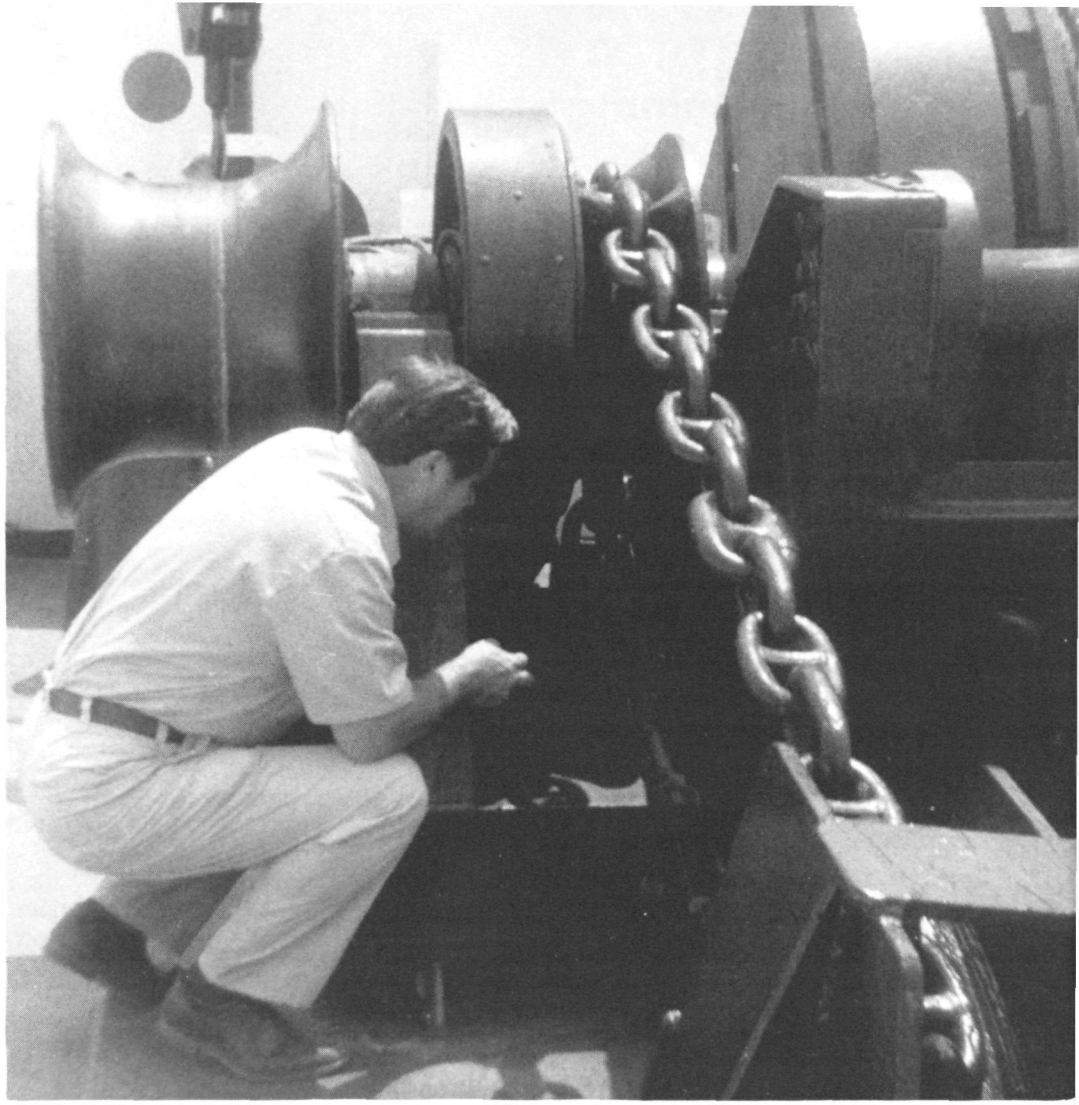
Lieutenant Commander Robert Smart, who has succeeded Walter as Fleet Inspector, estimated that 85 to 90 percent of the things found wrong in a ship are corrected following inspection. Smart, who is a graduate of the U.S. Naval Academy, has served on two U.S. Navy ships and one NOAA ship. Prior to this assignment, he served on the U.S. Staff for the International Global Atmospheric Research Program Atlantic Tropical Experiment Team. He attended the Merchant Marine Inspection School at the U.S. Coast Guard Reserve Training Center in Yorktown, Virginia.

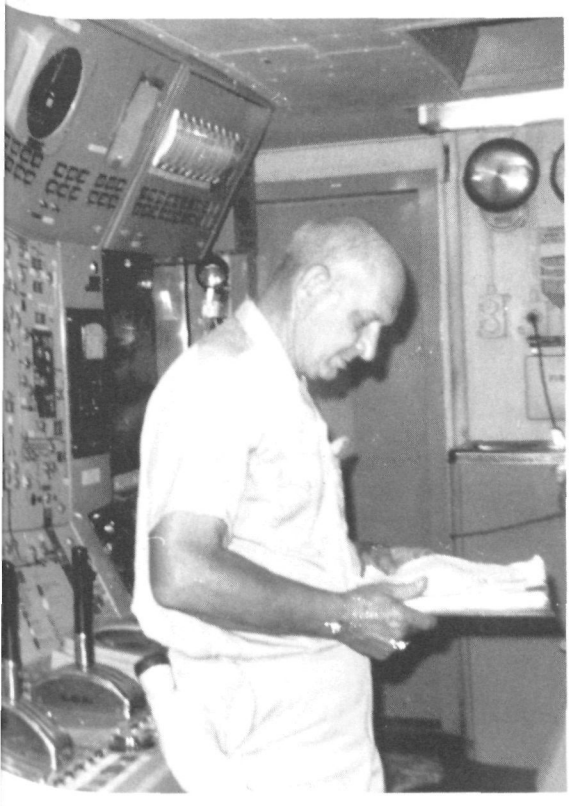
"Some of our recommendations may be considered unnecessary," he explained, "but the great majority of the deficiencies that we point out are corrected and as a result the NOAA fleet is in better shape today safetywise than ever before."

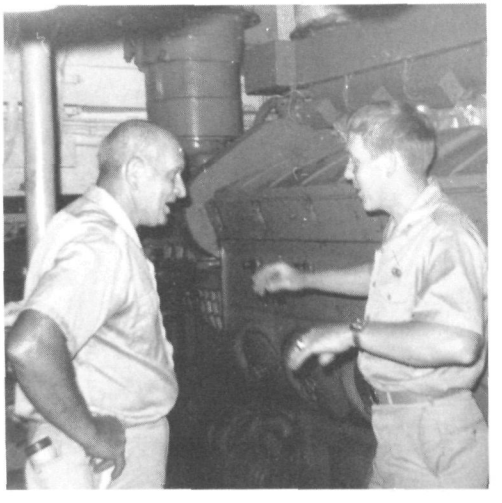
Smart said the inspection team is generally well received by the ships, although there is a variance in the degree of welcome extended to the safety inspectors. "Walter and Frome broke the ice," he said, "and it's much easier now for us." Frome has continued as deputy inspector.

"Our ships are in good condition without any really critical deficiencies," said Smart.

Normally a ship receives by mail a set of the 26-page check-off list, to complete and present to the Fleet Inspection Officer prior to formal inspection. This gives the ship the opportunity to use the same guidelines that the team uses. Over 500 items are inspected on each ship during the annual inspection. They fall under six general categories—Deck/Hull, Engineering, Electronics/Radio, Bridge Control, Casualty Control, and Sanitation/Health. After the completion of the inspection, the Captain is briefed on the results of the inspection, and a copy of the rough checklists completed by the team are given to him. Among the deficiencies noted on the team's worksheets, those items of particular concern are highlighted; only these items becomes part of the formal inspection report. Later, upon their return to Rockville, Smart and Frome work together to write the formal report on those deficiencies highlighted on the worksheets. After the report is completed, it is forwarded to the ship via the Marine Center. The Captain of the ship then follows up by writing his intentions as to the correction of deficiencies. When the ship cannot correct a deficiency, it will note that fact and the Marine Center engineering department will then review the inspection report and the ship's







During an inspection aboard the NOAA Ship Mt Mitchell, (above left) Herman Frome checks the anchor windlass, (lower left) and inspects the rescue boat; (top) Lt. Cdr. Robert Smart checks the fathometer in the pilot house; (left) Chief Raymond Schmitz reads a chart in the Central Engineering Control, and (above) discusses the ship's main engine with Lt. Cdr. Smart.

follow-up report before deciding what action it should take on the remaining deficiencies.

In addition to the written report, the head of the inspection team briefs the Director of the Marine Center, the Associate Director for Fleet Operations, and the Director of the National Ocean Survey of each ship inspected.

The program is similar in concept to the inspections done by the Navy, Army, and Air Force on their operating units and installations.

When the fleet inspection program was established under Rear Admiral Don Jones, then Survey director, both Jones and Powell realized that it was not enough to pick a team with the necessary technical expertise. A good dash of diplomacy had to be added to the team's makeup if the program was to be successfuly. A zest for the sea and a love of ships had to be included also.

"There's no question but what we had had to be very diplomatic about the way we went about our business," said Walter. "While things have changed considerably in recent years, skippers even now don't relish having 'outsiders' come aboard and tell them what's wrong with their ship. So it behooves us to be very tactful."

It is the responsibility of a commanding officer to see that his vessel is kept shipshape, but operational activities usually keep repairs to a minimum. To make up for this, commanding officers were urged to ask the Coast Guard to inspect their ships, but Walter said this was at best "a hit and miss proposition." It depended in good part on the ship being in the right place at the right time so the inspection could be made.

Consequently, the need for a central control over the maintenance of ships and the establishment of some degree of standardization became apparent, especially since NOAA ships engage in so many varied activities. These include hydrographic surveys, fisheries research, deep sea research and wire dragging.

"Prior to the inspection program," said Walter, "there was no clear program for determining when a vessel was shipshape."

An effort is made to inspect the ships while at sea, under operating conditions. "This is done most of the time," said Frome, "to insure that all machinery and other equipment are in a state of operational readiness." To meet this requirement, the team may have to resort to other than regular means of transportation to reach the ships at sea. In Alaska, the team even utilized a float plane to board and leave a ship. In New Jersey, a small boat from one ship put them on the beach and the team had to walk with luggage until a kind motorist gave them a ride to a local rent-a-car agency.

The inspection team spends about 25 weeks away from home. Each inspection takes two to four days, not counting travel time.

"We're the only personnel with permanent duty on land who go to sea regularly," said Frome.

AN AMERICAN TRADITION

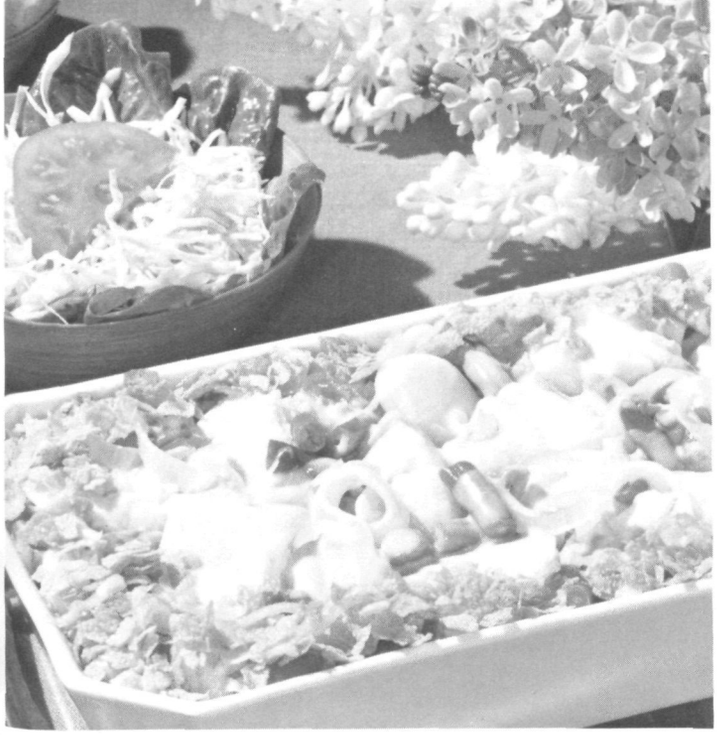
"As the land is full of God's good blessings, so is the sea replenished with great abundance of excellent fish as cods, sufficient to lade many ships, (and) which we found upon the coast in the month of June; seals to make oil withall, mullets, turbots, mackerels, herrings, crabs, and lobsters, crevises, and mussels with ragged pearls in them."
(The voyage of Martin Pring, 1603)

Soon after this glowing account of the abundant sea life to be found within easy reach of the shore, the earliest American settlers came, and —from the first—fish and shellfish were a favorite dish of those on or near the sea. The modern American family need not live near the seacoast to enjoy tasty and healthful seafood any time of the year. So take part in a real American tradition soon with one of these tempting recipes.

Bicentennial Crab Salad

1 pound backfin crabmeat or 2 packages (6-ounce each) king or snow crabmeat, fresh or frozen
½ cup salad dressing or mayonnaise
2 teaspoons sugar
1 tablespoon lemon juice
4 teaspoons grated orange rind
1 cup thinly sliced celery
1 cup orange section halves, well-drained
½ cup sliced pitted ripe olives
2 tablespoons sliced green onion
Crisp salad greens
Avocado or cantaloupe wedges, or orange sections (optional)

Thaw frozen crabmeat; drain well. Remove any remaining shell or cartilage. Mix salad dressing or mayonnaise, sugar, lemon juice, and orange rind. Combine well-chilled crabmeat, celery, orange section halves, olives, and onion. Add salad dressing mixture; toss lightly. Serve on crisp salad greens. Garnish with avocado or cantaloupe wedges or orange sections, if desired. Makes 5 cups salad mixture, about 6 servings.



Quick 'n' Easy Seafood Supper

- 1 package (1 pound) frozen cod, haddock, or other fish fillets
- 1 cup sliced onion
- 2 tablespoons melted margarine or cooking oil
- 1 can (11 ounce) condensed Cheddar cheese soup
- ¼ cup water*
- 1 can (1 pound) whole Irish potatoes, drained and sliced (2 cups sliced)
- 1 package (9 ounce) frozen cross-cut green beans, thawed
- ½ teaspoon salt
- ¼ teaspoon pepper
- ¼ teaspoon dry mustard
- 1 cup shredded process American cheese
- ¾ cup dry bread crumbs mixed with 2 tablespoons melted margarine or cooking oil**

Thaw frozen fish; cut into 1½ inch chunks. Cook onion in margarine or cooking oil until tender, but not brown. Add soup, water, potatoes, beans, salt, pepper, and mustard; mix well. Heat until bubbly. Fold in fish and ½ of the cheese. Spoon into shallow 1½ quart casserole. Sprinkle remaining cheese over top of fish mixture and cover with bread crumbs. Bake in moderate oven, 350° F., until hot and bubbly, 25 to 30 minutes. Makes 6 servings.

*Water drained from potatoes may be used, if desired.

**Fine cornflake crumbs may be used instead of bread crumbs and margarine.

New England Broil

- 2 pounds cod, haddock, pollock, or other fish fillets, fresh or frozen
- ¼ cup salad oil
- ¼ cup water
- 2 tablespoons wine vinegar
- 2 cloves garlic, crushed
- 1 bay leaf, crushed
- 1½ teaspoons salt
- ½ teaspoon paprika
- ¼ teaspoon crushed red pepper
- 6 thick tomato slices
- 1 cup soft bread crumbs
- 3 tablespoons butter or margarine, melted

Thaw frozen fillets. Skin fillets and cut into 6 portions. Place fish in a single layer in a shallow baking dish. Combine remaining ingredients except tomatoes, crumbs, and butter. Pour sauce over fish and let stand for 30 minutes, turning once. Remove fish and reserve sauce for basting. Place fish in a single layer on a well-greased bake and serve platter, 16 by 10 inches. Arrange tomato slices around fish. Broil about 4 inches from source of heat for 8 minutes. Baste fish once during broiling with reserved sauce. Remove from heat. Combine crumbs with butter or margarine and sprinkle over tomatoes. Broil 2 to 3 minutes longer or until fish flake easily when tested with a fork. Makes 6 servings.

Salmon Casserole With Cornbread Topping

- 1 can (1 pound) salmon
- 1 can (10¾ ounce) condensed cream of mushroom soup
- 1 package (9 ounce) frozen, cut green beans, thawed
- ½ package (1 pound 2 ounce) corn muffin mix (or 1¾ cups dry mix)
- ¼ cup finely chopped green pepper (optional)
- ¼ teaspoon dry mustard

Drain salmon; save liquid. Flake salmon; distribute evenly over bottom of shallow 1½ quart casserole. Combine soup, salmon liquid, and green beans in saucepan; heat. Pour soup mixture over salmon. Combine corn muffin mix, green pepper, and dry mustard in bowl. Add egg and ½ of the milk called for on corn muffin label and mix as directed in package directions. Spoon into 8 even mounds onto hot soup mixture. Bake in hot oven, 400° F., about 22 to 25 minutes or until topping is done and browned. Makes 4 servings.

Note: If desired the remaining ½ package of corn muffin mix may be prepared as directed on the package label. Bake in muffin pans and serve with the casserole.

Maine Fishermen's Cole Slaw

3 cans (3¾ or 4 oz. each) Maine sardines, drained
4 cups shredded cabbage
¼ cup chopped onion
⅓ cup chopped parsley
¼ cup shredded carrot
Cole Slaw Dressing
Salad greens
Paprika

Drain sardines. Combine cabbage, onion, parsley, carrots, and dressing. Arrange on salad greens. Top with sardines and sprinkle with paprika. Makes 6 servings.

Cole Slaw Dressing

¾ cup bottled oil and vinegar salad dressing
3 tablespoons chopped pimiento

Combine salad dressing and pimiento. Mix thoroughly. Makes approximately ⅞ cup dressing.

Baked Flounder In Wine Sauce

2 pounds flounder or sole fillets or other thin fish fillets, fresh or frozen
1½ teaspoons salt
Dash pepper
3 tomatoes, sliced
2 tablespoons flour
2 tablespoons butter or margarine, melted
½ cup skim milk
⅓ cup dry white wine
½ teaspoon crushed basil
Chopped parsley

Thaw frozen fillets. Skin fillets. Sprinkle fillets on both sides with 1 teaspoon salt and pepper. Place fillets in a single layer in a greased baking dish, 12 x 8 x 2 inches. Arrange tomatoes over top of fillets. Sprinkle with remaining ½ teaspoon salt. Blend flour into butter. Add milk gradually and cook until thick and smooth, stirring constantly. Remove from heat and stir in wine and basil. Pour sauce over top of tomatoes. Bake in a moderate oven, 350° F., for 25 to 30 minutes or until fish flakes easily when tested with a fork. Sprinkle with parsley. Serves 6.

Clam Can-Can Chowder

2 cans (7 ounce each) minced clams, undrained
2 cans (10½ ounce each) condensed cream of potato soup
3½ cups milk
2 tablespoons margarine
2 teaspoons dehydrated minced onion
1 small bay leaf
⅛ teaspoon pepper
1 can (12 ounce) corn and peppers
Paprika

Combine soup, milk, margarine, onion, bay leaf, and pepper. Simmer until hot, stirring occasionally. Add corn with peppers, and clams; heat. Remove bay leaf. Garnish with paprika. Serve with sea toast or favorite cracker, if desired. Makes 6 servings.

Whiting With Lemon-Rice Stuffing

8 pan-dressed whiting or other pan-dressed fish, fresh or frozen
1½ teaspoons salt
Lemon-Rice Stuffing
¼ cup margarine or butter, melted
2 washed, unpeeled lemons, thinly sliced

Thaw frozen fish; clean, wash and dry. Sprinkle inside and outside of fish with salt. Stuff loosely. Close openings with small skewers or wooden picks. If there is left-over stuffing, bake separately in small, well-greased, covered casserole. Place fish on a single layer of lemon slices in a well-greased baking pan, 14 x 11 x 1 inches. Drizzle melted margarine over fish. Cover surface of fish with remaining lemon slices. Bake in moderate oven, 350° F., for 25 to 35 minutes or until fish flakes easily when tested with a fork. Baste once during baking with the melted margarine. Discard lemon slices and remove skewers before serving. Makes 6 servings.

Lemon-Rice Stuffing

4 cups cooked rice
1 (10¾ oz.) can condensed cream of shrimp soup
¼ cup toasted slivered almonds (optional)
¼ cup chopped parsley
1 tablespoon lemon juice
¼ teaspoon grated lemon rind
Dash nutmeg
Dash pepper

Combine all ingredients. Use approximately ¾ cup stuffing per fish.

Crab-Rice Supper Salad

1 can (7 ounce) or 1 package (6 ounce) frozen snow or other crabmeat
¼ cup olive oil
2 tablespoons cider vinegar
1 tablespoon Dijon-style mustard
½ teaspoon basil
1 clove garlic, cut in half
2 cups chilled cooked rice
¼ cup finely chopped onion
1½ cups sliced celery
1 cup chopped, peeled, seeded tomato
¼ cup mayonnaise
¼ teaspoon salt
Washed greens
Tomato wedges or cucumber slices for garnishing (optional)

Thaw frozen crabmeat, if used. Drain crabmeat and remove any remaining cartilage. Cover and chill. Combine oil, vinegar, mustard, basil, and garlic; mix well. Pour over rice and onion; mix well. Cover and chill about 1 hour. Remove garlic. Add celery, tomato, mayonnaise, and salt; mix well. Save 6 small pieces of crabmeat for garnishing top of salads, if desired. Add remaining crabmeat to rice mixture; mix well. Cover and chill until ready to serve. Serve on crisp salad greens. Garnish with tomato wedges or cucumber slices, if desired. Makes about 5 cups salad.

Sunny Crab Sandwich

2 packages (6 ounce each) frozen crabmeat
1 cup sliced almonds
½ cup chopped celery
½ cup mayonnaise or salad dressing
2 tablespoons lemon juice
6 toasted buttered English muffins
12 cooked asparagus spears (or more, as desired)
6 slices (1 ounce each) Cheddar cheese
Paprika
Tomato wedges

Thaw frozen crabmeat; drain. Remove any remaining shell or cartilage. Combine almonds, celery, mayonnaise or salad dressing, lemon juice, and crabmeat. Arrange muffin halves on a cookie sheet, 15 by 12 inches. Place one or more asparagus spears on each muffin half. Cover asparagus and muffin with crab mixture. Cut each cheese slice diagonally into quarters. Place 2 triangles on each sandwich. Sprinkle with paprika. Bake at 400° F., for 15 to 20 minutes or until heated through and cheese is melted. Serve with tomato wedges. Makes 6 servings.

noaa/update

SUN MAY AFFECT OZONE SHIELD

Three Environmental Research Laboratories researchers have suggested that the sun be added to the list of agents that may be responsible for observed variations in the earth's ozone shield—the worldwide and regional ups and downs in ozone measurements of as much as two or three percent in less than a decade that have been blamed on a wide spectrum of influences from nuclear testing to supersonic transports.

During solar flares, the sun ejects streams of energetic protons that set off a variety of reactions in the earth's atmosphere, some of them causing production of nitric oxide.

Drs. Paul J. Crutzen, Ivar S. A. Isaksen, and George C. Reid, of ERL's Aeronomy Laboratory, who calculated the production of nitric oxide during three solar proton events, found that such events constitute a highly underrated cause of ozone variations.

Life on earth is shielded from possible harmful ultraviolet radiation by a tenuous layer of ozone in the stratosphere. The density of the ozone layer is crucial—while it does undergo small, ill-understood variations, significantly greater or smaller quantities could have many biological and meteorological effects.

Among the chief limiters of ozone in the atmosphere are nitrogen oxides, such as nitric oxide, which catalyze the destruction of ozone. The main source of nitric oxide is the conversion of nitrous oxide, produced by bacteria in the soil and ocean waters and released into the atmosphere.

At high latitudes, galactic cosmic rays (a flow of charged particles from outside the solar system) also contribute to the production of nitric oxide. Energetic protons—the principal component of galactic cosmic rays—invade the earth's atmosphere, colliding with air molecules. Stray electrons shoot off from the collisions, in turn colliding with, and breaking up, nitrogen gas molecules. Through a series of reactions, electrically charged fragments of nitrogen combine with oxygen and ozone to form nitric oxide.

The sun also produces energetic protons, spitting them out during solar flares. The protons reach the earth by a roundabout route and penetrate the atmosphere. Such solar proton events are accompanied by intense absorption of radio waves in the auroral zones, the regions around the polar caps where aurora tend to occur, and so are also known as polar cap absorption events.

The researchers conclude, writing in *Science*, that solar proton events are significant mass-producers of nitric oxide, and may help help explain some of the puzzling variations in the ozone layer.

SEA GRANT RESEARCHERS DEVELOP BREAKWATERS FROM DISCARDED TIRES

Sea Grant engineers at the University of Rhode Island have found a novel use for the discarded tires now accumulating at a rate estimated to exceed 200 million per year in the United States.

A team headed by Tadeusz Kowalski, URI associate professor of ocean engineering, has developed a method of assembling scrap tires to form moored, floating breakwaters for protecting small boat marinas and shorelines vulnerable to erosion. "The scrap-tire rafts are not only inexpensive in comparison with conventional fixed breakwaters," he says, "but they also are highly effective and ecologically sound."

The breakwater development effort, which began two years ago, has been funded by the Goodyear Tire and Rubber Company and the Office of Sea Grant.

The team has designed, built, and tested three types of scrap-tire breakwaters. "The third design," Mr. Kowalski says, "is the simplest and the best."

In this version, 18 tires standing on edge are strapped firmly together with stainless steel cable in a roughly diamond-shaped pattern, forming single units to be assembled into larger breakwaters. Each unit, essentially a small floating raft, can be tied together on shore in about 10 minutes. The units are then pushed into the water, where they are strapped together and moored to the bottom. The diamond-shaped rafts can be arrayed in a variety of configurations, depending on the requirements of the site, and the entire breakwater can be moved to meet changing seasonal or other conditions.

ERL SCIENTISTS DISCOVER TORNADO "SIGNATURE"

The tornado that struck Union City, Oklahoma in May 1973, could mark a turning point in the study and eventual prediction of these destructive whirlwinds.

NOAA researchers who are studying the storm have discovered what they believe may be a new radar "signature" for tornadoes. It is the first time a tornado itself, not just the larger circulations associated with tornadoes, has been detected by radar.

It is also the first time severe storm scientists have observed what they believe may be the birth of a tornado within the parent thunderstorm.

By tracing this distinctive signature through the physical extent and lifespan of the tornado, the scientists found that the vortex that becomes a tornado may develop in the middle levels of the storm, long before the funnel begins to stretch toward earth; and, that it reaches upward as well as down, a whirling core within the towering storm.

Meteorologists Donald W. Burgess, Leslie R. Lemon and Rodger A. Brown of the Environmental Research Laboratories' National Severe Storms Laboratory in Norman, Oklahoma, made these discoveries from observations of the Union City tornado with the laboratory's powerful Doppler radar.

Doppler radar determines the velocity with which an object is moving toward or away from it by measuring the change in frequency, or Doppler shift, of radio signals reflected from the target.

They found that adjacent radar sections or "gates" of the storm showed high velocity winds moving in opposite directions. Winds on one side of the tornado funnel were moving toward the radar at 65 miles (104 kilometers) per hour, while on the other side, less than a kilometer away, they were blowing just as fast in the opposite direction.

Two adjacent streams of air moving in different directions or at different velocities creates a condition known as wind shear. Since winds at one side of a vortex would be moving toward the observer while those on the opposite side would be moving away, the NOAA researchers deduced the observed "gate-to-gate" wind shear to be the radar signature of a vortex.

The NOAA researchers began scanning the thunderstorm that spawned the Union City tornado 23 minutes before the tornado touched down, and continued scanning until after it dissipated.

They found that the radar signature was not limited to the visible funnel dangling from cloud base to earth, but seemed to reach from the ground to a height of at least six miles (10 kilometers)—more than halfway up to the top of the storm. The signature could be discerned in the middle levels of the storm from the time when they first started the radar observations.

NOAA PROGRAMS PROMOTE SAFETY OF BOATERS

An improved electronic navigation system, Loran-C, is being added to 100 NOAA nautical charts this year. The move, long awaited by commercial shipping and recreational boaters, will provide a major assist in promoting safety at sea, and its announcement coincided with the observance of National Safe Boating Week. NOAA is a member of the National Safe Boating Committee, which annually promotes the observance.

Loran—for long range navigation—is used by ships to plot their positions. Loran-C is an improved version of Loran-A, which was developed during World War II, and is now widely used by commercial fishermen, shipping and pleasure boaters.

Loran-C can operate under all weather conditions, whereas Loran-A signals are often disrupted by atmospheric disturbances. Its addition by the National Ocean Survey to nautical charts results from the establishment of coastal loran stations that enable the program to function. With the construction of these stations along the coast, the program to add Loran-C to nautical charts will now go into full swing. Loran-C will be printed on one side of the chart and, where appropriate, Loran-A on the reverse side. The Loran-A system will continue to be used until the Loran-C program is fully in effect, probably in five years.

ERL Sights Dust Layer

An unusual and persistent reflective layer has been detected in the cloud-free stratosphere more than 12 miles (19 kilometers) above the earth by a sensitive ruby laser operating at the Environmental Research Laboratories' Mauna Loa Observatory in Hilo, Hawaii.

The transparent whitish veil was first discovered by the observatory's lidar—the laser equivalent of radar—in early October of last year by Observatory Director Dr. Ronald W. Fegley and Howard T. Ellis.

According to Dr. Fegley, no dust layer had previously been observed above the tropopause—the boundary between the weather-producing region of the atmosphere—during two years of lidar observations at the observatory.

The NOAA lidar system is currently operating once per week to monitor stratospheric aerosol concentrations, cloud properties, and aerosol profile changes in the lower atmosphere under ERL's Air Resources Laboratories' Geophysical Monitoring for Climatic Change program. The system was designed by Dr. Earl Barrett of ERL's Atmospheric Physics and Chemistry Laboratory.

As one of several benchmark observatories monitoring "clean air" throughout the world, the Mauna Loa station has the only lidar now functioning in the tropics. Because the atmosphere at the observatory altitude (3.2 kilometers) is extremely clear, the lidar can probe to heights up to 15 miles (25 kilometers) altitude.

The scientists have tentatively attributed the mysterious stratospheric layer, which made the sky a pronounced chalky blue for several months, to dust from the giant eruption of the Fuego volcano in Guatemala in early October, but add that there are some puzzling facts.

Dr. Fegley explains, "We observed the stratospheric layer for the first time on the eighth of October, two days before the Guatemala eruption was reported to have occurred and six days before the eruption became violent.

According to Dr. Fegley, the high altitude veil may influence long-term climate changes throughout the world. Because it extends over a large area, it acts like a giant filter covering the entire sky. The filtering action may cause a loss of solar energy which could result in a general cooling of surface temperatures.

SEARCH FOR SUNKEN WRECKS BEGINS IN NEW YORK HARBOR

NOAA's wire drag ships—the Rude and Heck—have launched a 10-week search in the traffic-congested approaches to New York Harbor for at least nine sunken wrecks regarded as dangerous to shipping.

The search will continue until mid-November. The ships, the only ones of their kind in the country, were constructed especially to locate underwater navigational hazards.

Their task is to verify or disprove reports of the existence of sunken vessels or other possible navigational hazards, such as shoals, reefs and pinnacle rocks. When proven, the ships determine the obstruction's precise location and the water's height above them. The positions of the wrecks are plotted on the nautical charts issued by the National Ocean Survey, and if deemed hazardous reported to the Coast Guard for publication in the Notice to Mariners.

In searching for wrecks and other underwater obstructions, the Rude and Heck steam parallel to each other, sometimes as much as two miles apart, dragging a quarter-inch steel wire, suspended under water from surface buoys to predetermined depths as great as 100 feet. As the wire catches on an obstruction, the wire becomes taut and the surface buoys generally form the letter V. A determination is then made of the exact location of the obstruction and the water's depth above its highest point. If necessary, divers examine it.

The Rude and Heck each carries a complement of 10 officers and crew. The ships are commanded by Commander Robert A. Ganse, a NOAA commissioned officer.

The wrecks being sought by the NOAA ships lie strung out in an area some two to 11 miles off the New York-New Jersey coast, stretching in a southerly direction from a point in the Ambrose Channel about five miles off Rockaway Beach, Long Island, to a point off Sea Girt, N.J. Ambrose Channel is a major traffic waterway leading into New York Harbor.

The wrecks have been reported lying in the Barnegat to Ambrose Traffic Lane and in the New York Harbor Precautionary Area where traffic lanes leading into the harbor converge.

EROSION STRUCTURES MAY MAKE PROBLEM WORSE

"Indiscriminate use of beach erosion control structures, such as groins, jetties, and the like, can result in an ever-expanding erosion problem," according to Dr. Warren E. Yasso, associate professor in the Science Education Department at Teachers College, Columbia University, and Elliot M. Hartman, Jr., associate professor in Westchester Community College's Science Department, authors of the first in a series of publications describing important aspects of the New York Bight.

Although many of the Bight's beaches are classified as critically eroding, "action to preserve them should be undertaken only following a comprehensive plan that considers the erosion problems of the entire shoreline," Dr. Yasso and Mr. Hartman say.

This monograph—"Beach Forms and Coastal Processes"—and 29 others scheduled to be issued in 1975 eventually will form part of a comprehensive MESA New York Bight Atlas. The publications are being produced through a cooperative effort of NOAA's MESA (Marine Ecosystems Analysis) program and the New York Sea Grant Institute. The MESA program is directed by NOAA's Environmental Research Laboratories. The Institute administers the State University of New York/Cornell University Sea Grant College program supported by the Office of Sea Grant.

Together, the monographs and the atlas will constitute the first comprehensive presentation of current knowledge of the New York Bight's marine environment and the impacts of human activities on it.

To slow the natural sand movement and protect coastal structures, countless bulkheads, seawalls, groins, and jetties have been built along the Bight's coastline. But since "the beach is the most complex physical environment on earth," the authors point out, "we know little in most cases about the short-term effects of coastal engineering structures and practically nothing about the long-term effects."

Buoy Data Published In Weather Log

Monthly marine meteorological data from U.S. ocean buoys are now being published in the Environmental Data Service's bimonthly periodical, *Mariners Weather Log*. Two months' data are summarized in each issue for each buoy reporting a significant amount of data.

The Mariners Weather Log is available to persons or agencies with marine interests from the Environmental Data Service, D762, Washington, D.C. 20235. The data may be obtained from the National Climatic Center, Federal Building, Asheville, N.C. 28801.

Economic Fishing Forecast Prepared

If present trends continue, the U.S. fisheries industry will grow only slightly in the next 10 years despite a rising demand for seafood products, according to the National Marine Fisheries Service.

Also, unless the U.S. industry can lift its production to levels that meet the Nation's future needs, the rising demand will be satisfied principally by imports of foreign fishing products, which have doubled in the last 10 years.

Such prospects are suggested in a "baseline" economic forecast which examines historical trends and traditional practices in U.S. fisheries and projects them to show conditions to be expected if no changes or improvements take place by 1985.

The report, prepared by Synergy, Inc., of Washington, D.C., is currently being analyzed by NMFS, which is preparing a National Fisheries Plan to be published later this year. A major objective of the plan is to establish goals and lines of action that will encourage increased U.S. production of fisheries products and thus reduce the heavy U.S. dependence on seafoods from abroad.

Georgia Receives Grant

NOAA has awarded a $1.5 million grant to help Georgia establish an estuarine sanctuary on Sapelo Island for scientific research and educational purposes.

This is the second grant awarded through NOAA under terms of the Coastal Zone Management Act of 1972 in an effort to preserve examples of the various types of estuaries in the U.S. and its territories.

With the Federal funds—and at least an equal amount provided by the State—9,600 acres of marsh and island surrounding the Duplin River in McIntosh County will be maintained in their natural state to permit long-term study of natural and human processes in estuarine ecosystems.

The Duplin River Estuary is ecologically typical of the Carolinian biogeographical classification of estuaries along the Atlantic coast between Cape Hatteras and Cape Kennedy, with extensive marshes and swamps, turbid and productive waters, and a range of plant and animal life generally found in temperate climates, with seasonal tropical elements.

The State's Department of Natural Resources will manage the area.

NOAA FLEET TO MONITOR POLLUTANTS

Shellfish Poison Can Be Detected Accurately, Fast

A procedure for detecting the presence in shellfish of saxitoxin—the paralytic shellfish poison sometimes associated with the so-called "red tide" blooms on the west coast—one hundred times more sensitive than any previous method has been devised by Sea Grant chemists at the Berkeley campus of the University of California.

"We are hopeful," said Dr. Robert B. Abel, Director of the Office of Sea Grant, "that this new technique may be used to prevent the unnecessary closing of shellfish areas. It should allow for the specific, rapid, and reliable inspection of shellfish for toxicity and be a much more desirable substitute for the present method of closing areas by calendar."

The new technique involves a chemical analysis of the shellfish that could provide a more scientific approach to the problem of paralytic shellfish poison than seasonal closings. Meat from the suspected animals is ground up and subjected to a series of relatively simple steps to extract any saxitoxin which may be present. The amount of saxitoxin, if any, can then be determined using a standard laboratory instrument called a fluorescence spectrophotometer.

"The procedure is so straightforward," claims Dr. Henry Rapoport, leader of the Berkeley Sea Grant group, "and the equipment needed so uncomplicated, that testing can be carried out on board a ship or in a small van on shore. The results are immediate and a decision can be made on the spot whether or not to harvest."

The team analyzed several samples of Alaska Butter clams and California mussels taken from 15 separate areas that had been closed to shellfishing. The scientists were able to detect saxitoxin in concentrations as low as four parts per billion, and found that shellfish from some of the closed beds would be considered safe for human consumption according to the compliance guidelines set by the Food and Drug Administration.

No one understands exactly what triggers the blooms of toxic plankton called dinoflagellates or how to control them, but it is known that shellfish, feeding on the plankton, can retain minute quantities of saxitoxin. Although the shellfish themselves appear to be unaffected by the poison, people can become ill from eating the tainted meat.

The 25-ship NOAA fleet has been directed to monitor slicks and other oil pollutants as part of a United Nations' program called Integrated Global Ocean Station System (IGOSS). The ships are operated by the National Ocean Survey.

NOAA's participation in IGOSS is part of a world-wide pilot program designed to pave the way for the monitoring of marine pollutants on a global scale. The two-year program is organized by the UN's Intergovernmental Oceanographic Commission and the World Meteorological Organization.

The U.S. coordinator for IGOSS is Robert Junghans of NOAA's Office of Environmental Monitoring and Prediction. He is Deputy Director of its Oceanographic Services Office and was a former member of the Secretariat of the Intergovernmental Oceanographic Commission.

The monitoring activities of the NOAA ships will cover areas in the Atlantic Ocean, Gulf of Mexico, Pacific Ocean and the Bering Sea and will include both inshore and offshore water. In addition to monitoring oil slicks, vessels with appropriate equipment will collect samples of oil tar balls. Other ships will gather, for laboratory analysis, samples of dissolved petroleum hydrocarbons from the upper three feet of the ocean.

The information gathered by U.S. participants is being forwarded to NOAA's National Oceanographic Data Center. The data will be archived and exchanged among nations so periodic assessments can be made of the state and degree of ocean contamination.

U.S. participants in the IGOSS program also include the Coast Guard, Defense Department, academic institutions, and cooperating ships of the commercial fleet.

Mr. Junghans said the Office of Technology of the U.S. Senate Commerce Committee soon will publish an analysis of marine pollution and safety measures in a report entitled "Oil Transportation by Tankers." That report shows, he said, that about one million tons of oil a year are dumped into the ocean in standard tanker operations such as tank cleaning, and deballasting.

Additionally, about 200,000 tons of oil are spilled yearly as a result of tanker casualties, and an added 250,000 tons of oil pollution annually is associated with tanker dry-docking activities, he said.

MODEL TESTED AS ATMOSPHERIC SOUNDER

Airplane soundings of the atmosphere go back to the days when goggled pilots flew instrumented biplanes to gather the weather information balloon-borne sensors do today.

Now Environmental Research Laboratories scientists are trying it again, with a bullet-nosed probe flown from a specially constructed airfield near Boulder, Colo.

But the NOAA probe was designed to measure only one aspect of the atmosphere—the electrical field. And it is a model.

Developed by ERL's Atmospheric Physics and Chemistry Laboratory and its contractor, Hobby Specialties of Boulder, the airplane has an eight-foot wingspan and six-foot fuselage, and is pushed along by a horsepower and a half of model airplane engine fueled on methane and castor oil.

It carries miniaturized instruments to sense the strength of the atmosphere's electrical field, earth currents, and the conductivity of the air. Its remote-controlled missions are flown in clear air, to altitudes of from 10,000 to 15,000 feet (3,000 to 4,500 meters). Although the model could safely penetrate some types of cloud, moisture in the cloud would interrupt the electrical record.

The airplane being developed by the laboratory costs about a hundredth what a military drone does.

Pilot Fredric Gould flies the model from a radio-control panel on the specially built airfield runway 400 feet long and 100 feet wide.

Airborne Ice Crystal Catcher Developed by ERL Scientists

Environmental Research Laboratories scientists have developed a snowflake collector and decelerator—an instrument that can collect, intact, delicate snow crystals, even from aircraft flying at speeds up to 200 miles (320 kilometers) per hour.

The device, which would be attached to the nose of a pressurized aircraft, consists of a 22-foot (7-meter) aluminum boom connected to a small refrigeration unit. A valve on one end of the receiver tank neutralizes the effect of pressure inside the aircraft which might prevent the ice crystals from entering. A throttle valve governs the rate of flow at the inlet, slowing the flakes so they drift gently in.

The refrigerated receiver tank contains a 35-millimeter film transport to which a special chemical solution is applied, causing the crystals to stick to the film and retain their shape for examination, photography, sublimation, and further analysis at a later date.

During wind tunnel tests of the new device, the air velocity was controlled at 200 miles per hour with receiver tank velocities at the point of impact recorded from five to 28 miles per hour. Using soap flakes as a reasonable facsimile of snow crystals, the scientists found the instrument design was satisfactory in retrieving the simulated crystals intact.

"We hope the device will help close a serious gap in understanding atmospheric ice and snow crystal habits and formation mechanisms," says Dr. Helmut K. Weickmann, Director of the Atmospheric Physics and Chemistry Laboratory, where the device was developed.

"Little progress has been made in this knowledge during the past 20 years because of difficulty in studying these processes. Collecting snowflakes at high speeds from pressurized aircraft in the past has pulverized the flakes upon impact."

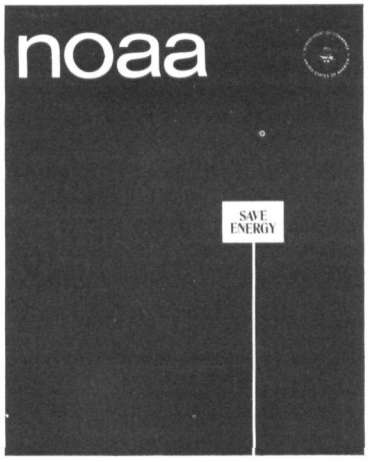
APCL scientists plan to use the instrument for studying how snow and ice crystal formation and behavior influence the formation of precipitation naturally and after cloud seeding.

"Ice crystals are the main scavengers that bring cloud water content earthward as snow or, after melting, as rain," Dr. Weickmann explains. "And we have to admit we understand very little about the physical processes that make the crystals form and grow.

"To understand the entire mystery of ice crystal growth, scientists must use aircraft flying between the earth's surface and 25,000 feet (8,000 meters) to permit collection and study of the flakes at all temperature ranges of origin."

NOAA Magazine Cover Places Third in Competition

The cover design of NOAA Magazine for January 1974 won third place in the Industrial Arts Methods (IAM) Magazine's Seventh annual contest—a top national competition among designers in both Government and industry. IAM said, "You can't get more of a bang into any message, than the strong, simple IAM Third Award winning cover of NOAA, the quarterly magazine issued by the National Oceanic and Atmospheric Administration of the Department of Commerce. It's just black and white, and who needs more with any idea as creative as this one, by Designer/Art Director William N. Welsh."



NOAA REGULATIONS LIMIT TUNA CATCH

NOAA has established regulations limiting the catch of Atlantic bluefin tuna to help conserve stocks of the threatened species.

The regulations, published in the Federal Register, permit the Director of the National Marine Fisheries Service to establish fishing seasons, quotas, reporting requirements, enforcement procedures, and penalties relating to the catch of the bluefin tuna.

Publication of the regulations followed signing of the Atlantic Tunas Convention Act of 1975 by President Ford, and, in effect, implements recommendations adopted by the International Commission for Conservation of Atlantic Tunas.

The Commission is responsible for the study of the populations of tuna and tuna-like fishes in the Atlantic Ocean, and recommends proposals for joint action by member governments to maintain fish stocks at levels permitting maximum sustainable catch.

Member countries of the Commission are Brazil, Canada, Cuba, France, Ghana, Ivory Coast, Japan, Korea, Morocco, Portugal, Senegal, South Africa, Spain, and the United States.

Provisions of the new regulations will permit the Director, NMFS, to establish open and closed seasons for Atlantic bluefin tuna weighing between 14 and 115 pounds or more than 300 pounds; permit anglers a daily bag limit of four Atlantic bluefin tuna weighing between 14 and 115 pounds; establish purse seine quotas of 1,100 short tons of fish weighing between 14 and 115 pounds and 200 short tons of fish weighing more than 300 pounds; establish a quota for other than purse seine fishermen of 2,250 fish weighing more than 300 pounds; and limit the catch of Atlantic bluefin tuna incidentally taken while fishing for other species to two percent of the total weight of the catch.

Prior to the enactment of the Atlantic Tunas Convention Act of 1975, the National Marine Fisheries Service had proposed to declare the Atlantic bluefin tuna a threatened species. With the passage of the Act, this action is no longer required and the Director will take steps to stop all actions to list the Atlantic bluefin tuna as a threatened species at this time.

Sun Sensors Readied

Pyrheliometer

NOAA scientists are comparing data obtained from pyrheliometers —precise sun-tracking instruments which measure the strength of direct solar radiation.

Such measurements are fundamental to studies of large-scale atmospheric processes, which are driven by energy from the sun, and to the design of solar energy conversion systems.

The pyrheliometer intercomparison is designed to ensure that instruments of different types, at different locations, obtain similar results. Conducted by the Environmental Research Laboratories' Air Resource Laboratories, it is the first such intercomparison to be made by NOAA's newly formed solar radiation calibration facility in Boulder, Colo., directed by Edwin Flowers. The facility is part of a larger solar radiation data program funded by the National Science Foundation.

Instruments in the intercomparison include two reference pyrheliometers from NOAA's Global Monitoring for Climatic Change (GMCC) program, which monitor the subtle variations associated with changing climate; two from the calibration facility; and two from California Institute of Technology's Jet Propulsion Laboratory.

Purpose of the study is to link pyrheliometers to national and international standards for such instruments.

U.S. Coastlines Jeopardized, Coastal Zone Document Warns

An Office of Coastal Zone Management document warns the nation's coastlines are in serious jeopardy because of increasing and conflicting demands being placed upon them. The coastal zone already is hard-pressed to accommodate huge numbers of people, but more are on the way. Today, for example, over one-half of the U.S. population lives within 50 miles of the seashore, but by the year 2000 that number is predicted to rise to four of every five Americans or 225 million people.

Posing an even greater problem, meanwhile, are oil refineries, airports, beaches and beach homes, highways, harbors, power plants, wildlife refuges, and commercial establishments — all competing with one another for the narrow strip of shore.

"State Coastal Zone Management Activities," a summary of problems and plans for corrective action in 31 of the 34 states and U.S. territories with coastlines, draws a stark picture of the stresses to which the coastal areas are being subjected.

But the document—in effect the first progress report of how states are utilizing the Coastal Zone Management Act of 1972 and approximately $8 million in the federal funds, administered by NOAA, it made available together with $5 million in state funds—also presents a hopeful view, provided the plans of the participating states are carried out to fruition.

Under the Coastal Zone Management Act, states may receive three annual grants to develop their program and a secondary grant to implement the plan. The law requires, however, that states contribute 50 cents in state matching funds for every $1 that OCZM provides. Of the states eligible to receive the grants, only Indiana, Guam, and American Samoa have yet to apply for them.

States which border the Atlantic and Pacific Oceans (as well as the Great Lakes) face enormous problems ranging from conflicting land uses and the siting of energy facilities to revitalization of coastal fisheries.

GRANTS AWARDED FOR FISHERIES STUDIES

NOAA has awarded a half million dollars in research grants to the Atlantic, Pacific, and Gulf States Marine Fisheries Commissions.

The funds will be used to develop a program for the rehabilitation of the fisheries of the U.S. by providing for the needs of recreational and commercial fishermen, while using sound conservation practices designed to protect America's valuable marine resources.

The grants—$200,000 to the Gulf States Marine Fisheries Commission, $175,000 to the Atlantic States Marine Fisheries Commission, and $125,000 to the Pacific Marine Fisheries Commission—were awarded under Congressional Resolution 11, introduced by Senator James O. Eastland of Mississippi, and Public Law 93-433.

Ocean Dumping Effects In N.Y. Bight Reported

A preliminary report after 18 months' study of the life and environment of the New York Bight —a roughly pentagonal 15,000-square-mile area extending from an apex between Long Island and New Jersey to the edge of the continental shelf about 100 miles offshore—concludes that:

—Despite significant evidence that ocean disposal of wastes off New York has caused some ecological damage, there appears to be no immediate threat to the public health or to Long Island beaches;

—Ocean dumping as now practiced there should cease once alternative disposal methods of lesser environmental impact are found.

The seven-year study, being conducted by the Environmental Research Laboratories' Marine Ecosystems Analysis (MESA) Program, is designed to provide a comprehensive look at how the New York Bight ecosystem copes with the environmental pressures of a major urban-industrial complex and some 20 million humans. Charles Gunnerson is the Director of the MESA program.

Soon after its start, the MESA New York Bight project began focusing on determining the specific ecological effects of offshore dumping of sewage sludge (a byproduct of waste-water treatment), dredge spoil, waste acid, and other materials at a rate of nearly half a billion cubic feet per year.

Other conclusions from the first report include:

—Little sediment or dumped material is transported over the ocean floor in the present dumping site areas except during the passage of major storms, when movement of as much as 1,200 feet has been observed over periods of several days.

—At the dredge spoil dump site, a mound of material some 30 feet high has accumulated over about a generation of dumping.

—Levels of nutrients (nitrogen, phosphorus, and silica compounds) are generally high near the sewage sludge dump, and slightly above "normal" around the dredge spoil dump site.

—The unsightly black mud popularized as "black mayonnaise" does not indicate the presence of sewage sludge.

—Concentrations of coliform (intestinal) bacteria in Bight shellfish beds appear to be increasing.

EDS Sponsors International Workshops

The Environmental Data Service recently sponsored a number of international environmental information workshops with Environment Canada and the Environmental Protection Agency in Washington, D.C. Environment Canada, of the Department of the Environment, is NOAA's Canadian counterpart. EPA's personnel participated primarily as observers and to share the results of previous U.S./Canadian workshops.

The objectives of the workshops were to become better acquainted with the persons in each agency responsible for specialized environmental data and information and library resources, and to learn more about the resources themselves in order to develop guidelines and procedures for more effective cooperation and exchange.

The workshops involved overviews of the primary functions of EDS and Environment Canada, as well as working group sessions in the fields of public information, library and documentation services, and specialized information and data services.

Definitive guidelines and administrative procedures for data and information exchange will be developed at subsequent meetings.

EDS Unit Relocated

The Marine Geology and Geophysics Branch, one of several data groups in the Environmental Data Service's National Geophysical and Solar-Terrestrial Data Center, has been relocated in Boulder, Colo., from Washington, D.C. to consolidate the Center's activities.

The Branch acts as a national clearinghouse for bathymetric, magnetic, gravimetric, seismic and bottom sample information collected under various programs by the United States marine institutions and government agencies.

Paul J. Grimm heads the 11-person professional staff of the Branch.

noaa/update

The NOAA Ship Discoverer lies at anchor among ice floes in the Bering Sea as two scientists drill for ice cores. The 303-foot, 3900-ton vessel, commanded by Capt. Clinton D. Upham, penetrated the ice pack as far as 50 nautical miles on her environmental study mission to Alaskan waters. She was based in Miami, Fla., before being assigned to Seattle, Wash.

Search for Marine Extracts Useful in Treating Cancer

A Sea Grant team at the University of Oklahoma is searching for extracts of marine organisms that may be useful in treating cancer and leukemia, hypertension, and cardiovascular disease.

According to Dr. Robert B. Abel, Director of the Office of Sea Grant, "This research program in landlocked Oklahoma, the only noncoastal or non-Great Lakes state with a Sea Grant, is one of the most significant programs designed to discover and identify marine substances with potential medical applications."

Supported by Sea Grant since 1971, the chemists and pharmacologists have provided the National Cancer Institute with extracts from 1665 marine species for testing against experimental tumor systems. Of these, 104 have been confirmed as active against leukemia in mice and 30 against human cancer cells in tissue culture. Some aspects of the program are funded by the National Cancer Institute.

Professors A. J. Weinheimer, L. S. Ciereszko, P. N. Kaul, and F. J. Schmitz and their students skin dive to collect their specimens for study. Marine plants and animals are collected from the tropical coral reefs of the Bahamas, Bermuda, Jamaica, Florida, and Eniwetok. The team also obtains specimens from the Drug Development Branch of the National Cancer Institute.

The Oklahoma team first derives crude extracts from the specimens. After the extracts' pharmacological action has been confirmed, they are subjected to chemical study to isolate the pure compounds with potential usefulness as drugs, and the structure of these pure compounds is determinated. Larger quantities are then obtained—by harvesting or by synthesizing them in the laboratory—and referred to interested pharmaceutical companies for the preclinical and clinical studies required before new drugs may be introduced.

Under an agreement with the university, the Upjohn Company screens the marine extracts for certain types of bioactivity. Last year, preliminary results of the company's tests found one marine extract active against bacteria and another against viruses.

Marine organisms of greatest interest to the scientists now are corals, sea whips, and sea fans, anemones, and other animals low on the evolutionary ladder. They also are studying two species of sponges, whose extracts lower blood pressure and improve the tone of the heart muscle. Natural and synthetic chemical compounds with these properties are potentially useful in treating high blood pressure and heart disease.

A major objective this year is development of streamlined standardized techniques for measuring the effects of the marine extracts. The team also will study the most potent nonproteinaceous marine toxin known—palytoxin.

Acoustic Sounder Being Used For First Time in Antarctic

Every few seconds a high-pitched pulse of sound probes the atmosphere around South Pole Station, as Environmental Research Laboratories scientists investigate the heat-exchange processes between ice and atmosphere with a new type of remote sensor—an acoustic sounder.

The instrument is being used for the first time in the Antarctic, to detect very fine temperature differences in the lowest layers of the atmosphere (the planetary boundary layer) in a cooperative project begun earlier this year by NOAA and the National Science Foundation.

"Antarctica is an ideal meteorological site for studying temperature inversion layers in the first 2,000 feet (600 meters) of the atmosphere. Inversions are nearly always present and there is no environmental noise interference from birds, mountainous terrain, and other sources," says Dr. Freeman F. Hall, chief of the Atmospheric Acoustics Program at ERL's Wave Propagation Laboratory. "During the Austral summer in Antarctica, the sun never sets, so we can study wave patterns without the daily temperature fluctuations caused by sunrises and sunsets."

A large proportion of the atmosphere's heat is deposited at the North and South Poles. The radiative heat loss from the ice coupled with the turbulent heat deposited into the ice determines the energy balance between the atmosphere and the surface. Understanding the heat transport mechanism is important to atmospheric scientists in formulating computer models of global circulation patterns.

"By comparing the turbulent and solar input to the ice with heat loss measured by spacecraft radiometers, we may be able to understand long term variations in ice temperatures, and study the effect of such variations on climatic dynamics," Dr. Hall explains.

"Radiation studies have been made of the amount of heat released by the ice, but until now no one has made detailed studies of the turbulent heat transport from the free atmosphere into the ice."

Dr. Hall and his colleagues found that the inversion layer of air hovering over Antarctica 97 percent of the time is much more stable than inversions in other parts of the world, but its makeup is similar to inversions in temperate regions.

Sea Grant Project Aim Is New Seafood Delicacy

A large, succulent crustacean from Malaysia could join shrimp and lobster in popularity with America's seafood consumers, if the efforts of a team of Sea Grant scientists in South Carolina are successful.

With support from NOAA, specialists at several South Carolina institutions are working together to develop successful techniques for cultivating the giant Malaysian prawn—*Micrabrachium rosenbergii*—in captivity.

Dr. Paul Sandifer of the South Carolina Marine Resources Research Institute, located at Charleston, heads the project. Associated with him is Dr. Theodore Smith, mariculture specialist.

Last spring and summer, they stocked five outdoor freshwater ponds with about 25,000 laboratory-reared postlarval prawns. When the ponds were harvested three to five months later, 60 to 70 percent of the prawns had survived and grown substantially.

At Clemson University, engineers Drs. Paul Zielinski and Walter Castro have experimented with two types of tanks for rearing the prawn larvae. Their studies not only are advancing the design of tanks, but are also providing new information on circulating patterns within the tanks and on the use of small air-lift pumps.

Dr. John Manzi of the College of Charleston is investigating the value of algae-rich "green" water as a supplemental food source for prawn larvae, and Jeanne Joseph of the Marine Resources Institute is studying the fat content of cultured prawns and the influence of diet on this content.

noaa/people

Dr. Thomas S. Austin, Director of the Environmental Data Service, is now Chairman of the interagency Panel on International Programs and International Cooperation in Ocean Affairs (PIPICO), succeeding **William Sullivan,** Coordinator of Oceans and Fisheries, Department of State.

Harvey R. Bullis, Jr., Director of the National Marine Fisheries Service Southeast Fisheries Center in Miami, Fla., was appointed Assistant International Coordinator for fisheries at the recent Cooperative Investigations of the Caribbean and Adjacent Regions (CICAR) VII meeting in Mexico City.

Dr. Harris B. Stewart, Jr., Director of the Environmental Research Laboratories' Atlantic Oceanographic and Meteorological Laboratories in Miami, Fla., has been appointed chairman of the seven-nation steering committee planning the Cooperative Investigation of the Caribbean and Adjacent Regions (CICAR) II Symposium.

Cdr. John D. Bossler, a NOAA commissioned officer with 16 years of service, has been named Deputy Director of the National Geodetic Survey.

Lt. Cdr. Ludvik Pfeifer recently was appointed Technical Director of the North American Datum Program, which is being coordinated with other nations in North and Central America.

Dow E. Boykin, Principal Assistant in the National Weather Service Office at Tampa, Fla., has been selected to head the NWS office at Daytona Beach. He replaces **Don Russell,** who has retired.

Dr. Allan R. Thomas has been appointed Director of the Office of Programs at the Environmental Research Laboratories in Boulder, Colo. He succeeds **John R. Robinson,** who has gone to a position in ERL's outer continental shelf environmental assessment program.

Norman Doelling has been named manager of the Massachusetts Institute of Technology Sea Grant Program's Marine Industry Advisory Service.

Donald A. Kluckman recently entered on duty as Meteorologist-in-Charge at the National Weather Service Meteorological Office in Neenah, Wis., replacing **Anne Elder.**

Cdr. Donald J. Florwick, former Executive Officer of the NOAA Ship Researcher, is the new Officer in Charge at the National Ocean Survey's Southeast Marine Support Facility in Miami, Fla.

Ignacio C. Rodriguez has been named Official in Charge of the National Weather Service Office at Pueblo, Colo.

Dr. Carleton Coulter, III, NOAA Facilities Engineer, has been elected a Fellow of the American Society of Civil Engineers in recognition of his engineering accomplishments.

Charles T. Whalen has been named chief of the National Geodetic Survey's Vertical Network Branch in Rockville, Md. He succeeds **Cecil Ellingwood.**

Lt. Michael F. Kolesar has been named Commanding Officer of the NOAA Ship George B. Bowers.

Dr. James D. McQuigg has been invited to serve on the National Research Council's Committee on Changing Climatic and Weather Patterns and their Effects on Agricultural and Renewable Resources Productivity.

Robert J. Coe has been named Meteorologist in Charge of the National Weather Service Meteorological Office at Marseilles, Ill. He replaced **Warren E. Sunkel,** who has transferred to Topeka, Kans.

John C. O'Brien is the Meteorologist in Charge of the new National Weather Service Meteorological Observatory at Longview, Tex.

Howard H. Eckles has received a Department of Commerce Bronze Medal and a special achievement award.

Richard Meyer, a technical assistant with the Operations Division of the Pacific Marine Center, has been named to the staff of experts formed to assist the Washington State Board on Geographic Names.

Julie Hass, who is working as a student aide in the Environmental Research Laboratories' Aeromomy Laboratory in Boulder, Colo., was selected from among a group of outstanding senior women representing Denver metropolitan area high schools, to receive the second annual student award of the Association of Federal Professional and Administrative Women.

Harry A. Lippincott is now Chief of the Vertical Control Section at the National Ocean Survey's Lake Survey Center in Detroit, Michigan.

Mrs. Ruth B. Brown, Personnel Staffing Assistant at the National Marine Fisheries Service Southeast Region, was recently honored as the NMFS Federal Employee of the Year for the Tampa Bay Area by the Tampa Bay Federal Executive Association.

Capt. Kelly E. Taggart has been named to succeed **Capt. William D. Barbee** as Commanding Officer of the NOAA Ship Oceanographer.

Carmen Blondin has received his formal appointment as U.S. Commissioner for the North Pacific Fur Seal Commission.

Mary E. Ambrose has been awarded a Department of Commerce Bronze Medal.

Lt. Cdr. William R. Daniels is the NOAA Ship Mt Mitchell's new Operations Officer.

Richard C. Hagan has entered on duty as Meteorologist in Charge of the Savannah, Ga., National Weather Service Office.

Gloria E. Shelton, an employee of the National Weather Service Systems Development Office's Equipment Development Laboratory, has become NOAA's first woman Electronics Technician.

Gerald O'Brien, Robert Saffle, Janet Hense, and **Paul Wofsy,** of the Weather Service's System Development Office, Digitized Radar Experiment (D/RADEX) Project, were recipients of a Unit Citation for their valuable contributions and superior performance in the application of a computer technology to the radar program of the NWS.

Dr. Frederick J. Smith has won the American Agricultural Economics Association's Distinguished Extension Program Award for 1975.

Dr. Hoyt Wheeland recently departed NMFS to become the Senior Fisheries Officer for the Food and Agriculture Organization in the South China Sea Fisheries Development Programme in Rizal, Philippines.

Maynard W. Ziomke of the North Platte, Nebr., National Weather Service Office has been awarded the Department of Commerce Bronze Medal.

Laverne M. Wermich of the Chicago, Ill. Weather Service Forecast Office has been awarded the Department of Commerce Bronze Medal.

Richard M. Ressor, Official in Charge of the Rockford, Ill., National Weather Service Office has been awarded the Department of Commerce Bronze Medal.

Helen Fleischhauer received a special achievement award for the high quality of her work as Technical Publications Editor for the Auke Bay Laboratory of the National Marine Fisheries Service Northwest Fisheries Center.

Commander James Collins is the new Chief of the National Ocean Survey's Coastal Mapping Division in Rockville, Md.

Michael Benefiel, who has been away from the National Marine Fisheries Service for two years as a research student in Tokyo, has returned as a Foreign Affairs Specialist with the Office of International Fisheries.

Robert B. Doeker, Director of the Space Environment Services Center of the Environmental Research Laboratories' Space Environment Laboratory in Boulder, Colo., has been appointed Management Coordinator for ERL's Equal Employment Opportunity program.

Dr. Kirby J. Hanson of the Environmental Research Laboratories has been appointed director of the Air Resources Laboratories Geophysical Monitoring for Climatic Change (GMCC) program.

Francis L. Cannon of Abilene, Tex., has been selected to head the National Weather Service Office in Wichita Falls, Kans.

Eugene W. Hoover, Lead Forecaster at the National Weather Service Forecast Office in Washington, D.C., has received a Department of Commerce Bronze Medal.

Dr. George M. Meaburn has been appointed Program Leader for the Fisheries Chemical Analysis Program of the National Marine Fisheries Service Southeast Utilization Research Center in College Park, Md. He succeeds **Mrs. Mary Ambrose,** who has retired.

Marvin H. Hofer is the new National Weather Service Port Meteorological Officer at San Francisco, Calif. He replaced **Paul A. Arnerich,** who has retired after more than 37 years of Federal service.

Robert F. Strickler has received a Department of Commerce Bronze Medal.

Joyce Toyne was selected as "Woman of the Year" by the New Horizon Chapter of the American Business Women's Association.

Arthur F. Talamantes, Jr., a Weather Service Specialist at San Antonio, Tex., has been named Official in Charge of the National Weather Service Office at San Angelo, Texas.

William E. Eggert has been selected by the National Weather Service as Chief of the Data Systems Division and Deputy Associate Director for Technical Services.

noaa/update

Scientist Restores Vegetation

A University of Miami Sea Grant scientist, using a new seeding technique, has restored vegetation on a bay bottom denuded by heated water and silt from a power plant.

Since the release of these effluents into Biscayne Bay ended, Dr. Anitra Thorhaug has succeeded in growing *Thalassium testudinum* — commonly called turtle grass because it is a favorite food of sea turtles—on the bay's bare floor.

Her research is supported by the Office of Sea Grant, and the Florida Power and Light Company and the Atomic Energy Commission have helped finance the studies.

"Where turtle grass is, the fish are," Dr. Thorhaug says. "It provides food and protection for sport and commercial fishes during various stages of their life cycles . . ."

Dr. Thorhaug had a new idea: Why not plant turtle grass seeds? She took a diving crew to the Bahamas where, wearing scuba gear, they harvested 8,000 *Thalassia* fruits, from which, at the University of Miami's Rosenstiel School of Marine Science, 20,000 seeds were separated, and treated with root-growth hormones.

In the meantime, her diving teams are planting turtle grass seeds in an area of Biscayne Bay between Miami and Miami Beach, where siltation and pollution long ago thinned out bottom vegetation and where few fish cruise.

KARO AWARD GOES TO OCEANOGRAPHER AND RESEARCHER

The officers and the crews of the NOAA Ships Researcher and Oceanographer recently received the Karo Award of the Society of American Military Engineers for their role in the Global Atmospheric Research Program's Atlantic Tropical Experiment (GATE) during the summer of 1974.

The Award is named for Rear Admiral H. Arnold Karo, former Director of the U.S. Coast and Geodetic Survey who later, as Vice Admiral, was Deputy Administrator of NOAA's predecessor agency, the Environmental Science Services Administration.

Seals to Radio Their Voyages To Scientists

Scientists at the National Marine Fisheries Service's Northwest Fisheries Center in Seattle, Wash., have equipped fur seals with sound to gain more information on their feeding, movements, and behavior.

Harnesses with radio transmitters have been attached to 50 young male fur seals when they returned to St. George Island. St. George and St. Paul are two of the Pribilof Islands in the Bering Sea used for breeding grounds by approximately 80 percent (1.3 million) of the world's northern fur seals.

Fur seals are harvested each year on St. Paul Island by NOAA under the provisions of the Interim Convention on the Conservation of North Pacific Fur Seals. Commercial harvesting on St. George Island was stopped in 1973 to permit scientists to study a protected population of northern fur seals.

Practically nothing is known about the normal cyclic activity of the young males because they have traditionally made up most of the annual harvest, which normally took place in June or early July. Lack of this knowledge reduces the accuracy of population estimates for young males. A count of these animals on land cannot give the total population because there are always animals feeding at sea and many are as late as October in arriving on the island. The census is further complicated because of differences in behavior due to age and because the ratio of the number of animals on and offshore probably changes because of weather and human disturbances.

The transmitters have a range of about one-half mile and will be monitored for a little over three months.

PROTOTYPE BUOY DEPLOYED IN PACIFIC

(From left) Dr. John W. Townsend, Jr.; Rear Admiral H.R. Lippold, Jr., Director Pacific Marine Center; and Congressman Joel Pritchard of Washington, principal speaker at the dedication of the buoy.

The prototype of an array of operational buoys designed to add a major capability to America's ocean and weather reporting system was recently accepted for NOAA in Seattle, Wash., by Dr. John W. Townsend, Jr., Associate Administrator.

The 50-ton, 33-foot high buoy, developed under a contract with the NOAA Data Buoy Office by General Dynamics Electronics Division, San Diego, Calif., was anchored about 240 miles out in the Pacific directly west of a point half way between Coos Bay, Oreg., and Crescent City, Calif.

NOAA plans to deploy about 30 such buoys over the next five years, contingent upon funding, to furnish atmospheric and oceanic data from ocean areas where weather patterns are formed and where storms are often spawned before moving landward.

Each buoy will have a disk-shaped hull with a center mast; meteorological and oceanographic sensors to measure wind speed and direction, barometric pressure, air temperature, surface wave height and period, and water temperature at seven depths; a three-year supply of batteries; mooring line; and electronics package.

The buoys will transmit data automatically by radio every six hours to Coast Guard shore communications stations in San Francisco and Miami. The Miami station will process all data from both points and transmit it, within an hour, to computers at the National Weather Service in Suitland, Md., for incorporation in the national weather forecasting system. In special cases the buoys can be interrogated, and the processed data will be obtained by Suitland within 15 minutes.

74 in '74: Attempts to Alter Weather

A new NOAA publication *Weather Modification Activity Reports, Calendar Year 1974,* includes information on 74 federal and nonfederal weather modification projects carried out last year. Federal regulations require that all nonfederally sponsored weather modification activities in the United States be reported to the Secretary of Commerce. Federal agencies report activities in this field through interagency agreement. Last year, the reporting rules were amended to obtain information on environmental impact and safety procedures associated with the various projects.

The report concludes that, in most activities, the consequences of the operations or experiments were carefully considered

NOAA Diving Manual Will Aid Divers in Scientific Research

NOAA has published a diving manual designed to guide divers in shallow water work—down to 300 feet—and provide them with the knowledge needed both for safe and efficient diving, and for carrying out useful scientific research.

The "NOAA Diving Manual: Diving for Science and Technology," was prepared primarily for NOAA's nearly 300 divers; however, it contains basic up-to-date information on the diving technology required to carry out scientific investigations and other working diver tasks, and is expected to be of use to scientific and working divers throughout the world.

Prepared by the Manned Undersea Science and Technology group, the manual includes contributions by 58 experienced scientific and operational divers from universities, Federal and state agencies, and private organizations throughout the United States.

Basic diving physics and physiology, diver training, equipment, breathing media and procedures, diving under varied conditions—such as under ice and in rivers and lakes—air diving and saturation diving, and marine animals hazardous to divers are covered.

The NOAA Diving Manual is for sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C.

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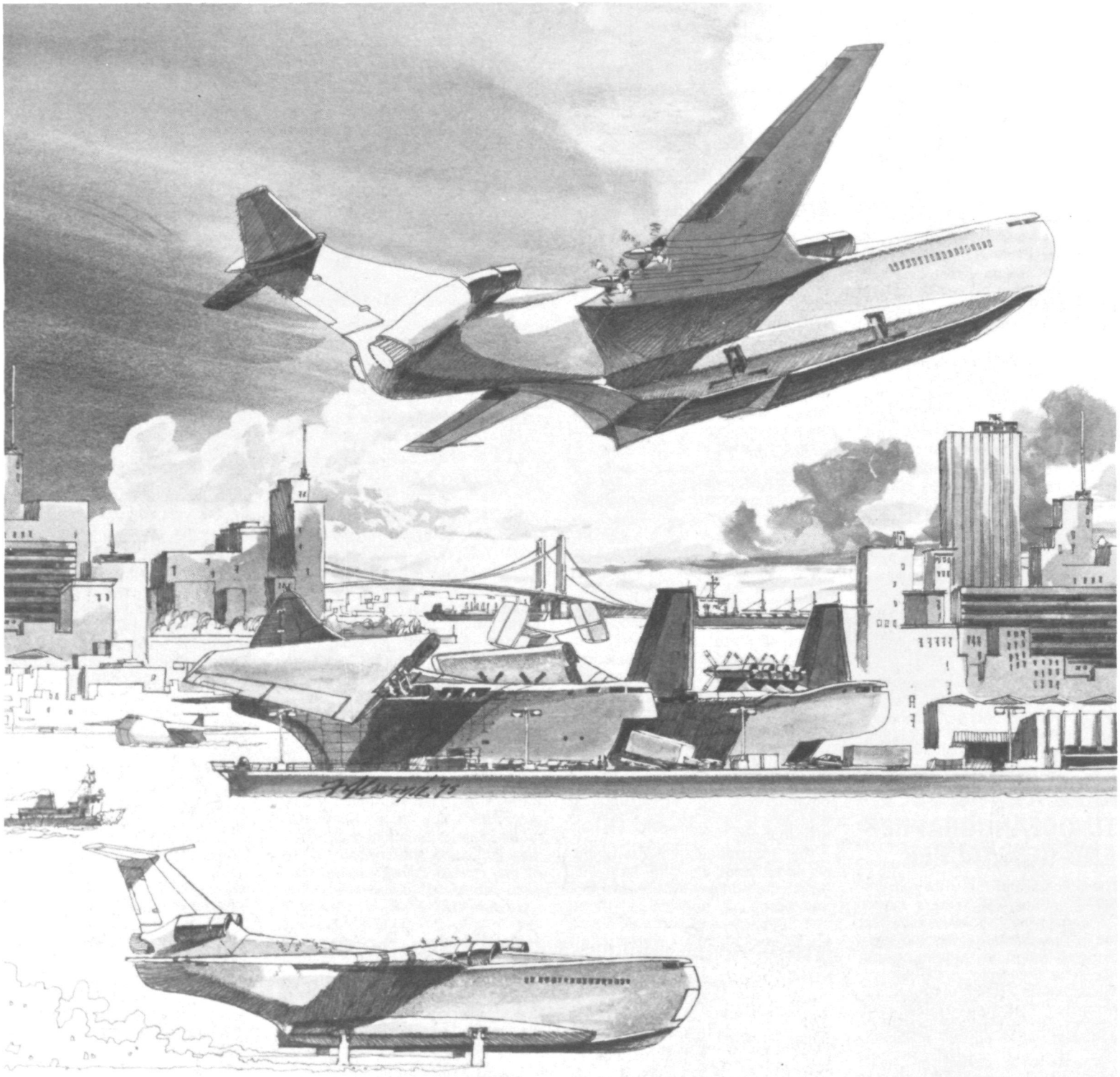

For story see page 28.

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