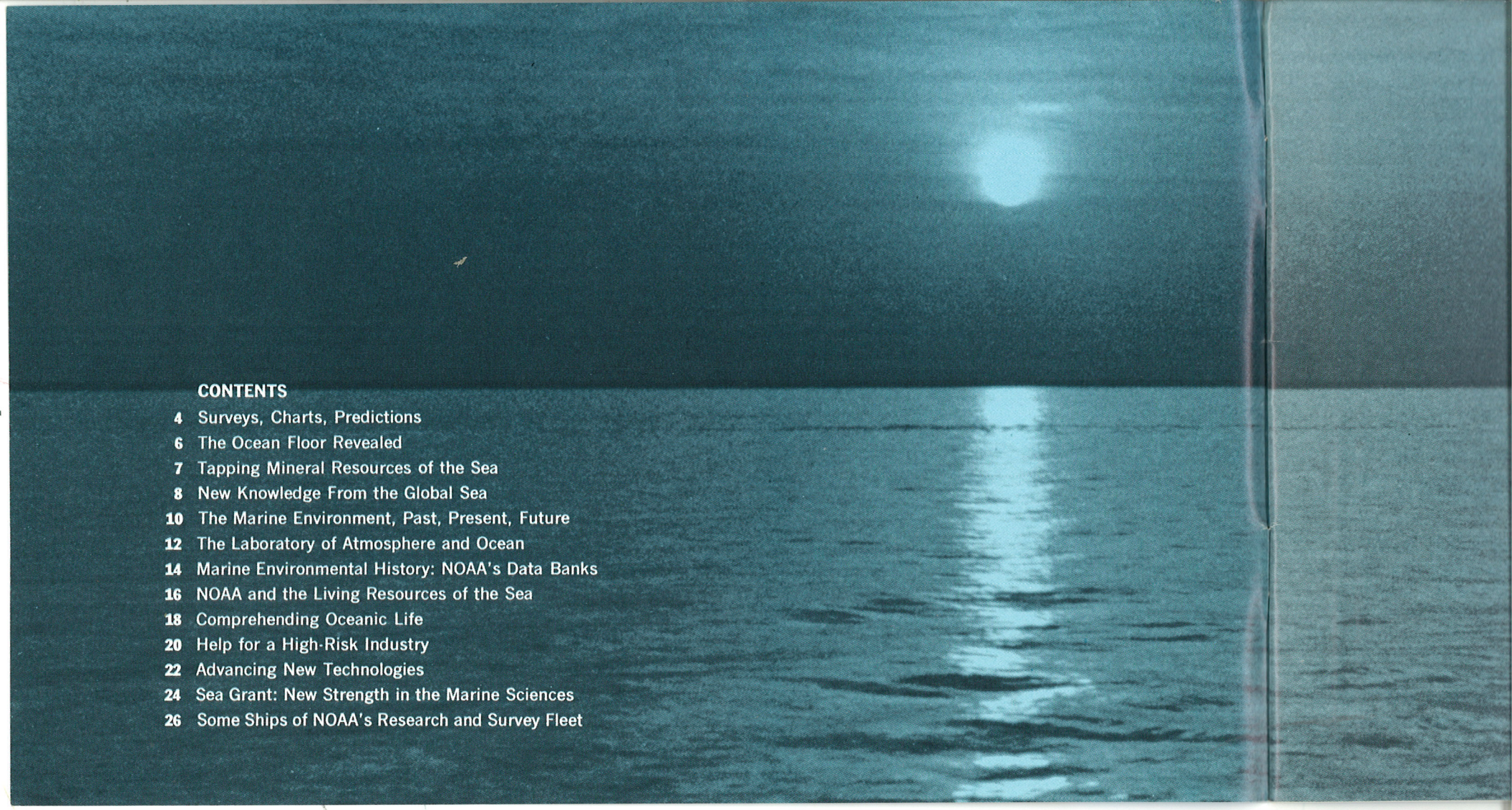
A UNITED STATES DEPARTMENT OF COMMERCE PUBLICATION

NOAA, THE MARINE ENVIRONMENT, AND OCEANIC LIFE

U.S. DEPARTMENT OF COMMERCE

National Oceanic and Atmospheric Administration



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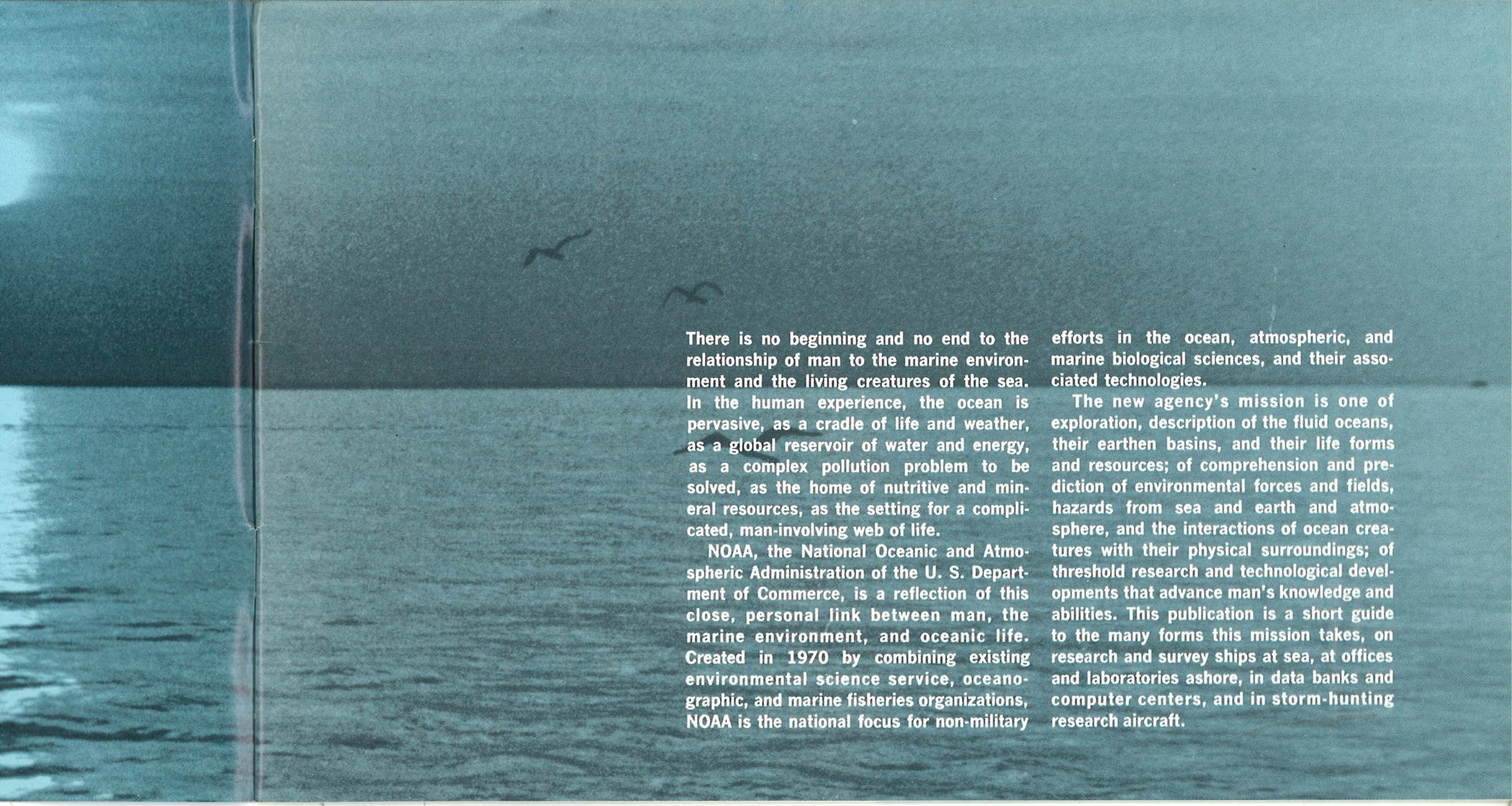
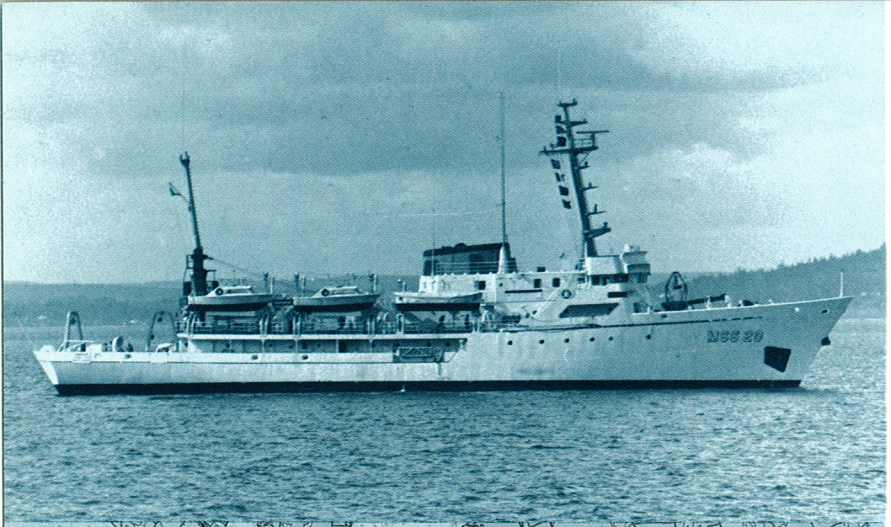


There is no beginning and no end to the relationship of man to the marine environment and the living creatures of the sea. In the human experience, the ocean is pervasive, as a cradle of life and weather, as a global reservoir of water and energy, as a complex pollution problem to be solved, as the home of nutritive and mineral resources, as the setting for a complicated, man-involving web of life.

NOAA, the National Oceanic and Atmospheric Administration of the U. S. Department of Commerce, is a reflection of this close, personal link between man, the marine environment, and oceanic life. Created in 1970 by combining existing environmental science service, oceanographic, and marine fisheries organizations, NOAA is the national focus for non-military efforts in the ocean, atmospheric, and marine biological sciences, and their associated technologies.

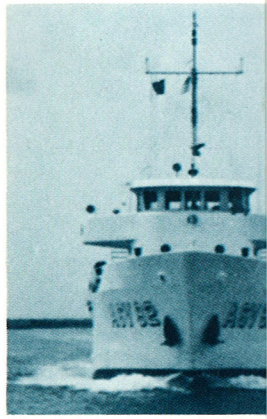
The new agency's mission is one of exploration, description of the fluid oceans, their earthen basins, and their life forms and resources; of comprehension and prediction of environmental forces and fields, hazards from sea and earth and atmosphere, and the interactions of ocean creatures with their physical surroundings; of threshold research and technological developments that advance man's knowledge and abilities. This publication is a short guide to the many forms this mission takes, on research and survey ships at sea, at offices and laboratories ashore, in data banks and computer centers, and in storm-hunting research aircraft.



Hydrographic surveys by new ships like the Fairweather **(left) produce raw data for nautical charts. Chart shoreline is obtained from aerial photographs, like these paired panchromatic (above, left) and infrared (above, right) photos.**

SURVEYS, CHARTS, PREDICTIONS

NOAA's National Ocean Survey charts our coastal and Great Lakes waters in a never-ending task of describing depths, shoreline, and other navigationally important features as they are revised by man and nature. Survey ships equipped to gather such data automatically sound water depths with a precisely navigated positional grid, and bring data ashore in computer-ready form.



Circulatory surveys by the to measure currents, tempe currents and to manage poll

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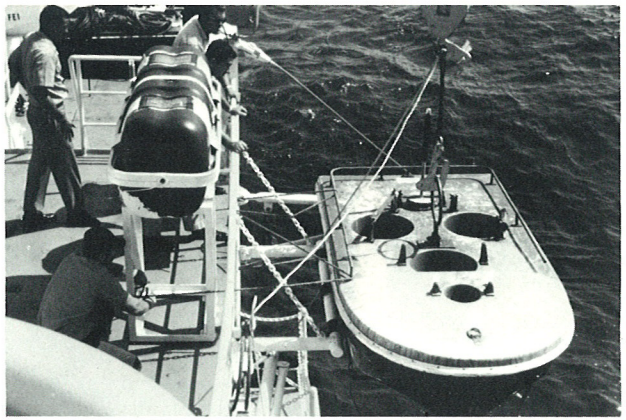
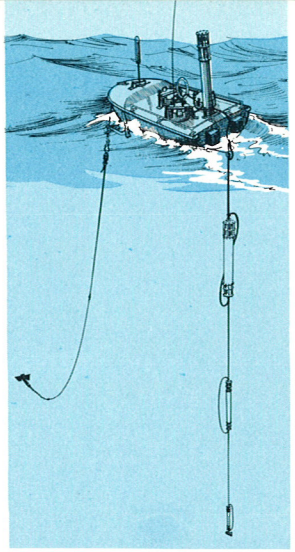


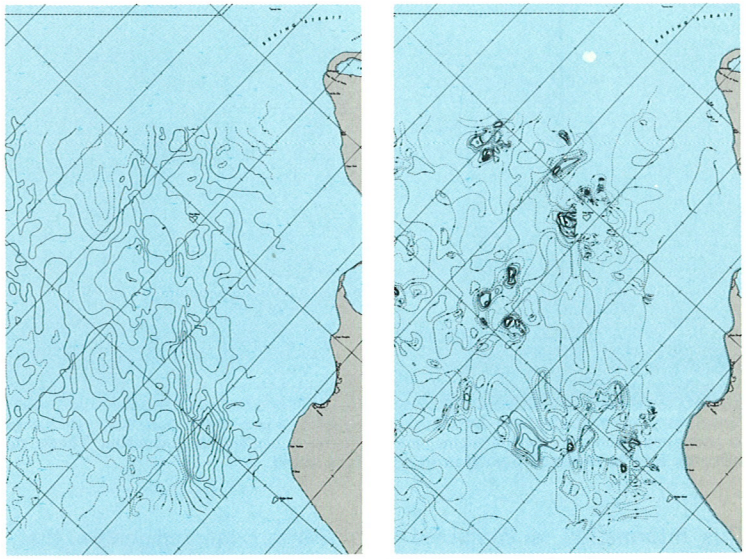


Circulatory surveys by the NOAA ship Ferrel **(above, left) use sensors suspended from anchored buoys to measure currents, temperature, and salinity at preselected depths. These data are used to predict tidal currents and to manage pollution in estuarine areas.**

This information is combined with shoreline maps compiled from aerial photographs, and finally produced as a nautical chart. As with much environmental work today, charting and mapping occupy the talents of both men and computer-controlled machines. Every year, the end product of this work is some 2.7 million nautical chart copies, issued in updated form for those who use the sea and our Great Lakes.

Special surveys are also made. Some employ wire drag ships, which tow a submerged cable that snags such hard-to-locate hazards as sunken ships and pinnacle rocks. Others use sophisticated measuring devices suspended from moored buoys to measure currents, salinity, and temperature at various depths automatically, over periods of weeks. These surveys and measurements are applied to developing tidal current prediction tables and charts and to determining flushing rates and other characteristics of estuaries — important information for controllers of coastal zone pollution.

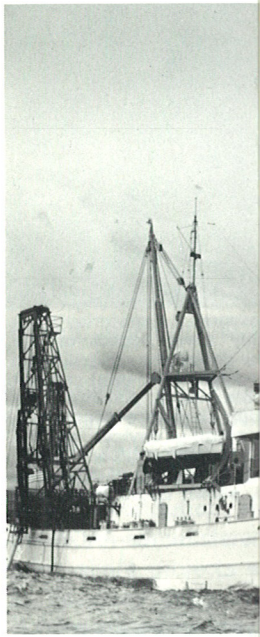
A coastal network of tide gages records the rise and fall of the tides, and provides the basis for pollution studies, tide predictions, shore and sea boundaries, and for tidal corrections to nautical charts. They also provide information used to develop storm surge and earthquake-generated tsunami warnings for coastal communities. The tide gage network also serves as a system for monitoring and understanding the encroachments and recessions of the world's oceans upon and from the North American Continent, over decades of time.



Bathymetric maps, like the one shown at left, describe the hills and valleys of the ocean floor. To help the shelfward search for new resources, gravity (above, left) and geomagnetic (above, right) overlays are being added to bathymetric displays.

THE OCEAN FLOOR REVEALED

A new series of maps shows the ocean floor's hills and valleys and plains — its bathymetry — in the same way that topographic maps on the land show relief features. Bathymetric maps, now being compiled for America's continental shelf region (a land area comparable in size to the Louisiana Purchase) at a scale of 1:250,000, and associated displays of magnetic and gravity fields and sub-bottom rock structure, will help today's pioneers find their way to economically and environmentally acceptable development of offshore resources. Similar maps are being developed now for the deep ocean floor.



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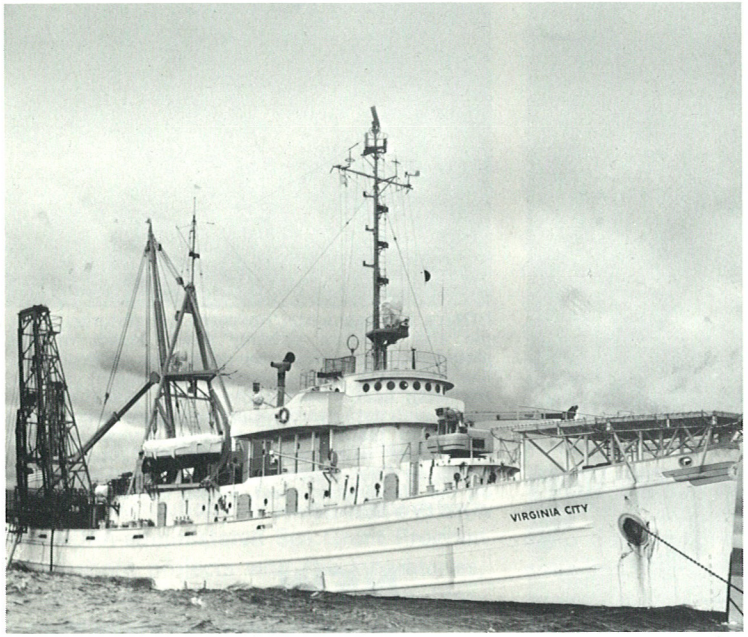

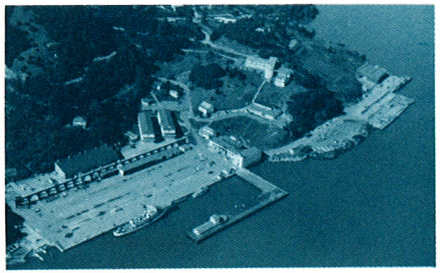

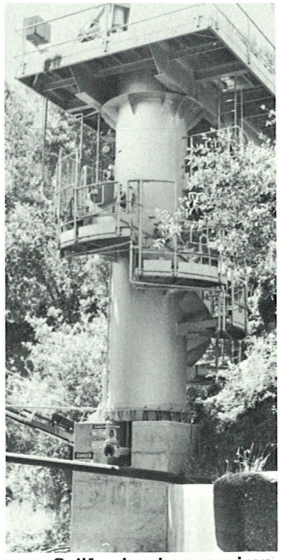

NOAA's Marine Minerals Technology Center, Tiburon, Calif., develops environmentally acceptable methods of tapping the marine resources of the ocean floor. The Virginia City **(left) can drill and process samples (above, left) which are evaluated in facilities like the 30-foot tower (above, right).**

TAPPING MINERAL RESOURCES OF THE SEA

At NOAA's Marine Minerals Technology Center, near San Francisco, researchers are developing new and better ways of sampling sea floor sediments, detecting different types of mineral deposits, and determining the ecological impact of different undersea mining techniques on various underwater environments. Using research ships and land-based test tanks, laboratory aquaria, and a wide range of geophysical and geological sensors, the Center improves man's abilities—and softens man's sometimes heavy hand—in the search for mineral resources in the sea. Sea Grant institutions are also pursuing these lines of research.

SEATTLE POST INTELLIGENCER PHOTO

NOAA's Environmental Research Laboratories sample and measure virtually every aspect of the global ocean, using new-generation instruments like the STD (salinity-temperature-depth) sensor (far left), heat probes (above, left), plankton nets (left), and data-coordinating shipboard computers. Efforts to place remote sensing devices on the ocean floor have included instrumentation experiments on Cobb Seamount, a submerged mountain off the Washington coast, shown above being surveyed by a Scuba diver.

NEW KNOWLEDGE FROM THE GLOBAL SEA

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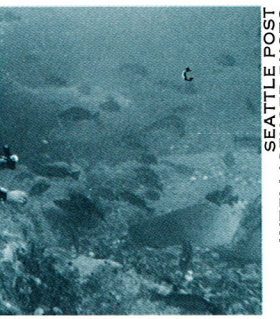

SEATTLE POST INTELLIGENCER PHOTO

Research Laboratories sam-
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Research into the physical and geophysical aspects of the marine environment has two centers of action within NOAA's Environmental Research Laboratories: the Atlantic Oceanographic and Meteorological Laboratories, in Miami, Florida; and the Pacific Oceanographic Laboratory, on the Seattle campus of the University of Washington, and its Joint Tsunami Research Group, on the Honolulu campus of the University of Hawaii. Much of the work at both centers is linked to research activities of colleague laboratories within NOAA—the biological laboratories of the National Marine Fisheries Service, for example—and to investigators in universities and private industry. Individuals and institutions receiving support from the NOAA-administered Sea Grant Program often share projects with the laboratories, as do many State, regional, and multinational research organizations.

The Miami laboratories consolidate the former Atlantic Oceanographic Laboratories —the Physical Oceanography Laboratory, Marine Geology and Geophysics Laboratory, and Sea-Air Interaction Laboratory—and the National Hurricane Research Laboratory. Work here has been associated with studies of plate tectonics and continental drift theory, the Gulf Stream and other major current systems, coastal and estuarine processes, air-sea interaction, tropical meteorology, and experimental weather modification, including the joint NOAA-Navy-Air Force hurricane modification experiment called PROJECT STORMFURY.

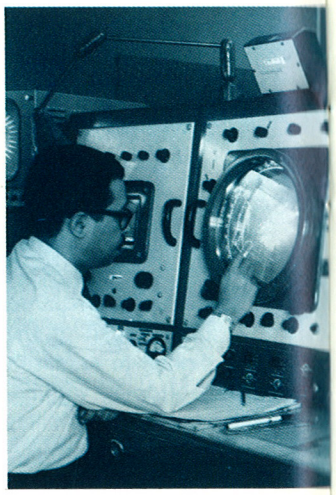
Major projects underway or planned by the laboratories include the TransAtlantic Geotraverse; continued participation in CICAR (Cooperative Investigation of the Caribbean and Adjacent Regions), EGMEX (Eastern Gulf of Mexico), and other cooperative studies; investigations of seafloor sedimentation in selected Atlantic canyons; participation in the Mid-Ocean Dynamics Experiment (MODE), its precursory MODE I sequence, and the new International Deep Sea Tide Program; intensified estuarine and coastal zone studies; and detailed studies of planetary boundary layer and ocean-atmosphere processes. A strong mathematical modeling effort at Miami is developing numerical simulators of estuarine processes, hurricanes, and other phenomena.

At the Seattle laboratory, ocean basin studies have focused on delineating and describing the Pacific system of crustal plates, with emphasis on such active and palaeo plate boundaries as spreading centers, trenches, and transform faults. This program derived from SEAMAP* data taken in the North Pacific during the 1960s, and the lab has extended its description from that base. A major future effort here is a proposed geotraverse from Hawaii to Asia.

Studies of ocean structure and motion cover such processes as the response of near-surface ocean layers to wind and storm systems, and propagation of internal waves generated by interactions of surface tides and the continental shelf. Coastal zone studies are intensifying at the Seattle laboratory, with planned experiments in Puget Sound and other northern estuaries.

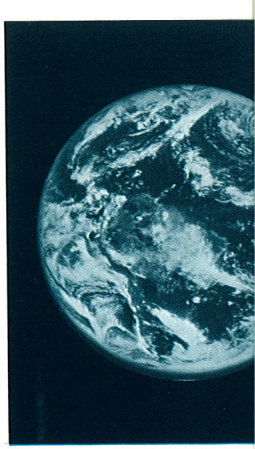
Tsunami research at Honolulu examines generation, propagation, and shallow water transformation of these destructive waves. Efforts are under way to establish open-ocean systems to monitor tsunamis, and the shallow water transformation problem is being studied analytically and in numerical models. Recent progress here has suggested that planetary waves may be monitored through their magnetotelluric signatures, a possible method of monitoring large-scale ocean circulation.

*A systematic ocean survey conducted by what is now NOAA's National Ocean Survey.



THE MARINE ENVIRONMENT, PAST, PRESENT, FUTURE

NASA PHOTO



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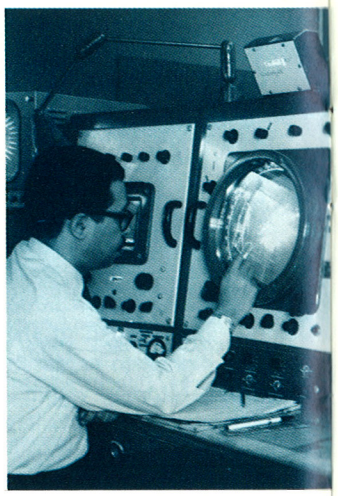

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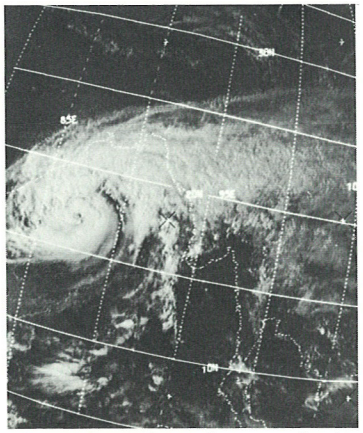
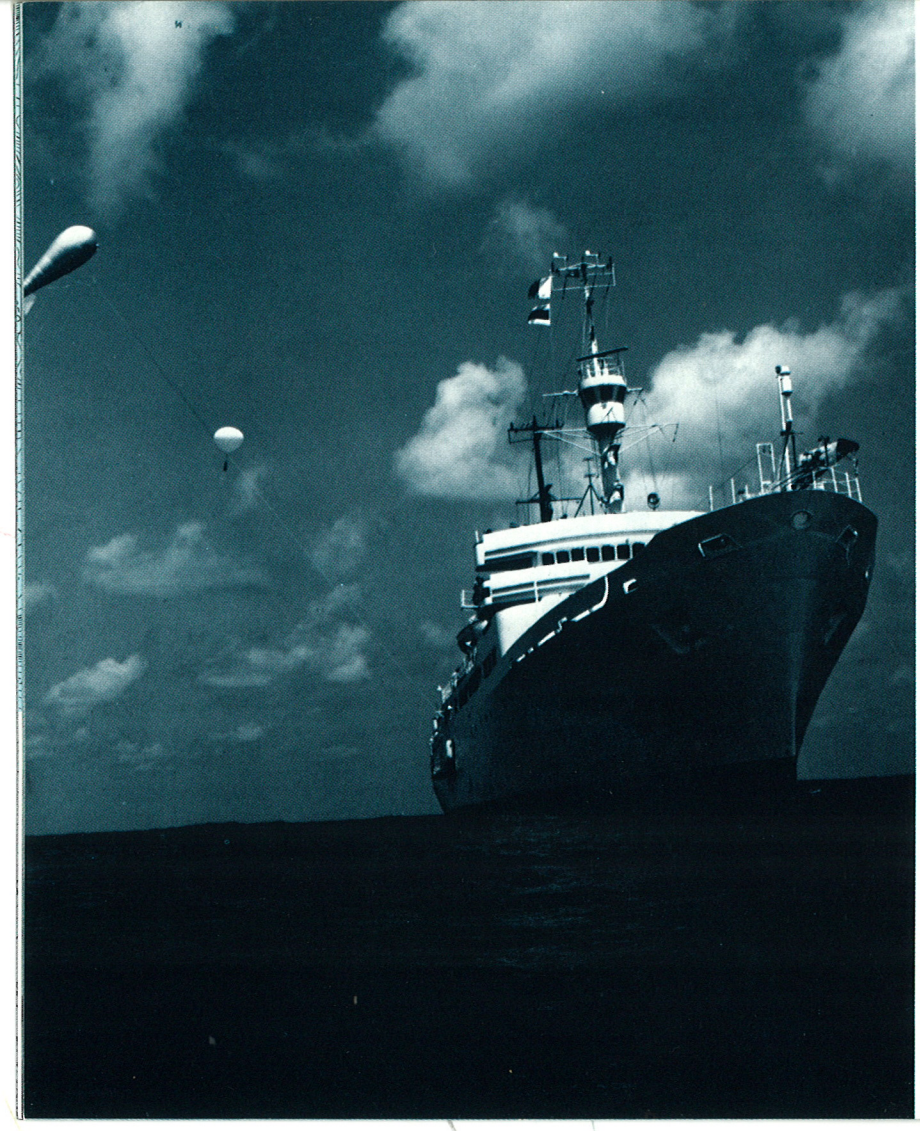


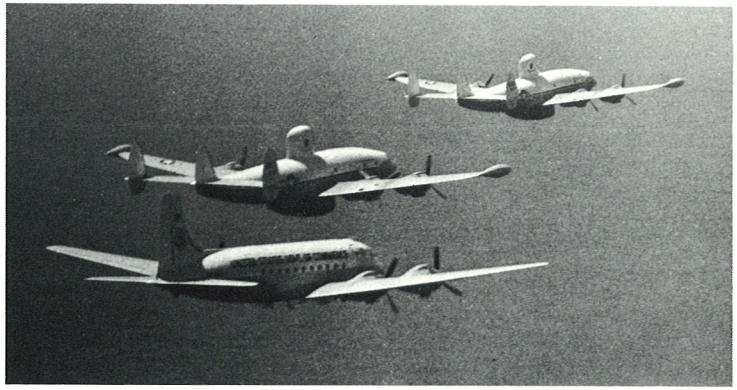
Marine weather services provide reports, forecasts, and warnings to all who use the sea. Developed from observations taken at sea (like the radiosonde launch at far left), radar (left), geostationary satellites and polar-orbiting spacecraft (above, left) a portrait of present and future marine environmental conditions is disseminated by a variety of methods, among them the NOAA VHF Radio Weather transmission at far right.

Much of the marine environment is so changeable that the best description of it is a prediction. Weather, sea state, and the hazards of atmosphere and ocean are all the subjects of marine environmental prediction development at NOAA.

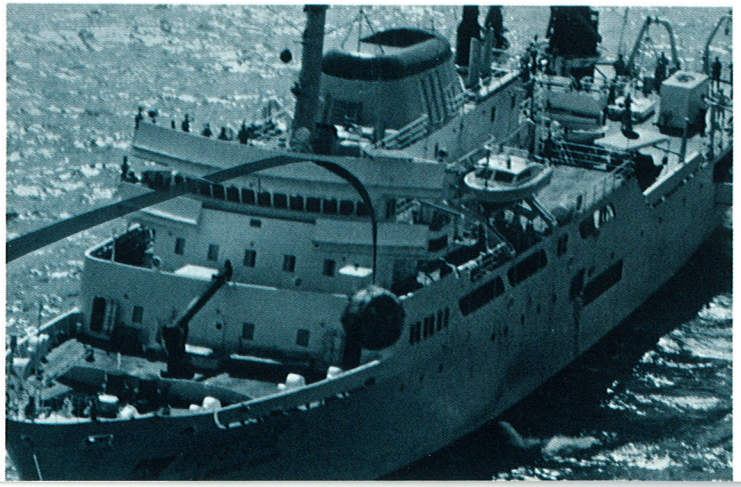
Meteorologists in NOAA's National Weather Service put together their weather "puzzle" from measurements made at hundreds of surface locations, on oceangoing ships and weather reconnaissance aircraft, from satellite photographs and radar images, and from profiles of temperature and humidity made by sensor-bearing balloons and by experimental sensors aboard earth-orbiting satellites. Weathermen and their high-speed computers, using mathematical models of the atmosphere, then predict what future conditions will be. More knowledge of conditions at the air-sea boundary, and over the sparsely covered ocean area, will improve the accuracy of these forecasts.

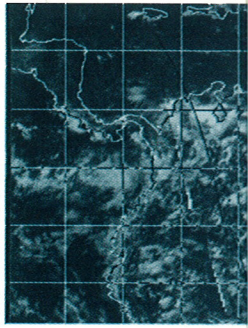
MAREP (from Marine Environmental Prediction) is the acronym given to the efforts of the Department of Commerce and other federal agencies to bring together into one unified predictive system NOAA's marine weather services, predictions of tides and currents and of sea state and surf conditions, forecasts of fish abundance, and other existing and planned services. This involves new sensors and platforms—for example, satellites and ocean-moored buoys—and significant advances in our comprehension of oceanic life and its relation to marine environmental processes.





BOMEX, the Barbados Oceanographic and Meteorological Experiment, was the first major area study of the type urgently needed for improved environmental prediction. At left, the Discoverer **flies a balloon-borne air-sea boundary layer instrument package and wears a bow-array of sensors. Gathered data was sent ashore daily in packages hooked by low-flying Air Force transports (below). Commerce Department and Navy aircraft (above) supply atmospheric observations over the anchored ship.**





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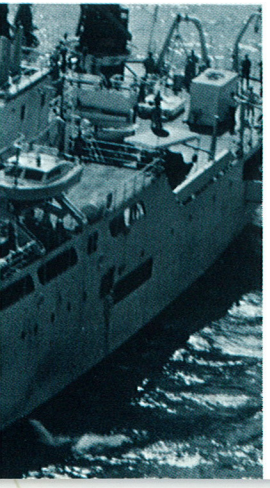
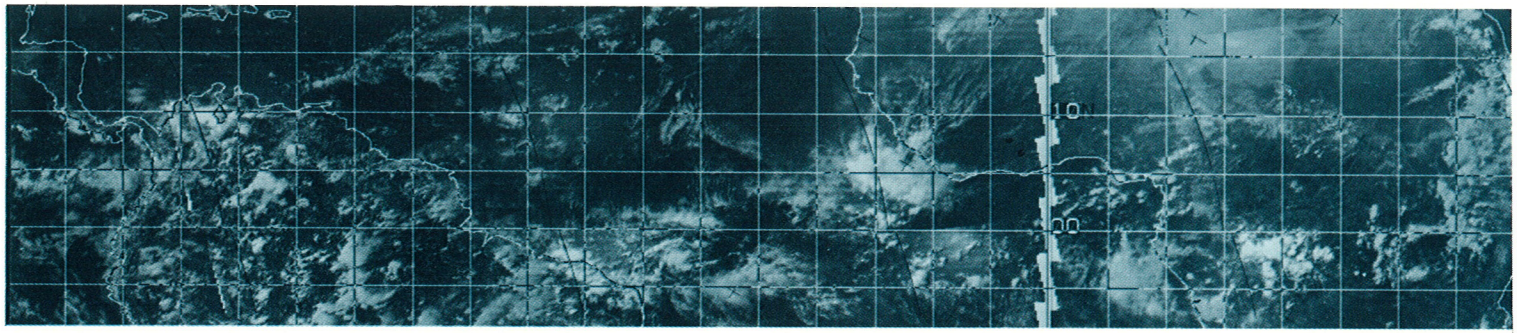
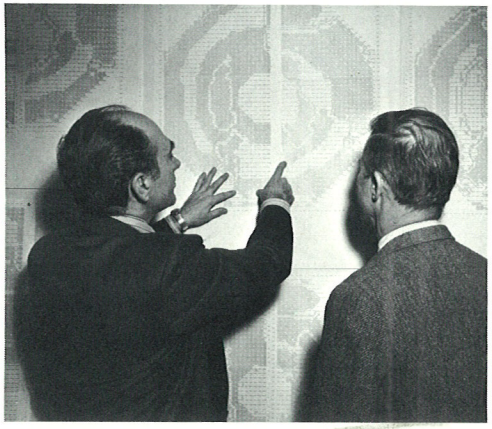


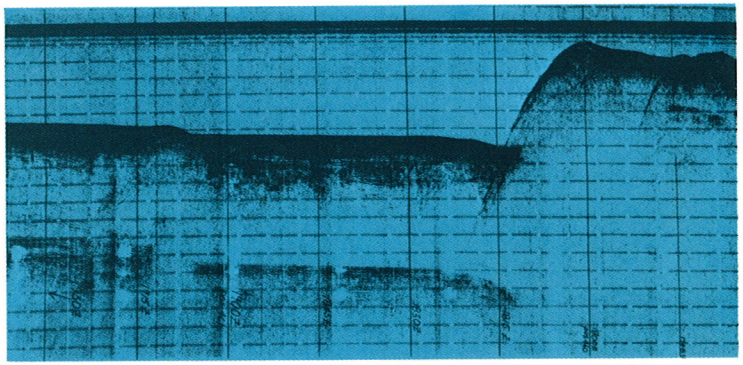


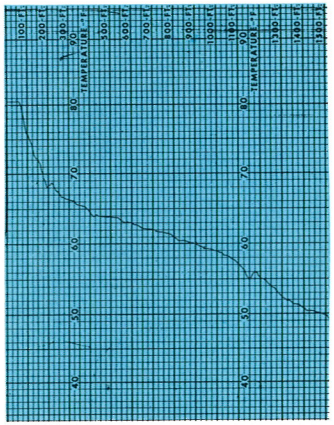
THE LABORATORY OF ATMOSPHERE AND OCEAN

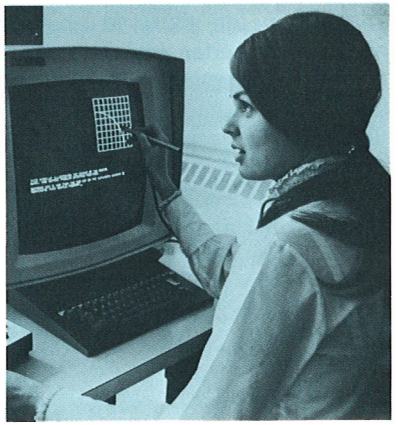
GATE, the GARP Atlantic Tropical Experiment (GARP=Global Atmospheric Research Program) will subject ocean-sized areas to scientific scrutiny, and use larger BOMEX-style arrays in the area shown in the satellite mosaic above. Among the beneficiaries of such research are developers of mathematical models of the atmosphere, which translate weather into numbers, as in the computer printouts below.

The search for improved prediction techniques (and better ways to gather and use marine environmental data) takes NOAA and its colleague organizations into the field for major experiments. BOMEX, the Barbados Oceanographic and Meteorological Experiment, studied about 90,000 square miles of tropical Atlantic, from the sea floor to the stratosphere, for three months in the summer of 1969. Area experiments now being planned will cover much larger samples and involve more institutions and nations, to determine what happens between the atmosphere and ocean, and how these processes influence weather, climate, and the "hydroclimate" of the oceans. Data gathered in these field studies are applied to improving the details of mathematical models of the atmosphere, ocean, and their interactions. Another study —a joint United States Canadian effort known as the International Field Year for the Great Lakes—is designed to give us a comprehensive understanding of the physical, chemical, and biological processes at work in Lake Ontario and its basin and, by extension, in all the Great Lakes, to help clean them up.









Past descriptions of environmental conditions come in many forms from NOAA's Environmental Data Service—weather observations from the National Climatic Center (left), seismic reflection profiles (above) from the National Geophysical Data Center, and "wet" data from the National Oceanographic Data Center, including bathythermograph profiles (below, left), retrievable in such forms as a video display (below, right).

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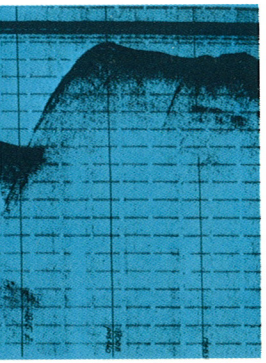

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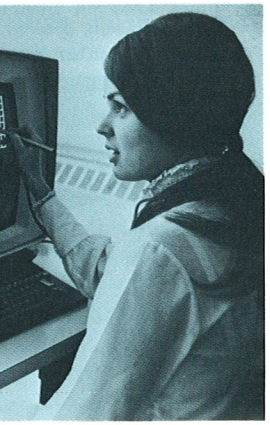

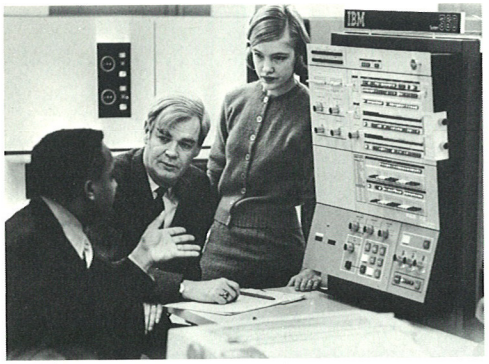

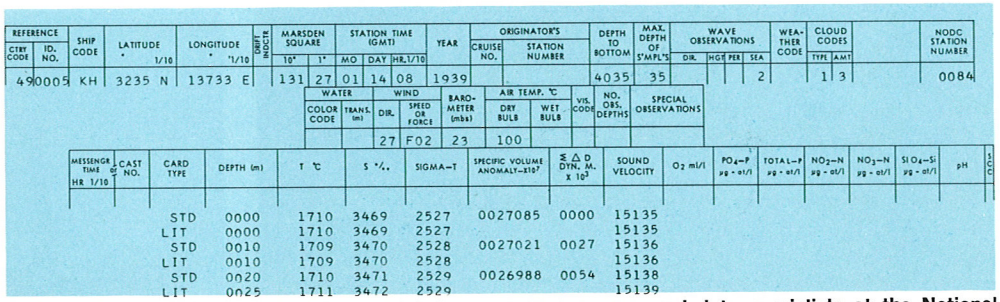

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MESSENGR TIME HR 1/10	CAST NO.	CARD TYPE	DEPTH (m)	T °C	S ‰	SIGMA-T	SPECIFIC VOLUME ANOMALY-10^7	$\Sigma\Delta D$ DYN. M. x 10^3	SOUND VELOCITY	O_2 ml/l	PO_4-P µg-at/l	TOTAL-P µg-at/l	NO_2-N µg-at/l	NO_3-N µg-at/l	SiO_4-Si µg-at/l	pH	
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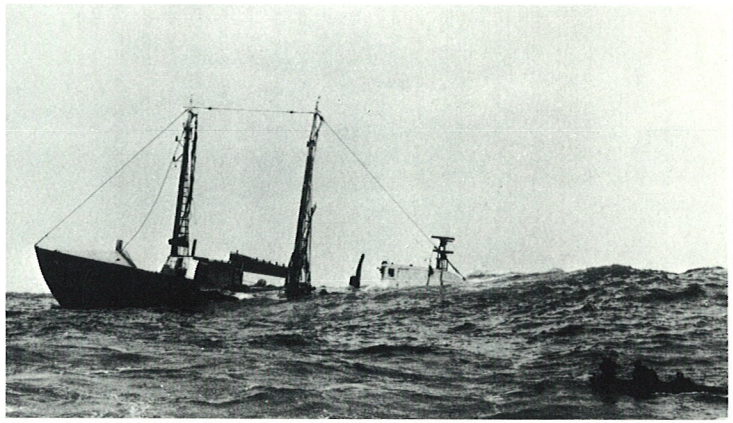
		STD	0020	1710	3471	2529	0026988	0054	15138								
		LIT	0025	1711	3472	2529			15139								

Better ways to handle marine environmental data engage managers and data specialists at the National Oceanographic Data Center, which processes massive quantities of information like ocean station printouts (above) on its batteries of high-speed computers (below).

MARINE ENVIRONMENTAL HISTORY: NOAA'S DATA BANKS

Properly archived, marine environmental data become a kind of history. At NOAA, this history is dispersed through the oceanographic, climatic, geophysical, and other data centers of the Environmental Data Service, and the archives of the National Ocean Survey.

The National Oceanographic Data Center houses the world's largest useable collection of oceanographic data, retrievable in a variety of forms. Some 40 million marine weather observations are archived in retrievable form at the National Climatic Center, Asheville, North Carolina, the repository for all weather data obtained by federal agencies and cooperating meteorological services abroad. Geomagnetic, geodetic, seismological, bathymetric and upper-atmosphere data are also handled by their respective data banks. All are available in useable, quickly retrievable forms. These data centers also administer their corresponding World Data Centers which facilitate international data exchanges.



U.S. COAST GUARD PHOTO

The good and bad of commercial fishing: a rich menhaden catch off the mid-Atlantic coast and a storm-battered fishing vessel sinking off the Grand Banks. NOAA's National Marine Fisheries Service attempts to mitigate the risks of taking a living from the sea.

NOAA AND THE LIVING RESOURCES OF THE SEA

Comprehending, assessing, other side of the Fisheries species like skipjack tuna (above, right). Much effor (right), where many impor lives, and where threats of

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U.S. COAST GUARD PHOTO

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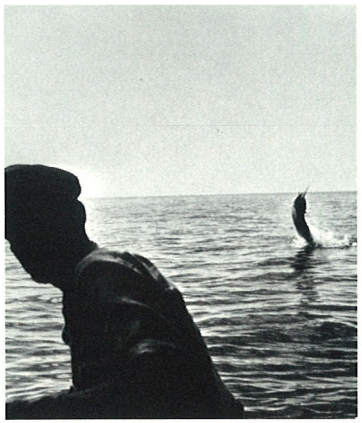
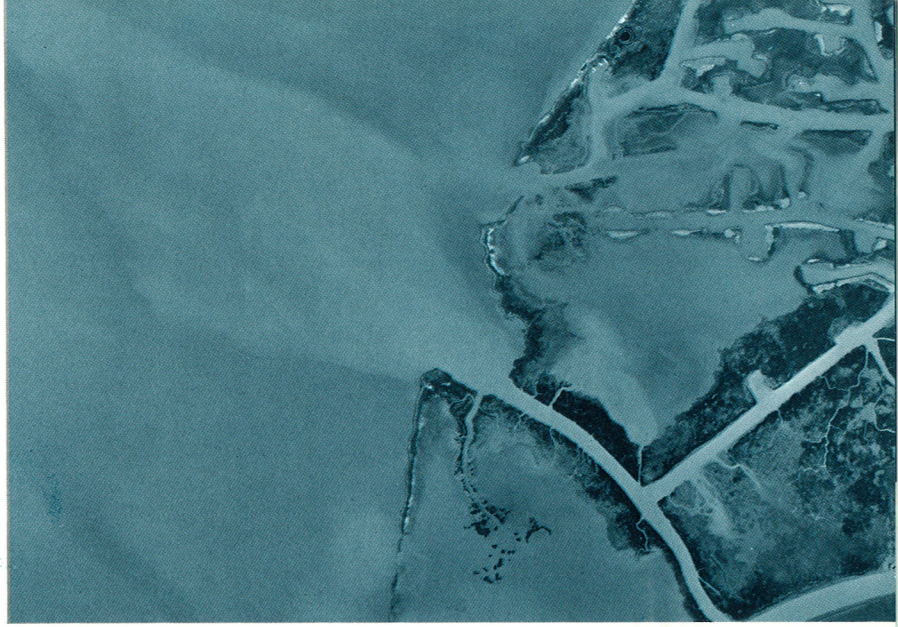


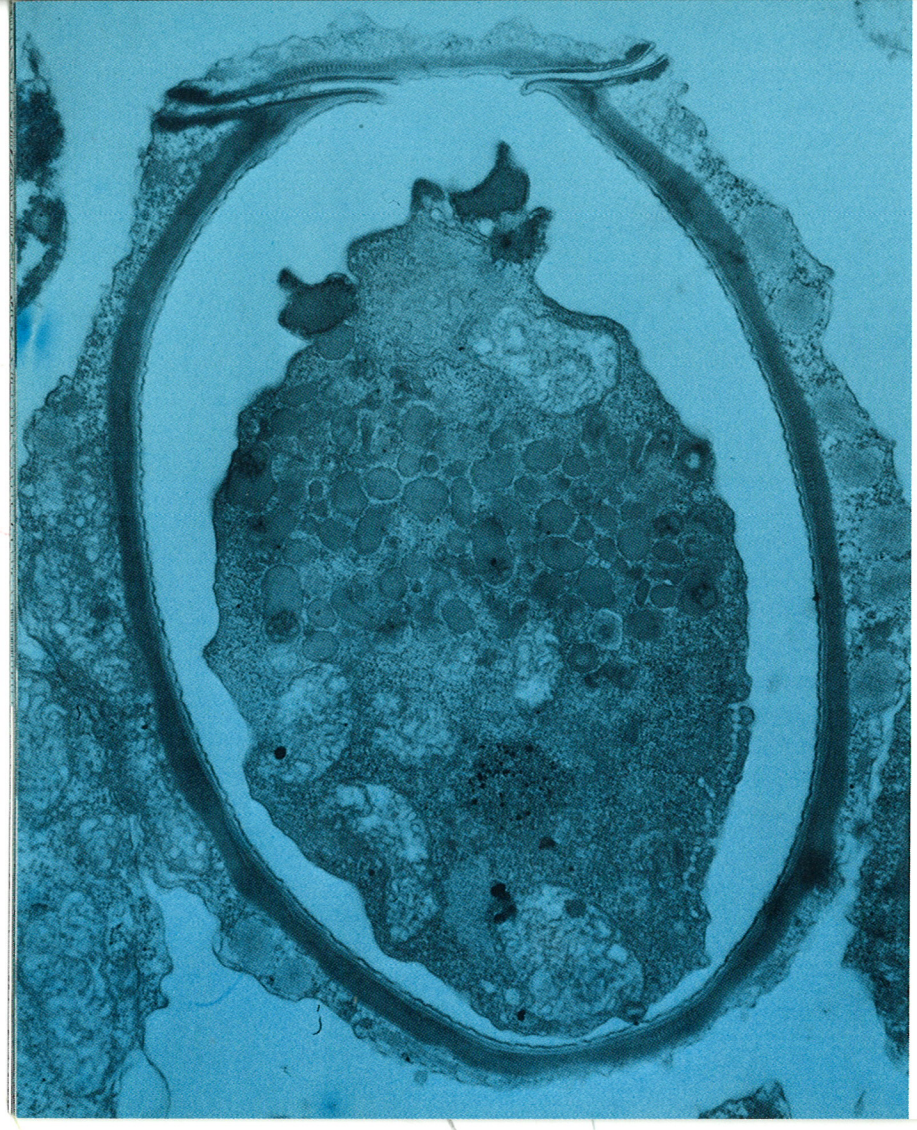


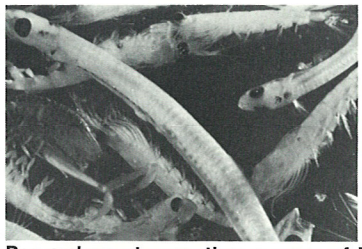
Comprehending, assessing, and managing our living marine resources is the other side of the Fisheries Service mission, both the open-ocean commercial species like skipjack tuna (above, left) and marine game fish like marlin (above, right). Much effort goes to understanding the ecology of estuaries (right), where many important marine species spend critical periods of their lives, and where threats of pollution and "development" are severe.

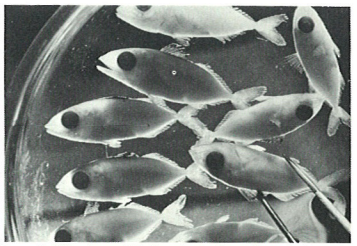
Man's efforts to take food and feed from the sea have been successful enough to make him the ocean's preeminent predator, and to make him look at oceanic life with the eye of a student, a husbandman, a conserver; we no longer believe, in the United States, that unmanaged resources can survive the men who tap them.

Those who venture seaward to fish for livelihood or for the excitement of a marlin's fight touch a fragile resource, and are touched in return—sport fishing, a major industry today, depends absolutely on the continued abundance of marine game fish, which is not certain; and commercial fishermen live with the specters of varying fish abundance, the destruction of fishing grounds by coastal pollution, the dispersal of fish species by environmental changes, formidable foreign competition, rising costs, and the harsh realities of the marketplace.

A century ago, the Federal Government first moved to confront the difficult ecological, economic, institutional, and human problems associated with America's living marine resources—her fisheries—and the men who fish them, the industries which move them, the people who buy them. Now, this federal effort resides in NOAA and its National Marine Fisheries Service, which seeks to comprehend, develop, use, and conserve the living resources of the oceans, and to foster a viable fishing industry.







Researchers at more than a score of National Marine Fisheries Service laboratories on all U.S. coasts investigate the life cycles, behavior, and population dynamics of important species. At left, electron-photomicrographed Minchinia **spore, believed to be the infective stage of a serious mid-Atlantic oyster disease; above, zooplankton from the Gulf of California (left) and tuna larvae (right) collected in Pacific resource-assessment surveys.**

COMPREHENDING OCEANIC LIFE

Following the resources they seek to comprehend, National Marine Fisheries Service researchers today work at more than a score of laboratories along United States' coasts. At these biological centers, scientists study the important marine life of the region—New England groundfish, sea scallops, marine sardines, lobsters, and the big marine game fish taken for sport off Atlantic ports; shellfish and menhaden off the mid-Atlantic; scallops, shrimp (our richest fishery), and other

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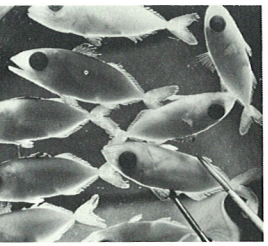

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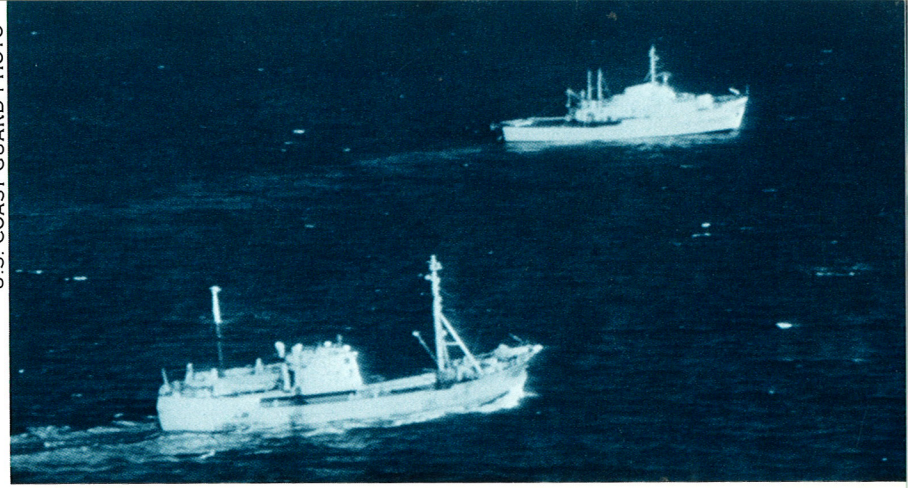
U.S. COAST GUARD PHOTO

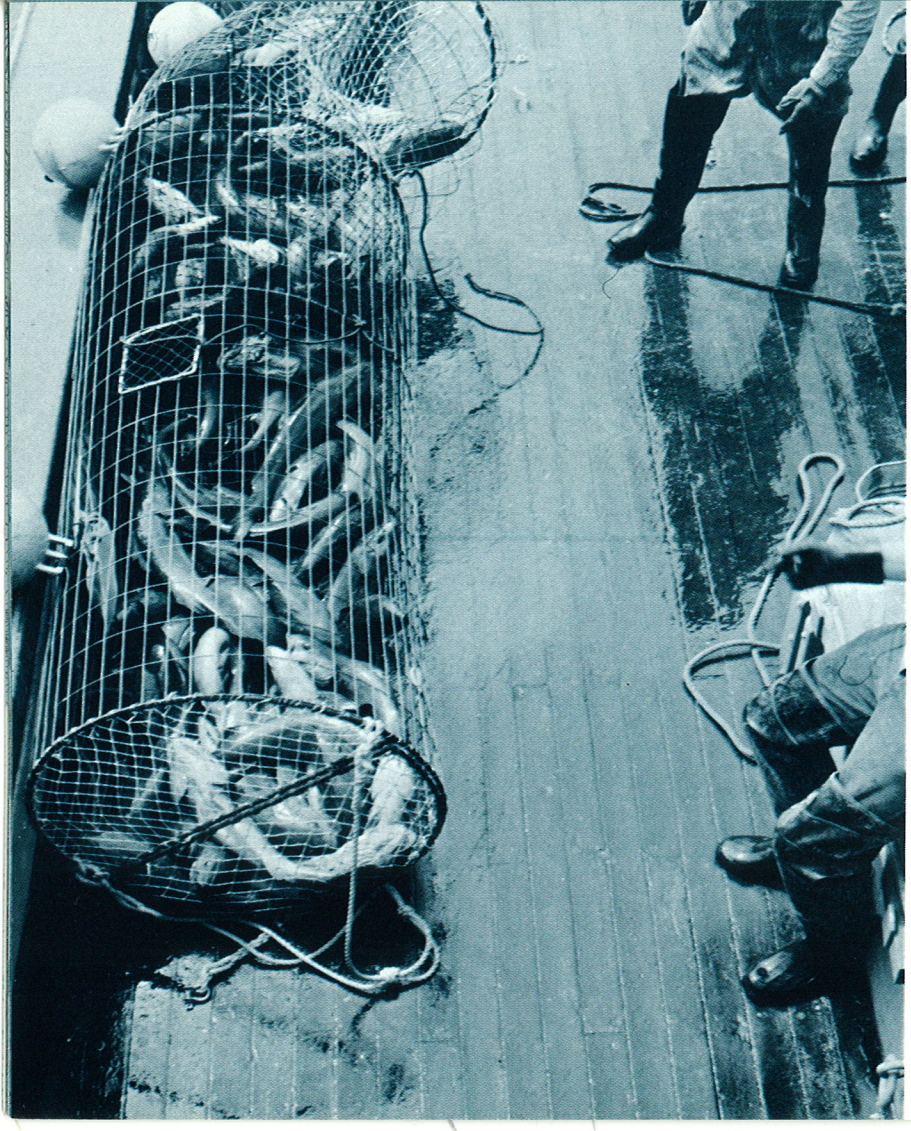


Much of the job must be done outside the laboratory, some with scientists of other nations. A scuba diver off Baja California (above, left) investigates the interior of a tuna purse seine, while scientists from the Woods Hole laboratory brave the North Atlantic winter to evaluate groundfish abundance there. At right, the Soviet research vessel Albatros **and NOAA's** Albatross IV **(background) engage in cooperative fisheries research off New England.**

shellfish, menhaden, and sports fish in the Gulf of Mexico; Pacific salmon, herring, groundfish, king crab, and shrimp from northern California to the Bering Sea, and the fur seal herds of the Pribilof Islands; big game fish from California to the equator, tuna from San Francisco to Peru.

The research is as broad as the resources it studies, and deals in certain specialties: shellfish disease and mortality; blood serology and other methods of discriminating between fish subpopulations (mingling but non-breeding stocks); investigations of estuaries, where most fish spend critical periods of their early life, and where the threat of pollution and environmental destruction is most severe; the interrelationship of ocean creatures and their physical environment; anadramous fish like the Pacific salmon, and their survival in the face of heavy pelagic fishing and structural and thermal hazards along such once-wild spawning and migration runs as the Columbia River; experimental culture of shrimp, northern anchovy, pompano, salmon, and other species; surveys, assessments, and predictions of seasonal abundance.

The National Marine Fisheries Service, with the U.S. Coast Guard, conducts surveillance and enforcement patrols, to ensure the effectiveness of negotiated controls. Much of the biological laboratories' work supports United States negotiations with other countries in managing offshore fisheries resources, and advances the cooperative work of numerous international fishery commissions in conserving internationally fished resources. But the investigations also serve the laboratories' strong parallel mission: to develop an essentially full understanding of oceanic life, its populations, and its responses to natural and man-generated changes of environment. As with other marine environmental research in NOAA, these activities are enhanced by close links with Sea Grant and other institutions and projects, and by ties between the laboratories and their regional equivalents.



The National Marine Fisheries Service helps fishermen improve their gear and working grounds. The sablefish pot at left, one of many improvements developed by the exploratory fishing and gear research base in Seattle, Washington, protects the catch from other fish, allows undersize fish to escape, and prevents the fish-on-fish damage common to trawl net fishing. Financial assistance helps fishermen buy modern fishing vessels like the one shown above.

HELP FOR A HIGH-RISK INDUSTRY

The National Fisheries Ser
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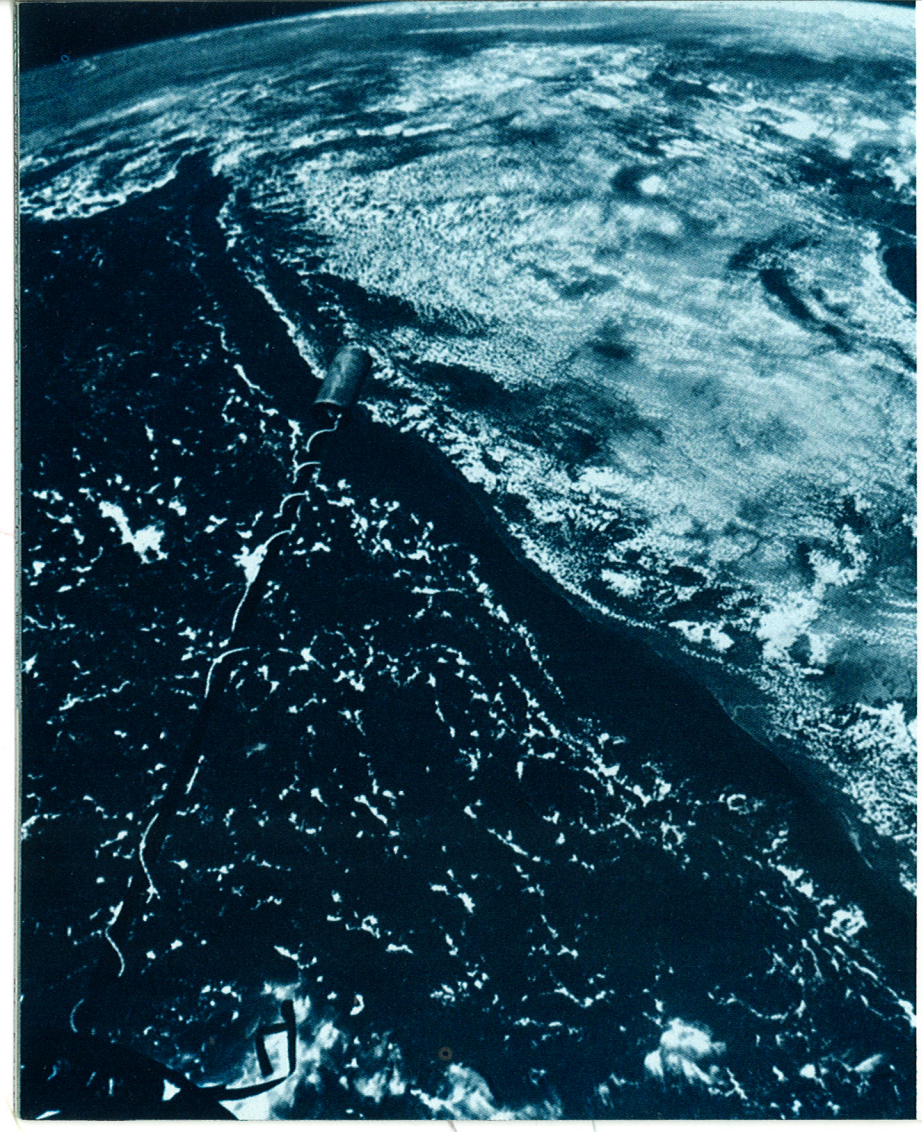
The National Fisheries Service provides statistical analyses and a nationwide market information service, based on interviews with fishermen, processors, retailers, and consumers. Both the industry and the consumer are served by agency market-development activities.

Fishing is a high-risk business even before the fish are netted and on deck. To reduce the element of chance for the fishermen and the legion of processors, distributors, buyers, sellers, and consumers who come together in the marketplace, the National Marine Fisheries Service provides a special family of services.

At exploratory fishing and gear research bases on three coasts the agency fields a strong effort to develop alternative resources, better ways to harvest existing ones, and ways to make the hazardous work of fishing safer. A financial assistance program aids commercial fishermen in obtaining capital to purchase and improve their fishing vessels.

Fishery food scientists at laboratories around the country have led the way to today's wide assortment of convenient fishery products and are working on still better ways to present the consumer with wholesome fishery products for the table. A voluntary in-plant inspection program, paid for by the fishing industry, provides continuous inspection and grading of fishery products. Attention is directed now to protecting the consumer against the recently detected hazards of heavy metals and pesticide contamination of some fish products.

Economists and marketing experts reduce the levels of risk to the industry by recording and forecasting market conditions. The National Marine Fisheries Service also helps the entire industry and ultimately the consumer through the dissemination of information on the nutritional and health values of fishery products, through programs to relieve supply-demand imbalances, through the development of markets for underutilized species, and through other consumer oriented activities.



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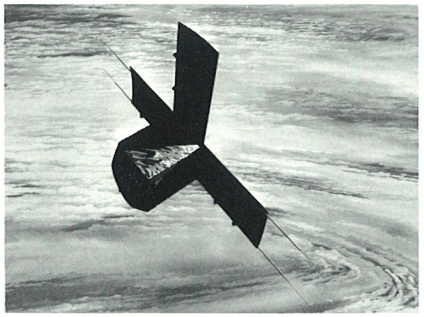
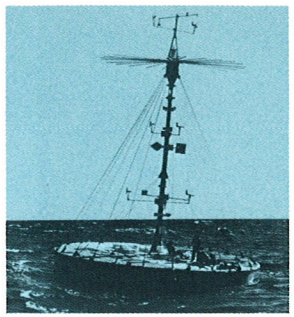
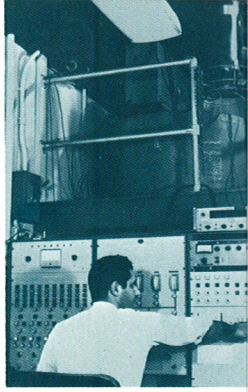




The marine environmental promise of earth photographs from manned satellites is apparent in the photo of the Indian peninsula at left, in which the trained eyes of NOAA oceanographers detect areas of upwelling, warm and cool currents, and various coastal processes. Satellites in the NOAA series (above, left) already support products useful to oceanographers and fisheries scientists, and NOAA's developing data buoy (above, right) will provide essentially continuous marine environmental observations.

ADVANCING NEW TECHNOLOGIES

The marine environmental and marine biological activities of NOAA are expanding our comprehension of the physical world and the oceanic creatures with whom we share it. These activities also impel a broad range of new technologies, many of them at or beyond their nominal state of the art.



NOAA's National Oceanog evaluating marine environ at sea. Fisheries enginee detecting fish and obser (above, right). Submersibl as direct-observation platf

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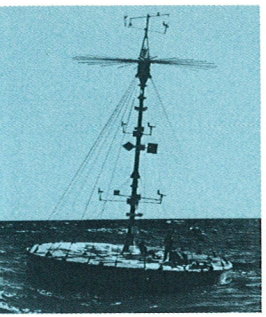

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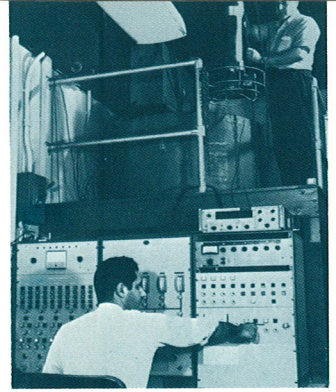
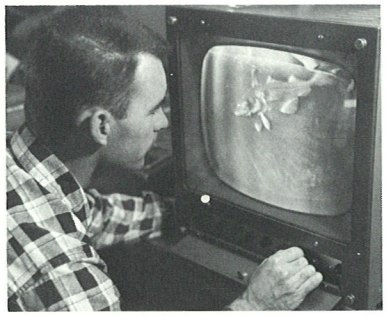
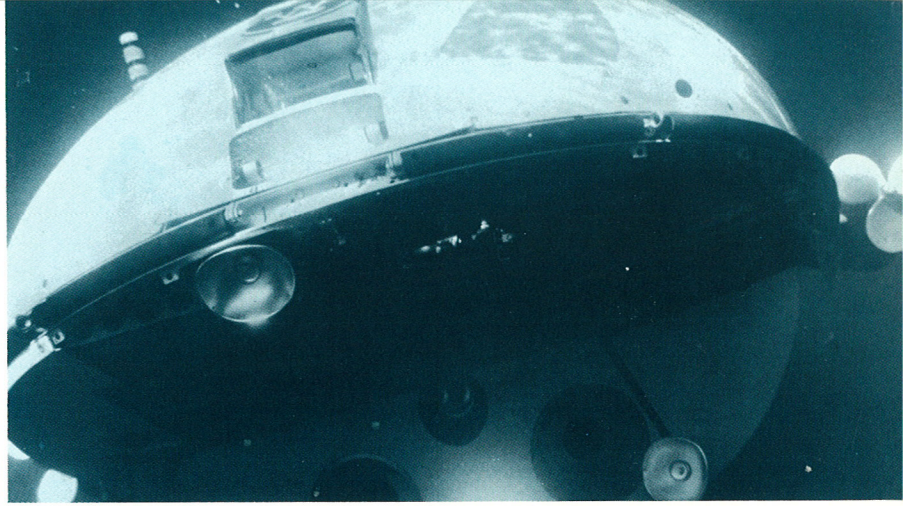






NOAA's National Oceanographic Instrumentation Center provides a focus for evaluating marine environmental sensors, in the laboratory (above, left) and at sea. Fisheries engineers are developing remote sensing techniques for detecting fish and observing them, for example, by underwater television (above, right). Submersibles like Deepstar **(right) will be used in the future as direct-observation platforms by NOAA's marine scientists.**

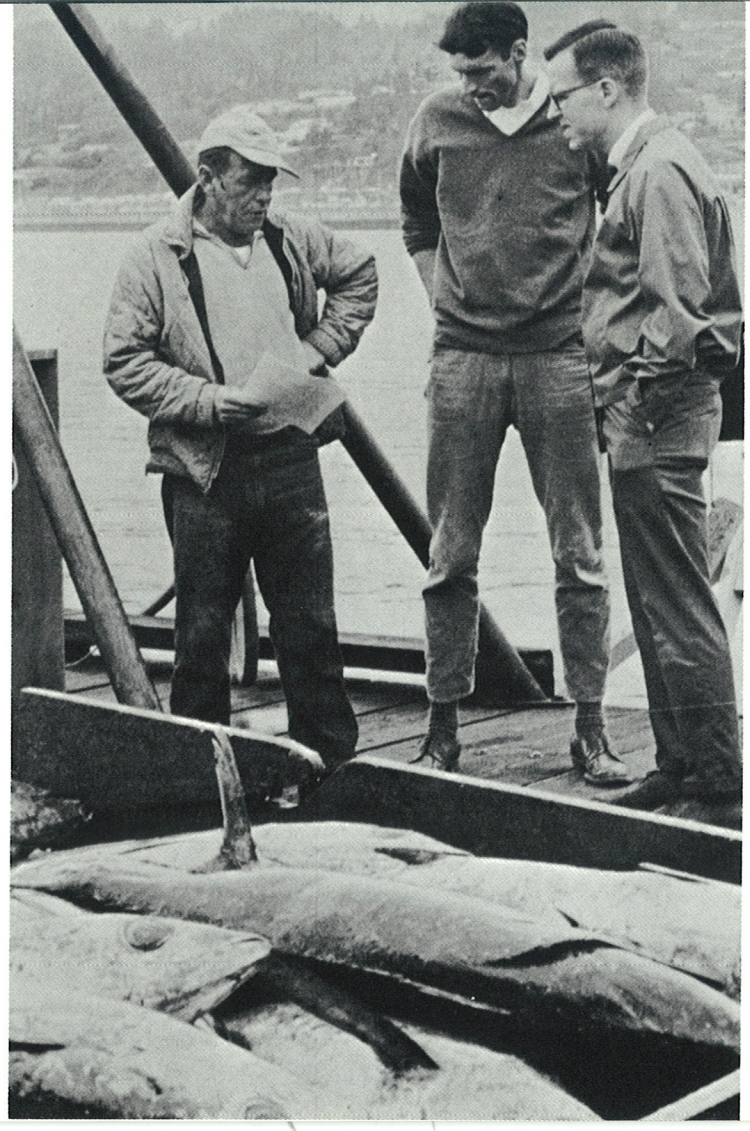
Computer technology, especially computer modeling of environmental and marine biological events, is driving research in industry and elsewhere toward new generations of bigger, faster, "brighter" machines to collect and move the mountain of marine environmental data.

Earth-orbiting satellites with new sensors are producing data for new products routinely—for example, sea surface temperature maps—and satellites will eventually include remote sensors to monitor both the marine environment and its near-surface life. Oceanographic analyses of Gemini and Apollo photographs interpreted by NOAA scientists showed rich details of oceanic circulation and upwelling, estuarine mixing, thermal contrasts, and other features that real-time marine environmental and resources monitoring systems will require.

As new instruments come along, scientists at NOAA's National Oceanographic Instrumentation Center test and evaluate them in a wide variety of laboratory simulators and in the marine environment itself. This Commerce Department service provides information for science, industry, and the interested public on the reliability of marine environmental sensors and samplers, and helps develop standards.

NOAA's Data Buoy Center is developing a prototype system of automatic ocean buoys for obtaining essentially continuous marine environmental data. Ultimately, arrays of these buoys will provide real time data on the ocean, its overlying atmosphere, and its living resources.

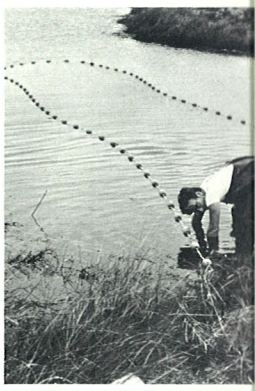
There is no substitute for first-hand observation by scientists in scuba gear, deep-diving submersibles, underwater habitats, and environmental monitoring ranges. Man-in-the-sea technology is a central feature in NOAA's long range research plans, to add the essential human "sensor" to the work of describing the oceans.



Sea Grant aid has permitted selected institutions to develop into centers of strength in the marine sciences, and to provide valuable service programs. At left, Oregon State University Sea Grant students talk to a local tuna fisherman, and, above, broadcast their "Albacore Central" data to help tuna clippers.

SEA GRANT: NEW STRENGTH IN THE MARINE SCIENCES

The Sea Grant Program, formerly administered by the National Science Foundation and now administered by NOAA's Office of Sea Grant, provides a broad and flexible means by which federal support can be used to stimulate development, conservation, and use of the marine environment



At other institutions, Sea
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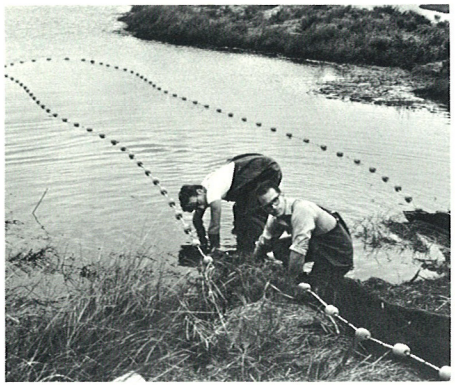
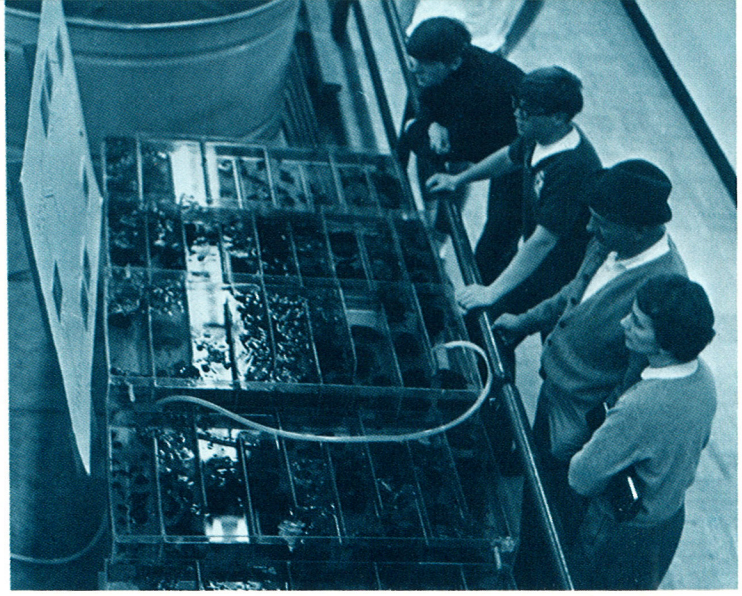




At other institutions, Sea Grant has emphasized such things as mariculture, like this now-commercial Gulf shrimp culture experiment (above, left), development of new instruments like Texas A&M's electrical logging sediment probe (above, right), and resource-improving projects like the oyster-rearing operations at Oregon State (right).

and its resources, and to advance related physical and social sciences.

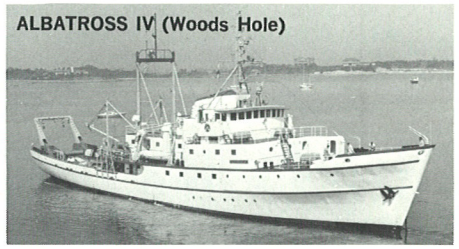
Sea Grant institutional support is focused on certain major universities, among them Hawaii, Miami, Michigan, North Carolina, Oregon State, Rhode Island, Texas A&M, Washington, Wisconsin, Southern California, California/Scripps Institution of Oceanography. A more than incidental return here is the strong liaison which develops between State and local governments and the marine scientific centers of strength represented by Sea Grant institutions.

Sea Grant project support aids individual projects, mainly at colleges and universities, in marine resource development, and sponsors both undergraduate and postgraduate education of engineers and the training of about 400 technicians at the two-year college level. Several universities receiving Sea Grant support have established marine extension services.

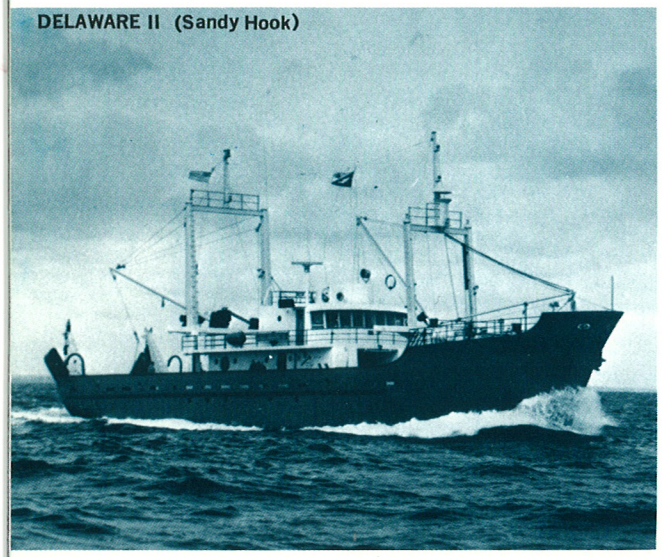
There have been many early successes in the Sea Grant program, including commercial harvests of pond-grown shrimp in Texas, a systems analysis of the North Pacific fisheries in Washington, mineral harvests from the Great Lakes, studies of marine law in Maine, "Albacore Central" environmental reporting in Oregon, artificial upwelling in the Virgin Islands, studies of new drugs and pharmaceuticals in sponges and seaweeds by investigators at several colleges and universities and a search for solutions to the jurisdictional problems of the marine environment and its resources. Sea Grant has begun to answer the question of where the marine scientific talent we need in America will come from.

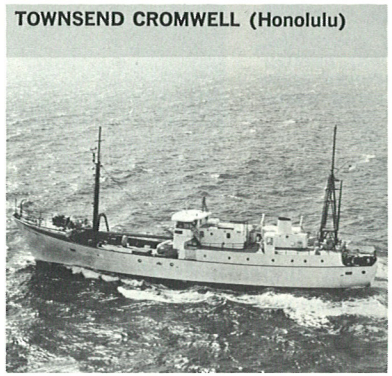

RESEARCHER (Miami)

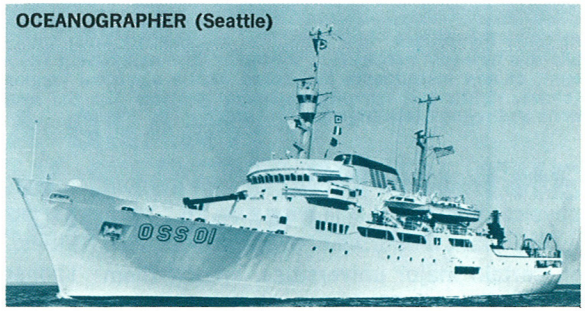

OREGON II (Pascagoula)


ALBATROSS IV (Woods Hole)

SOME SHIPS OF NOAA'S RESEARCH AND SURVEY FLEET


DELAWARE II (Sandy Hook)


TOWNSEND CROMWELL (Honolulu)


OCEANOGRAPHER (Seattle)

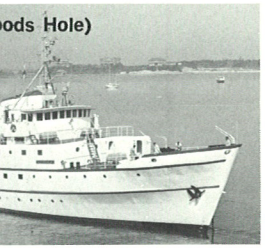

DAVID STARR JORDAN (La Jolla)


LAIDLY (Detroit)


DISCOVERER (Miami)


Nine ships of NOAA's fleet
Seattle are the Oceanograp
Arthur, Fairweather, Rainie

SEATTLE TIMES PHOTO



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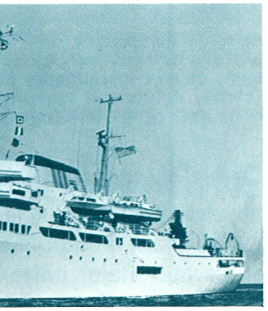

LAIDLY (Detroit)

Nine ships of NOAA's fleet gathered at the Pacific Marine Center in Seattle are the Oceanographer, Pathfinder, Surveyor, Davidson, McArthur, Fairweather, Rainier, Miller Freeman, **and** Kelez.

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